

वार्षिक प्रतिवेदन ANNUAL REPORT 2024



भा.कृ.अनु.प - अखिल भारतीय समन्वित मसाला अनुसंधान परियोजना
ICAR-ALL INDIA COORDINATED RESEARCH
PROJECT ON SPICES

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Karan Dhanya-1



CAZRI Cumin 1



Gujarat Fennel-13



RMt-259



Jodhpur Jeera 1



SAS-KEVU



IISR Surya

About welcome page

IISR-Surya is a high-yielding, light-coloured turmeric variety developed through clonal selection at ICAR-Indian Institute of Spices Research, Kozhikode. Tailored to meet the specific requirements of the masala and powdering industry, this variety exhibits a yield advantage of 20–30% over local light-coloured turmeric types, with a maximum yield potential of up to 41 t/ha under ideal conditions. The curcumin content of IISR-Surya ranges from 2% to 3%, aligning with standards required for processing and value addition. The variety has been officially notified in 2025 for cultivation in the states of Kerala, Telangana, Odisha, Jharkhand, and Arunachal Pradesh, offering a reliable option for turmeric farmers seeking enhanced productivity and market acceptability.

ICAR-ALL INDIA COORDINATED RESEARCH PROJECT ON SPICES (ICAR-AICRPS)



Annual Report 2024



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About cover page

"Boldest from East"- SAS KEVU.

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Black Pepper

Genetic Resources

PEP/CI/1.1: Germplasm collection, characterization, evaluation and conservation

(Centres: Ambalavayal, Dapoli, Panniyur, Pundibari, Sirsi, Yercaud)

A total of 476 black pepper germplasm accessions, including 416 indigenous, 3 exotic, and 57 wild relatives, are being conserved across six AICRPS centres, strengthening genetic resource conservation efforts. The details of germplasm collections of black pepper maintained at various AICRPS centres are presented in Table 1.

Table 1. Black pepper germplasm collections maintained at various AICRPS centres

Centre	Indigenous		Exotic	Total
	Cultivated	Wild & related species		
Ambalavayal	20	-	-	20
Dapoli	29	-	-	29
Panniyur	263	57	3	323
Pundibari	22	-	-	22
Sirsi	54	-	-	54
Yercaud	28	-	-	28
Total	416	57	3	476

At present, a total of 323 accessions (263 cultivated types, 57 wild & related types and 3 exotic types) of black pepper are being maintained at PRS, Panniyur. Ten new accessions were collected during 2023-24 from farmers' fields and planted in the nursery for multiplication. During 2024-25, the genotypes PRS 14 and PRS 62 were the top yielders. PRS 14 ranked first with 13.4 kg green berry yield and 4470 spikes vine⁻¹ followed by PRS 62 with 12.5 kg green berry yield and 806 spikes vine⁻¹. Spike length was maximum for PRS 124 (17.05 cm) followed by PRS 62 (13.17 cm). The number of developed berries/ spikes was more for PRS 124 (85.20) followed by PRS 116 (68.40). The 100-berry weight was high for PRS 17 (22 g) followed by PRS 158 (12.07). The dry recovery % was more for PRS 62 (35.26 %) followed by PRS 158 (35.07 %) and PRS 124 (34.24 %).

Among the 34 different black pepper germplasms under field evaluation at Sirsi, significant differences were observed in plant height and number of leaves. P1 (Check) recorded the highest mean height (1.95 m), followed by SV-1 (1.93 m), and the lowest height (0.46 m) was observed in Bilimalligesara. Regarding the number of leaves, P1 (Check) had the maximum number (55), followed by SV-17 (34) and Sigandini (28), while the lowest number of leaves (11) was recorded in BPL Gold.

A total of twenty accessions are maintained in the germplasms block at Ambalavayal. The accessions include Girimunda, Thevam, Sreekara, Subhakara, Vijay, Sakthi, Panchami, Pournami, Palode 2, Malabar Excel, Panniyur 1, Panniyur 2, Panniyur 3, Panniyur 4,

Panniyur 5, Panniyur 6, Panniyur 7, Panniyur 8, Thekkan and Cul 5308. At Pundibari, 22 black pepper accessions including released varieties and genotypes collected from Sub-Himalayan Terai region adjoining Bhutan boarder (including Totopara) are being maintained.

The germplasm collection (29) from various locations in the Konkan region is maintained at the College of Horticulture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli. Plant height ranged from 3.1 to 7.6 m. The highest vine height (7.6 m) was observed in DBSKKVPN-28, while the shortest (3.1 m) was in DBSKKVPN-15. DBSKKVPN-19 had the most spikes per vine (158), and DBSKKVPN-17 had the fewest (28). The highest dry berry yield (1.2 kg vine^{-1}) was recorded in DBSKKVPN-19, and the lowest ($0.18 \text{ kg vine}^{-1}$) in DBSKKVPN-23.

In 2024, berry set was observed in 28 accessions at Yercaud. Spike length ranged from 10.13 cm to 13.63 cm. The longest spike was observed in PN 58 (13.63 cm), followed by PN 32 (12.97 cm), while the shortest spike length was observed in PN 84 (10.13 cm). The mean number of berries per spike ranged from 50 to 72.67. The highest mean number of berries per spike was recorded in PN 11 (72.67), followed by PN 33 (72.33), and the lowest mean number of berries per spike was recorded in PN 51 (50.00).

Crop Improvement

PEP/CI/3 Coordinated Varietal Trial (CVT)

PEP/CI/3.5: CVT 2018 on Black pepper Series IX

(Centres: Ambalavayal, Chintapalle, Sirsi, Panniyur, Kozhikode, Dapoli, Yercaud)

Coordinated Varietal Trial (CVT) on black pepper 2018 Series IX, conducted under RBD with 11 genotypes viz., HP 780, HP 1411, OPKM, HP 117 X Thommankodi, IISR Thevam, Kumpukkal, Ponmani, PRS 137, SV 7, Kurimalai along with Panniyur-1 (check) across seven locations, out of which the trial come to bearing during 2024-25 at Panniyur, Kozhikode, Yercaud, and Dapoli, assessed genotypes for green berry yield, dry berry yield, and dry recovery percentage. Among the tested entries, Panniyur 1 (National check) consistently ranked first in terms of mean green berry yield ($0.90 \text{ kg vine}^{-1}$) and dry berry yield ($0.305 \text{ kg vine}^{-1}$) across locations, demonstrating its superior productivity. The second-highest performer was IISR Thevam, which recorded a mean green berry yield of 0.8825 kg and dry berry yield of 0.30 kg, followed closely by HP 1411 and Kurimalai. However, when considering dry recovery percentage, OPKM emerged as the top performer with the highest mean dry recovery of 34.88%, followed by Kumbakkal (34.34%), IISR Thevam (34.29%), and SV 7 (34.18%).

Table 2. Performance of black pepper entries under CVT – 2018 Series IX during bearing year 2024–25 assessed for green berry yield, dry berry yield, and dry recovery percentage.

Genotypes	Green berry yield (kg)						Dry berry yield (kg)						Dry Recovery%					
	PAN	KOZ	YCD	DAP	Mean	Rank	PAN	KOZ	YCD	DAP	Mean	Rank	PAN	KOZ	YCD	DAP	Mean	Rank
HP 780	-	0.48	0.99	0.61	0.69	6	-	0.17	0.31	0.21	0.23	5	-	34.6	31.2	34.3	33.37	8
HP 1411	0.52	0.47	1.68	0.48	0.79	3	0.18	0.15	0.56	0.16	0.26	3	35.3	31.2	33.1	32.9	33.14	9
OPKM	0.2	0.52	1.19	0.64	0.64	7	0.07	0.18	0.42	0.22	0.22	6	34.9	34.4	35.6	34.7	34.88	1
HP1117 x Thommankodi	-	0.57	1.11	0.43	0.7	5	-	0.2	0.39	0.14	0.24	4	-	34.4	34.7	32	33.7	7
Kumbakkal	0.47	0.42	0.96	0.51	0.59	9	0.17	0.14	0.33	0.17	0.2	8	35.7	34.2	34.2	33.3	34.34	2
Ponmani	-	0.42	0.81	0.53	0.59	9	-	0.14	0.27	0.19	0.2	8	-	34.4	32.6	35.2	34.06	5
PRS137	-	0.34	1.22	0.33	0.63	8	-	0.11	0.35	0.1	0.19	10	-	34.2	28.4	29.6	30.73	11
SV 7	0.52	0.08	1	0.46	0.52	11	0.18	0.03	0.36	0.15	0.18	11	34.6	33.9	35.8	32.5	34.18	4
Kurimalai	0.53	0.31	1.69	0.46	0.75	4	0.18	0.1	0.45	0.15	0.22	6	33.9	33.8	26.4	32.6	31.66	10
IISR Thevam	1.54	0.46	1.14	0.39	0.88	2	0.53	0.13	0.41	0.13	0.3	2	34.6	34.1	35.7	32.7	34.29	3
Panniyur 1	1.38	0.54	1.15	0.53	0.9	1	0.49	0.18	0.35	0.2	0.31	1	35.2	32.7	30.7	37	33.91	6
CD (P<0.05)	0.13	0.19	0.06	0.13			0.03	0.06	0.02	0.09			1.23	1.62	1.1	3.8		
CV (%)	25.6	26.9	2.85	8.42			26.1	23.6	2.99	10.3			5.3	2.81	1.96	5.97		

Where: PAN: Panniyur; KOZ: Kozhikode; YCD: Yercaud; DAP: Dapoli

Crop Protection

PEP/CP/5.10: Observational trial on efficacy of *Trichoderma asperellum* and *Pochonia* for the management of *Phytophthora* foot rot and nematodes in black pepper (Centres: Appangala, Sirsi, Panniyur)

The field trials were initiated in 2021 for the duration 2021-24 (three years) at three locations: Appangala, Sirsi, and Panniyur. At Appangala field trials conducted at ICAR-IIHR, CHES, Chettalli using the black pepper variety *Panchami*. Pooled data analysis revealed that, under control conditions, disease incidence varied between 20.31% and 32.84%, with the highest incidence recorded at Sirsi, followed by Panniyur. Among the different treatments, the most significant reduction in disease occurrence was observed in T₄ (drenching with Metalaxyl-Mancozeb @ 0.125%) at Panniyur and Sirsi. In contrast, at Appangala, T₃ (drenching *Trichoderma asperellum* biocapsule) exhibited the highest effectiveness in reducing disease severity. Additionally, at the Sirsi location, T₃ was identified as the alternative treatment for disease management. These findings highlight the potential of chemical and biological interventions in managing the disease across different locations, with varying effectiveness depending on environmental and site-specific factors.

Table 3. Pooled analysis showing the effect of treatments on foot rot incidence (Disease Severity Index, DSI%) and dry berry yield (kg/vine) in black pepper during 2021–24

Treatments	Disease Severity Index (DSI%)				Dry Berry Yield (kg/vine)			
	PAN	SIR	APG	Mean	PAN	SIR	APG	Mean
T1 : Control	22.29 (4.72) ^a	32.84 (34.96) ^a	20.31 (4.51) ^a	25.15 (-4.99)	0.52 ^c	0.44 ^c	0.50 ^c	0.49
T2 : Soil application of Trichoderma asperellum + neem cake	13.11 (3.62) ^b	19.35 (26.10) ^c	17.81 (4.22) ^b	16.76 (-4.08)	0.68 ^{ab}	0.65 ^a	1.10 ^a	0.81
T3 : Drenching with T. asperellum (biocapsule formulation)	13.03 (3.61) ^b	23.08 (28.71) ^{bc}	14.06 (3.75) ^c	16.72 (-4.05)	0.72 ^{ab}	0.58 ^{ab}	1.06 ^{ab}	0.79
T4 : Drenching with Metalaxyl + Mancozeb @ 0.125%	7.47 (2.73) ^c	18.55 (25.51) ^c	16.40 (4.05) ^b	14.14 (-3.70)	0.78 ^a	0.63 ^{ab}	0.61 ^{bc}	0.67
T5 : Soil solarization + T. asperellum + neem cake	13.17 (3.63) ^b	25.79 (30.52) ^b	17.18 (4.14) ^b	18.71 (-4.28)	0.56 ^{bc}	0.57 ^b	0.82 ^b	0.65
T6 : Soil application of T. asperellum (biocapsule) + PGPR mix	7.55 (2.75) ^c	27.88 (31.87) ^{ab}	17.21 (4.15) ^b	17.55 (-4.06)	0.71 ^{ab}	0.56 ^b	0.93 ^{ab}	0.73
CV (%)	19	8.68	5	35	18	6.92	20.13	26
CD (P=0.05)	0.23	3.66	0.21	NS	0.15	0.07	0.25	NS

Where: APG: Appangala; SIR: Sirsi; PAN: Panniyur

Note: Values in parentheses indicate transformed values (square root transformation of percent data); values with different letters within a column differ significantly at $P \leq 0.05$ based on CD.

PEP/CP/7.1: Evaluation of effective insecticides against pollu beetle, *Lanka ramakrishnai* infesting black pepper
(Centres: Appangala, Panniyur)

The field trials commenced in 2021 and were designed to span a period of three years (2021–24) across two locations: Appangala and Panniyur. As the study approaches its final year, a comprehensive pooled data analysis from different centres has been conducted.

The analysis revealed that, under control conditions, the incidence of pest infestation ranged from 13.05% to 15.01%, with the highest incidence observed at the Appangala. At the Panniyur centre, the most effective treatment was T₂ (Chlorantraniliprole at 0.5 ml/L), which resulted in the lowest recorded percentage of crop damage at 0.76%. Additionally, the highest yield was obtained from plots treated with T₁ and T₂. In contrast, at the Appangala centre, the most effective treatment was T₄ (Flubendiamide @ 0.5 ml/L), which achieved a pest damage rate of 3.61%. These findings provide valuable insights into the efficacy of different pest management treatments under varying environmental conditions.

Table 4. Pooled analysis of the efficacy of insecticidal treatments against Pollu beetle (*Lanka ramakrishnai*) infestation in black pepper across Panniyur and Appangala centres during 2021–24

Treatment	Percentage of damage by Pollu beetle (Pooled data)		
	Panniyur	Appangala	Pooled value
T ₁ -Chlorantraniliprole @ 0.3 ml L ⁻¹	0.94 (0.95) ^c	5.75 (2.39) ^{bc}	2.86 (1.52) ^b
T ₂ -Chlorantraniliprole @ 0.5 ml L ⁻¹	0.76 (0.85) ^c	4.11 (2.02) ^c	2.10 (1.32) ^b
T ₃ -Flubendiamide @ 0.3 ml L ⁻¹	1.82 (1.33) ^{bc}	4.78 (2.18) ^{bc}	3.00 (1.67) ^b
T ₄ -Flubendiamide @ 0.5 ml L ⁻¹	1.59 (1.23) ^{bc}	3.61 (1.89) ^c	2.40 (1.50) ^b
T ₅ -Spinetoram @ 0.3 ml L ⁻¹	2.80 (1.67) ^b	5.08 (2.25) ^{bc}	3.71 (1.90) ^b
T ₆ -Spinetoram @ 0.5 ml L ⁻¹	1.02 (0.98) ^c	4.06 (2.01) ^c	2.23 (1.39) ^b
T ₇ -Quinalphos @ 2 ml L ⁻¹	1.25 (1.07) ^c	7.12 (2.66) ^b	3.60 (1.71) ^b
T ₈ -Control (water spray)	13.05 (3.59) ^a	15.01 (3.87) ^a	13.83 (3.70) ^a
CD (P=0.05)	0.48	0.59	0.47
CV	1.51	0.48	0.74

Note: Values in parentheses indicate transformed values (square root transformation of percent data); values with different letters within a column differ significantly at $P \leq 0.05$ based on CD.

Cardamom

CAR/CI/1.1: Germplasm collection, characterization, evaluation and conservation

(Centres: Mudigere, Pampadumpara)

A total of 284 cardamom accessions are presently conserved at AICRPS centres viz., Pampadumpara and Mudigere jointly. The details of germplasm collections of cardamom maintained at two AICRPS centres are presented in Table 5.

Table 5. Details of cardamom germplasm maintained by two AICRPS centres

AICRPS Centre	Cultivated	Wild and related species	Total
Mudigere	90	Nil	90
Pampadumpara	190	4	194
Total	280	4	284

A total of 190 cardamom accessions are presently conserved in the gene bank of Pampadumpara and 90 accessions at Mudigere. Among the 90 germplasm accessions evaluated at Mudigere, the maximum plant height was observed in M-2 (372.84 cm), followed by MCC-309 (362.00 cm), PDP-1 (368.73 cm), M-3 (352.45 cm), and M-1 (341.74 cm). The maximum number of tillers per clump was recorded in 12-7-D11 (45), followed by 26-16-D11 (41), CCS-800 (30), and M-1 (30). SKP-170 was found to be the best for panicles per clump (35.46) and yield per plant (470.50 g plant⁻¹). At Pampadumpara, 109 cardamom accessions received IC numbers from the NBPGR, New Delhi and 130 cardamom plants showed uniform bearing and observations were taken accordingly.

At the Pampadumpara centre, four unique accessions of small cardamom were collected during 2024–25 from the farmer's field of Mr. Satheesan and are currently under farm trial evaluation. The accessions include Deksha (Acc. 7), Aroma (Acc. 8), Royal Green Cardamom (Acc. 12), and Natural Greengold (Acc. 13). All the accessions belong to the Malabar-type group and are characterized by their comparatively short stature when assessed against other varieties.



Figure 2. Unique cardamom accessions collected by AICRPS Pamapdumpara during 2024–25.

Crop Improvement

CAR/CI/3 Coordinated Varietal Trial (CVT)

CAR/CI/3.9: CVT 2018 on hybrids of cardamom-Series IX

(Centres: Appangala, Mudigere, Myladumpara, Pampadumpara, Sakaleshpura)

Coordinated Varietal Trial (CVT) on hybrids of cardamom IX, conducted under RBD with 10 genotypes across five locations, out of which the trial come to bearing during 2024-25 at Appangala, Myladumpara, Pampadumpara, and Sakaleshpura, assessed genotypes for dry capsule yield. Among the ten cardamom hybrids tested, MHC-2 recorded the highest mean dry capsule yield (757.7 kg/ha), primarily due to its exceptional performance at Pampadumpara (2202.7 kg/ha), indicating its strong location-specific adaptability and potential for commercial cultivation in that region. The hybrid Bold × IC 547219 followed with a mean yield of 614.2 kg/ha and demonstrated consistent performance across all four centres, particularly excelling at Pampadumpara (1417.2 kg/ha), suggesting its wider adaptability than the check variety Njallani Green Gold (255.5 kg/ha).

Table 6. Performance of hybrid cardamom entries for dry capsule yield (kg/ha) under Coordinated Varietal Trial during 2024–25 across four centres

Entries	Dry Capsule Yield (Kg/ha)				
	APG	SAK	MYL	PAMP	Mean
Bold × IC 547219	517.7	99.5	422.2	1417.2	614.2
(GG×Bold) × Appangala 1	285.1	119.8	396.9	282.0	270.9
(GG×NKE 19) × Bold	96.5	108.4	349.5	693.5	312.0
MHC - 1	57.9	131.9	494.8	643.7	332.0
MHC - 2	248.2	117.6	462.3	2202.7	757.7
SHC-1	92.0	137.1	417.2	214.0	215.1
SHC-2	277.2	153.3	376.4	206.0	253.2
PH-13	185.1	100.1	388.3	731.0	351.1
PH-14	198.5	83.3	399.9	359.3	260.3
Njallani Green Gold (check)	176.6	105.7	485.9	253.7	255.5
CV	24.3	18.89	1.47	10.2	
CD @ 5%	25.36	45.24	10.59	122.0	

Where:

APG: Appangala; SAK: Sakleshpur; MYL: Myladumpara; PAMP: Pampadumpara. Njallani Green Gold was used as the check variety. CD: Critical Difference at 5% level of significance; CV: Coefficient of Variation.

CAR/CI/4.4: Multi-location evaluation of thrips tolerant cardamom lines

(Centres: Appangala, Mudigere, Myladumpara, Pampadumpara, Sakaleshpura)

The experiment on multi locational evaluation of thrips tolerant lines in cardamom was initiated during 2017 to screen the promising small cardamom line against cardamom thrips. Trial was undertaken at five centres, with 6 genotypes (IC 349362, IC 349364, IC 349370, IC 349606, Njallani Green Gold and ICRI 8) in 3 replications. Observations on thrips population and thrips damaged capsule (%) were recorded at monthly intervals along with other growth parameters. At Appangala, thrips incidence was recorded on six cardamom accessions. Among them, IC 349370 exhibited the lowest incidence (0.56 thrips/leaf sheath), while the national check Njallani Green Gold recorded the highest incidence (2.57 thrips/leaf sheath), indicating significant variation in susceptibility. At Pampadumpara, evaluation of cardamom accessions for thrips damage revealed that IC 349362 and IC 349606 recorded no visible damage (0.00%),

while the highest damage was observed in the national check Njallani Green Gold (15.67%), followed by IC 349370 (8.67%). Accessions IC 349364 and ICRI 5 showed moderate damage levels of 3.67% and 6.00%, respectively. At Sakleshpura, the mean percentage of thrips-damaged capsules was highest in the control (Njallani) at 50.9%, followed by IC 349362 (43.7%) and ICRI 8 (40.4%). Among the accessions, IC 349364 recorded the lowest mean damage at 33.8%, indicating its potential tolerance to thrips infestation, while IC 349606 and IC 349370 also showed relatively lower mean damages of 37.1% and 39.2%, respectively. At Myladumpara, the lowest thrips incidence was recorded in the accession IC 349370 with only 0.08 thrips per leaf sheath, indicating high resistance. In contrast, the national check Njallani Green Gold exhibited the highest thrips incidence at 2.80 thrips per sheath, while the local check ICRI 5 recorded 0.94, suggesting that the evaluated accessions, particularly IC 349370, performed significantly better in resisting thrips infestation.

CAR/CI/4.4: MLT of leaf blight tolerant lines of small cardamom 2018

(Centres: Appangala, Mudigere, Pampadumpara, Myladumpara, Sakleshpur)

In order to screen out the leaf blight tolerant small cardamom genotypes, multilocal trial of leaf blight tolerant lines of small cardamom initiated during 2018-19. The trial was laid in RBD design with three replications of 6 test entries viz., IC-349650, IC-547222, IC-547223, IC-547156, IC-349649 and IC-349648 along with a susceptible check (IISR Vijetha) and two resistant checks (Appangala 1 & Njallani Green Gold).

Table 7. Pooled performance of leaf blight tolerant cardamom lines evaluated across locations under multilocal trial during 2024-25

Entry	Leaf blight (PDI)					Dry Capsule Yield (Kg/ha)				
	APG	MYL	PAMP	SAK	Mean	APG	MYL	PAMP	SAK	Mean
IC349650	15.9	7.6	27.3	8.3	14.8	232.9	29.9	1135.0	180.3	394.5
IC547222	11.7	7.5	24.7	10.0	13.4	262.1	35.2	1262.6	198.6	439.6
IC547156	13.3	7.6	12.3	6.6	10.0	194.2	36.0	1396.9	130.3	439.3
IC349649	13.3	8.4	23.7	25.0	17.6	194.4	39.0	650.2	204	271.9
IC349648	14.7	6.5	29.0	13.3	15.9	189.8	38.1	1083.1	151	365.5
IISR Vijetha	13.9	11.0	20.3	30.0	18.8	250.6	41.7	557.1	159	252.1
Appangala 1	23.3	6.8	13.7	20.0	15.9	84.2	39.2	1020.6	172.7	329.2
Njallani Green Gold	11.7	6.1	29.2	20.0	16.7	229.0	93.8	1726.9	190.9	560.1
CD	3.6	-	-	3.2	3.4	4.9	6.0	30.6	8.85	12.6
SE(m) ±	1.7	-	-	9.7	5.7	2.3	0.0	592.5	27.1	155.5
CV	14.7	-	-	12.8	13.8	11.4	8.1	NS	8.84	9.4

Footnote: Trial was conducted in RBD with three replications. Njallani Green Gold and Appangala 1 were included as resistant checks, and IISR Vijetha as susceptible check.

APG – Appangala; MYL – Myladumpara; PAMP – Pampadumpara; SAK – Sakleshpur.

PDI – Percent Disease Index of leaf blight; CD – Critical Difference at 5% significance; SE(m) – Standard Error of Mean; CV – Coefficient of Variation

During 2024-25, pooled analysis of multilocal trial for screening leaf blight-tolerant lines in cardamom conducted revealed that IC547156 recorded the lowest leaf blight incidence with mean PDI (10.0%), indicating the best tolerance across locations, followed closely by IC547222 (13.4%). In case of dry capsule yield, the highest mean yield was recorded by the

national check Njallani Green Gold (560.1 kg/ha), followed by IC547222 (439.6 kg/ha) and IC547156 (439.3 kg/ha), both of which combined good yield with tolerance to leaf blight. The susceptible check IISR Vijetha had higher disease incidence (mean PDI 18.8%) and a lower mean yield (252.1 kg/ha), confirming its utility as a susceptible reference. These results suggest that IC547222 and IC547156 are promising entries combining leaf blight tolerance and superior yield performance across diverse environments.

Crop Management

CAR/CM/5.5: Effect of micronutrients on growth and yield of small cardamom

(Centres: Appangala, Mudigere, Myladumpara, Pampadumpara, Sakleshpur)

The trial on effect of micronutrient on growth and yield of small cardamom was initiated in the year 2019-20 with two treatments; 1. Recommended dose of fertilizers and 2. Recommended dose of chemical fertilizers + IISR cardamom micro nutrient four sprays at March, April, May, June @ 5 g/ L.

Table 8. Effect of micronutrients on yield in cardamom (g/plant) across centres

Cultivars	Pampadumara		Mudigere		Myladumpara		Sakleshpur	
	T ₁	T ₂	T ₁	T ₂	T ₁	T ₂	T ₁	T ₂
V ₁	184.33	424.10	50.7	55.6	207.05	228.06	322.8	344.5
V ₂	293.33	538.67	49.2	57.5	194.15	181.9	348.6	366.8
V ₃	285.02	416.00	54.4	60.5	215.24	283.25	292.2	365.4
CD 0.05 (V)	39.18		4.2		-		21.9	
CD 0.05 (T)	47.99		3.7		-		21.3	
CD 0.05 (V x T)	67.86		NS		-		NS	
CV(%)	10.11		-		-		19.6	
V ₁	GG		Mudigere -1		Thiruthali		ICRI - 3	
V ₂	KAU PV-3		Mudigere -2		ICRI -5		ICRI - 8	
V ₃	KAU PV-5		Mudigere -3		MCC 260		Appangala - 1	

Among different centres, Pampadumpara reported the highest yield (538.57 g/plant) under T₂ in V₂. The T₂ has showed higher yield across all three varieties in Pampadumpara, Mudigere and Sakleshpur. In Myladumpara, except in V₂ (ICRI-5), all varieties gave higher yield under T₂. In Mudigere, among the three varieties, M-3 has recorded significantly higher yield per plant (60.5 g) as compared to other two varieties. Among micro nutrient spray treatments foliar spray of IISR micro nutrient mix at four stages (March, April, May and June) @ 5 g per litre of water recorded significantly higher yield per plant (57.9 g) as compared to control (51.5 g). Although the interaction effect was non-significant, higher capsule yield per plant (60.5 g) was observed in M-3 variety in T₂ as compared to T₁. Significant differences were recorded in the morphological and yield characters among the treatment in Pampadumpara. Maximum plant height was recorded for PV3 (299.82 cm) and T₂ (272.691 cm). Maximum no. of tillers (34.933) and panicles (20.694) were recorded under T₂. PV3 recorded maximum number of panicles (21.292), panicle length (75.417 cm) maximum fresh weight (416.00 g/plant) and dry weight (69.21 g/plant) under T₂. In Myladumpara, maximum yield was obtained in MCC 260

(Njallani Green Gold) when supplemented with foliar application of IISR micro nutrient mix in V_3T_2 (283.25 g/plant) followed by Thiruthali in V_1T_2 (228.06 g/plant) compared to V_2T_2 (181.9 g/plant). There was improvement in no. of racemes per panicle for V_1 (Thiruthali) compared to other two varieties. Application of IISR micro nutrient mix resulted in significant improvement in this yield attributing character for V_2 & V_3 compared to control plants. There was also significant improvement in length of panicles in T_2 among three varieties. Significant variations were observed among growth and yield parameters among the treatments in Sakleshpur. Significantly higher plant height was observed in ICRI 8 variety (366.8 g/plant) under T_2 . Similarly, significantly higher number of tillers per clump and dry capsule yield was recorded under T_2 . Overall, better growth and yield attributes were recorded in the treatment where IISR cardamom power mix was applied. In Appangala centre, T_2 recorded better growth and yield parameters. Size of capsule was better in micronutrient sprayed treatment in all genotypes. Yield ranged from 10.55 to 39.14 (g/plant) in control and from 18.94 to 42.29 (g/plant) under micronutrient application. Appangala-1 recorded 13.43%, and Njallani Green Gold 44.16 % yield increase over control. Due to drought throughout cropping season crop setting was very low during 2024-25.

CAR/CM/5.6: Site-specific recommendation for varying yield target of cardamom
(Centres: Mudigere, Myladumpara, Pampadumpara, and Sakleshpur)

Table 9. Effect of site-specific nutrient recommendations for varying yield targets on small cardamom

Treatment	Mudigere		Pampadumpara		Myladumpara		Sakleshpur	
	Dry capsule yield (kg/ha)	No. of panicles (cm)	Dry capsule yield (kg/ha)	No. of panicles (cm)	Fresh Yield (kg/ha)	No. of panicles (cm)	Dry capsule yield (kg/ha)	No. of panicles (cm)
T_1	92.50	5.00	19.763	22.508	239.57	37.63	123.30	6.80
T_2	106.60	5.40	21.54	23.448	164.30	25.66	142.10	7.40
T_3	113.30	5.80	28.38	22.587	193.79	28.96	154.60	8.10
T_4	116.00	6.20	9.32	26.813	272.95	39.41	148.40	8.00
Mean	107.10	5.60	-	-	-	-	142.10	7.58
CD (0.05)	8.61	NS	NS	NS	-	-	9.60	0.84
CV (%)	9.44	19.70	62.31	12.498	-	-	32.30	19.70

The trial on effect of site-specific nutrient recommendations for varying yield targets on small cardamom was initiated in the year 2020-21 with four treatments; T_1 - $N:P_2O_5:K_2O = 125:125:250$ kg/ha; T_2 - $N:P_2O_5:K_2O = 64.0: 230.3: 335.0$ kg/ha for target yield of 6 q/ha; T_3 - $N:P_2O_5: K_2O = 165.8: 250.0: 465.6$ kg/ha for target yield of 8 q/ha and T_4 - $N:P_2O_5:K_2O = 275.6:275:550$ kg/ha for target yield of 10 q/ha.

None of the centres have achieved the targeted yield mentioned in the treatments. Among different centres, Mudigere and Myladumpara reported higher yield of 116.0 kg/ha and 272.95 kg/ha respectively in T_4 , whereas Pampadumpara and Sakleshpur reported higher yield of 28.38 kg/ha and 154.60 kg/ha respectively in T_3 .

Crop Protection and Food safety

CAR/CP 6.11: Evaluation of fungicides to manage rhizome rot of cardamom (Centres: Appangala, Mudigere, Pampadumpara and Myladumpara)

The experiment on the evaluation of efficacy of fungicides against rhizome rot in small cardamom was initiated in 2020 with five treatments (T₁: Spray and drench Tebuconazole @ 1 ml L⁻¹; T₂: Spray and drench Fenamidone + Mancozeb @ 2 g L⁻¹; T₃: Spray and drench Metalaxyl- Mancozeb @ 1.25 g L⁻¹; T₄: Spray and drench copper oxychloride @ 2 g L⁻¹; and T₅: Recommended package of practices) with four replications each designed in RBD.

The pooled data from the three-year study revealed significant variations in disease incidence across the locations and treatments. At the Appangala centre, the lowest disease incidence (24.89%) was recorded in treatment T₁, which involved spraying and drenching with Tebuconazole at a concentration of 1 ml L⁻¹. This treatment exhibited a 31.28% improvement in disease reduction compared to the control (T₅), demonstrating its effectiveness in mitigating disease severity. The second-best performing treatment at this location was T₃, which also showed promising results. A similar trend was observed at the Pampadumpara centre, where T₁ effectively reduced disease incidence. Conversely, at the Myladumpara centre, the lowest disease incidence was recorded in treatment T₃, which involved the spray and drench application of Metalaxyl + Mancozeb at 1.25 g L⁻¹. This suggests that the effectiveness of disease management strategies may vary based on local environmental conditions and pathogen dynamics. Across all locations, the disease incidence in the control treatment (T₅) ranged from 5.5% to 36.22%, with the highest disease severity observed at Appangala. The findings underscore the importance of site-specific disease management strategies and highlight the potential of Tebuconazole (T₁) and Metalaxyl + Mancozeb (T₃) in effectively controlling disease incidence in cardamom cultivation. The percent disease incidence score for rhizome rot incidence recorded at different locations during kharif, 2020-23 can be comprehended through Table 10.

Table 10. Efficacy of fungicides against Rhizome rot (*Rhizoctonia solani*; *Pythium vexans*; *Fusarium oxysporum*) of cardamom

Treatments	Appangala (2020 – 2023)			Pampadumpara (2021 -2023)			Myladumpara (2020 – 2023)		
	PDI	Redn (%)	Yield	PDI	Redn (%)	Yield	PDI	Redn (%)	Yield
T ₁ : Tebuconazole	24.89 ^a	31.3	467.5	9.02	-62.5	87.0	3.78 ^b	67.3	382.1
T ₂ : Fenamidone + Mancozeb	28.29 ^b	21.9	325.9	3.47	37.5	83.3	2.59 ^a	77.6	446.2
T ₃ : Metalaxyl + Mancozeb	25.61 ^a	25.3	351.6	9.70	-74.8	86.9	3.37 ^{ab}	70.8	430.5
T ₄ : Copper oxychloride	36.05 ^c	0.46	282.3	5.55	0.0	80.8	5.81 ^c	49.7	339.7
T ₅ : POP	36.22 ^c	-	283.1	5.55	-	90.1	11.55 ^d	-	307.6
CD (p<0.05)	3.63	-	4.84	NS	-	NS	0.91	-	24.91
SE(d)	2.46		1.8				0.91		
CV (%)	9.9	-	13.1	7.3	-	21.4	10.9	-	4.2

Additionally, residue analysis and benefit-cost (B:C) ratio calculations were conducted at the Appangala and Myladumpara centres to evaluate the economic viability and safety of the applied treatments. The results of the residue analysis (Table 11) confirmed that pesticide residues in the produce of treated plants were below detectable levels (BDL), ensuring

compliance with safety standards. Among the treatments recorded the highest B:C ratio at both centres, indicating its superior economic viability and effectiveness in disease management.

Table 11. Result of pesticide residue analysis and benefit-cost ratio analysis of fungicidal treatments in the cardamom trial conducted at Appangala and Myladumpara Centres

Treatment	Pesticide Residue		B:C Ratio	
	APG	MYL	APG	MYL
T ₁ Carbendazim 12% +Mancozeb 63% WP 2 g L ⁻¹	BDL	BDL	3.26	1.40
T ₂ Hexaconazole 5% SC 2 ml L ⁻¹	BDL	BDL	1.81	1.33
T ₃ Mancozeb 75% WP 2 g L ⁻¹	BDL	BDL	3.34	1.56
T ₄ Tebuconazole 25.9% w/w EC 1 ml / lit	BDL	BDL	1.30	1.27
T ₅ Control	BDL	BDL	1.98	1.23

Footnotes: APG: appangala & MYL: Myladumpara

BDL: Below Detectable Level; B:C Ratio: Benefit-Cost ratio.



Figure 3. Field view of rhizome rot disease incidence at Appangala

CAR /CP 6.12: Evaluation of fungicides to manage leaf blight in cardamom (Centres: Appangala, Mudigere, Pampadumpara and Myladumpara)

The experiment on the evaluation of fungicides against leaf blight in small cardamom was initiated in 2020 with five treatments (T₁: Spray Tebuconazole @ 1 ml L⁻¹ or Carbendazim @ 2g L⁻¹; T₂: Spray Hexaconazole @ 2ml L⁻¹; T₃: Spray Azoxystrobin @ 0.5g L⁻¹; T₄: Spray Carbendazim @ 2g L⁻¹ or Tebuconazole @ 1ml L⁻¹; and T₅: Recommended package of practices) with four replications each designed in RBD.

Pooled analysis over three years (2020-23) revealed that treatment T₂, which involved spraying Hexaconazole at a concentration of 2 ml L⁻¹, was the most effective in minimizing disease severity across all three locations (Table 12). In Appangala, Pampadumpara, and Myladumpara, T₂ consistently demonstrated the highest reduction in disease incidence compared to other treatments. Notably, at the Myladumpara centre, all tested treatments were on par and outperformed the control (T₅ – Recommended Package of Practices), with disease incidence in the control treatment remaining the highest. This suggests that while T₂ was the most effective treatment overall, alternative treatments also provided significant improvements over the existing PoP, reinforcing the need for an optimized disease management strategy tailored to each location. These findings highlight the potential of Hexaconazole (T₂) as a reliable option for controlling disease in black pepper, while also emphasizing the necessity of site-specific recommendations for maximizing disease control and crop productivity. The disease incidence in control ranged from 14.12 to 46.17 %.

Table 12. Result of efficacy study of fungicides against Leaf blight (*Colletotrichum gloeosporioides*) of cardamom

Treatments	Appangala (2020 – 2023)			Pampadumpara (2021 -2023)			Myladumpara (2020 – 2023)		
	PDI	Redn (%)	Yield	PDI	Redn (%)	Yield	PDI	Redn (%)	Yield
T ₁ : Carbendazim+ Mancozeb	22.77 ^{ab}	25.66	427.81 ^c	45.21 ^a	3.21	54.14	5.25 ^a	62.79	307.97 ^b
T ₂ : Hexaconazole	19.72 ^a	35.45	445.05 ^a	28.98 ^c	37.95	44.21	4.13 ^a	70.80	377.07 ^c
T ₃ : Mancozeb	23.61 ^{ab}	22.71	438.81 ^b	42.42 ^{ab}	9.18	38.33	5.49 ^a	61.09	374.94 ^c
T ₄ : Tebuconazole	27.24 ^{bc}	10.83	401.32 ^c	38.04 ^b	18.64	50.63	4.11 ^a	70.94	327.11 ^b
T ₅ : POP	30.55 ^c	-	413.22 ^d	46.71 ^a	-	61.04	14.12 ^b	-	285.53 ^a
CD (p<0.05)	4.91	-	5.12	6.35	-	NS	0.63	-	19.71
CV (%)	24.78	-	25.64	10.42	-	20.55	13.50	-	3.82

Pesticide residue analysis was conducted at the Appangala and Myladumpara centres to assess the safety of the applied treatments in cardamom cultivation. The results indicated that in treatment T₂ (spraying of Hexaconazole at 2 ml L⁻¹), residue levels were found to be below the detectable limit (BDL) at both centres, ensuring compliance with food safety standards and regulatory guidelines. This suggests that hexaconazole, when used at the recommended dosage, does not pose a significant residue risk in the harvested produce. However, at the Appangala centre, residue levels for treatments T₁ and T₃ were recorded above the Maximum Residue Limit (MRL). In addition to residue analysis, both the Appangala and Myladumpara centres reported a higher benefit-cost (B:C) ratio for the treatments, indicating that the disease management strategies implemented in the trial were not only effective but also economically viable. The increased B:C ratio suggests that farmers adopting these treatments can achieve better financial returns due to improved disease control, leading to higher yield and profitability.

Table 13. Result of pesticide residue analysis and benefit-cost ratio analysis of fungicidal treatments in the cardamom trial conducted at Appangala and Myladumpara Centres

Treatment	Residue (mg/kg)		B:C Ratio	
	APG	MYL	APG	MYL
T ₁ : Carbendazim 12% + Mancozeb 63% WP @ 2 g L ⁻¹	Carbendazim – 1.19 Mancozeb – 1.22	BDL	2.23	1.20
T ₂ : Hexaconazole 5% SC @ 2 ml L ⁻¹	BDL	BDL	2.35	1.48
T ₃ : Mancozeb 75% WP @ 2 g L ⁻¹	Mancozeb – 0.65	BDL	2.31	1.47
T ₄ : Tebuconazole 25.9% EC @ 1 ml L ⁻¹	BDL	BDL	1.94	1.27
T ₅ : Control	BDL	BDL	2.27	1.15

Footnotes: APG: Appangala & MYL: Myladumpara

BDL: Below Detectable Level; B:C Ratio: Benefit-Cost ratio.



Figure 4. Field view of leaf blight disease incidence at Appangala

CAR /CP 6.13: Observational trial on the efficacy of bioagent formulations to manage rhizome rot and nematodes of cardamom

(Centres: Appangala, Pampadumpara and Myladumpara)

The trial was laid out in a randomized block design (RBD) at three locations, with six treatments (T₁: Control; T₂: *T. asperellum* talc formulation mass multiplied in cowdung:neem cake mixture 9:1, mix *T. asperellum* talc formulation @ 1-2 Kg per 100 Kg mixture. Apply 2-5 Kg *T. asperellum* mass multiplied mixture/plant; T₃: *T. asperellum* biocapsule formulation, 1 biocapsule in 100 L water, apply 2-3 litre solution per plant; T₄: Metalaxyl+Mancozeb, drench the fungicidal solution 0.125%; T₅: *Pochonia chlamydosporia* liquid formulation, drench @ 1ml L⁻¹; T₆: Recommended nematicide, drench the nematicide solution) with four replications each.

The pooled data analysis (Table 14) from the past two years of the study indicate that treatment T₃, which involved the application of *Trichoderma asperellum* biocapsule formulation (1 biocapsule per 100 L of water, applied at 2-3 L per plant), was the most effective in reducing the Percent Disease Index (PDI) at both the Appangala and Myladumpara centres. This treatment was closely followed by T₂, which utilized a *T. asperellum* talc formulation mass-multiplied in a cow dung and neem cake mixture (9:1). The T₂ formulation was prepared by mixing *T. asperellum* talc at a rate of 1-2 kg per 100 kg of substrate mixture and applied at 2-5 kg per plant. At the Pampadumpara centre, however, there were no statistically significant differences among the treatments, suggesting that local environmental or soil conditions may have influenced the efficacy of the applied formulations.

Additionally, nematode incidence was absent at the Appangala centre throughout the study period. However, at the Myladumpara centre, treatment T₃ not only contributed to disease reduction but also demonstrated enhanced nematode control, indicating its potential dual role in managing both fungal pathogens and plant-parasitic nematodes. These findings highlight the promising role of *T. asperellum* formulations, particularly the biocapsule technology, in sustainable disease and nematode management strategies for cardamom cultivation.

Table 14. Effect of Biological and Chemical Treatments on Rhizome Rot, Nematode Incidence, Yield and B:C Ratio of Cardamom Across Three Locations (2021–2023)

Treatments	Appangala (2021 – 2023)			Pampadumpara (2022 -2023)			Myladumpara (2021 – 2023)			BCR
	RR. PDI	Nema PDI	Dry Yield	RR. PDI	Nema PDI	Dry Yield	RR. PDI	Nema PDI	Dry Yield	
T ₁ : Control	32.12 ^c	Nil	184.55	20.83	20.33	40.59	9.72 ^d	1.95 ^c	267.48 ^a	1.07
T ₂ : <i>T. asperellum</i> talc	23.38 ^a	-	207.10	8.33	2.56	40.39	3.28 ^{ab}	0.96 ^a	326.98 ^b	1.28
T ₃ : <i>T. asperellum</i> biocapsule	26.48 ^a	-	201.26	15.62	3.46	46.36	2.57 ^a	0.82 ^a	327.30 ^b	1.28
T ₄ : Metalaxyl+Mancozeb	27.59 ^b	-	209.40	12.50	13.66	40.26	3.01 ^{ab}	1.52 ^b	311.95 ^b	1.14
T ₅ : Rec Nematicide	27.77 ^b	-	200.77	17.70	4.52	38.53	4.47 ^c	0.73 ^a	269.98 ^a	1.06
CD (p<0.05)	28.70 ^b	-	199.90	14.58	5.33	44.12	3.64 ^b	1.03 ^a	278.44 ^a	0.98
CV (%)	3.22	-	13.99	NS	NS	NS	0.80	0.38	18.49	

Footnotes: RR. PDI: Percent Disease Index of Rhizome Rot; Nema PDI: Percent Disease Index of Nematode Incidence; Dry Yield: Dry capsule yield in kg/ha; BCR: Benefit-Cost Ratio

Large Cardamom

Genetic Resources

LCA/CI/1.1: Germplasm collection and evaluation of large cardamom

(Centres: ICAR Regional Station, Gangtok, ICRI Regional Research Station, Gangtok)

North Eastern Himalayan region, is a rich reservoir of genetic diversity in large cardamom (*Amomum subulatum* Roxb.), and both **ICAR Regional centre for NEH Sikkim Centre, Gangtok**, and the **Indian Cardamom Research Institute (ICRI), Gangtok Regional research station** have played pivotal roles in the collection, conservation, and evaluation of its genetic resources. A total of 66 large cardamom accessions are presently conserved at AICRPS centres viz., ICAR- RC NEH, RS, Gangtok and ICRI RRS, Gangtok jointly (Table 5).

Table 51: Details of cardamom germplasm maintained by two AICRPS centres

AICRPS Centre	Total collections
ICRI RRS, Gangtok	7
ICAR- RC NEH, RS, Gangtok	59
Total	66

Since **2010**, **ICRI-Gangtok** has undertaken systematic efforts to collect and conserve large cardamom germplasm across altitudinal gradients. A total of **59 accessions** have been collected and are being maintained at two dedicated field gene banks located at **Pangthang (1952 m amsl)** and **Kabi (1567 m amsl)**. All accessions have been **characterized and evaluated** for key agronomic and morphological traits. Importantly, **passport data** for each accession have been generated as per the **ICAR-NBPGR format**, ensuring proper documentation and long-term utility in breeding and conservation programs. During 2024-25, **ICRI-Gangtok Centre** successfully collected two distinct **germplasm accessions** from the **Lower Subansiri district of Arunachal Pradesh**, representing both **wild and cultivated diversity**. The passport data of collected accessions were detailed in table16.

Acc. No.	Cultivar / Landrace Name	Biological Status	Latitude & Longitude	Altitude (m)	Location (Village, Tehsil, District)	Remarks / Notable Traits
SCC-321	Landrace (Wild)	Wild collection	N 27°38', 93°42 E '	1330	Seya, Pistana Sub-Division, Lower Subansiri	Spike formed at the base of the clump similar to cultivated large cardamom (<i>A. subulatum</i>), however, round shaped capsules are also formed at the top of tillers which on maturity sweet in taste.
SCC-322	Ramsey	Cultivated	N 27°40', 94°36 E '	1280	Seya, Pistana Sub-Division, Lower Subansiri	Capsules are large in size compare to general Ramsey cultivar also nos. of capsule more
SCC-218	Uttarey Varlang	Cultivated	~ West Sikkim	~1800	Uttarey, West Sikkim	Exhibits disease tolerance; promising for breeding



Figure 5. Plant view and fruit morphology of large cardamom accession SCC-322 ('Ramsey') collected from Seya, Lower Subansiri, Arunachal Pradesh

Parallely, the ICAR Sikkim Centre, Gangtok, in collaboration with ICRI, RS, Tadong centre has collected an unique landraces from farmer fields named 'Uttarey Varlang' from West Sikkim and documented under accession number SCC-218. Passport evaluation of SCC-218 revealed notable traits such as inherent disease tolerance, making it a promising candidate for future breeding programs.

Crop Improvement

LCA/CI/2 Coordinated Varietal Trial (CVT)

LCA/CI/2.1: CVT on large cardamom-2023

(Centres: ICAR Regional Station, Gangtok, ICRI Regional Research Station, Gangtok, KVK Anjaw, Pasighat)

Coordinated Varietal Trial (CVT) on large cardamom was initiated in the year 2023, which was laid out in RBD with 10 genotypes across three locations, out of which the trial result on morphological triats as well as data on pest and disease incidence under natural conditions came from two locations ICRI Gangtok, and ICAR Gangtok during 2024-25.

Table 17. Evaluation of Morphological Traits of Large Cardamom under CVT (2023–24) recorded from both AICRPS Centres

Entry	Plant height (cm)			No. of tillers/clump			Nos. of leaves/tiller			Leaf length (cm)			Leaf breadth (cm)		
	ICRI	ICAR	Mean	ICRI	ICAR	Mean	ICRI	ICAR	Mean	ICRI	ICAR	Mean	ICRI	ICAR	Mean
SCC 216 (Ramla)	58.2	61	59	5.1	5.7	5.4	4.4	4.5	4.5	26.5	27	27	8.2	8.3	8.3
SCC 217 (Ramla)	57.8	60	59	5.3	5.9	5.6	4.3	4.4	4.4	26.7	27	27	7.4	7.5	7.5
SCC 213 (Golsey)	33.5	36	35	5	5.6	5.3	1.5	1.6	1.6	14.5	15	15	5.5	5.7	5.6
SCC 214 (Golsey)	35.3	38	37	1.3	1.9	1.6	1.3	1.4	1.4	14.6	15	15	5.1	5.2	5.2
SCC 242 (Ramsey)	53.1	55	54	4.5	5.1	4.8	4.1	4.2	4.2	25.3	26	25	7.7	7.8	7.8
SCC 264 (Sawney)	61.6	64	63	4.9	5.5	5.2	4.2	4.3	4.3	28.4	29	29	7.6	7.7	7.7
SCC 307 (Varlangey)	60.2	63	61	4.9	5.5	5.2	3.7	3.8	3.8	25.5	26	26	4.6	4.8	4.7
ICRI Sikkim-1 (National Check)	65.2	68	66	4.7	5.3	5	4.1	4.3	4.2	26.5	27	27	8	8.1	8.1
Sawney (Local Check)	56.6	59	58	5	5.6	5.3	3.1	3.2	3.2	24.8	25	25	7.4	7.6	7.5
Seremna (Zonal Check)	55.5	58	57	4.7	5.3	5	3.8	4	3.9	28.2	28	28	7.4	7.5	7.5
SEm±	1.51	1.51	1.5	0.14	0.1	0.1	0.07	0.1	0.1	0.69	0.7	0.7	0.14	0.1	0.1
LSD (p=0.05)	4.62	4.6	4.6	0.43	0.4	0.4	0.24	0.2	0.2	2.22	2.2	2.2	0.46	0.4	0.4

Evaluation of ten large cardamom genotypes across ICRI and ICAR Gangtok centres revealed significant variability in morphological traits. Among the genotypes, ICRI Sikkim-1 recorded the highest plant height (66 cm), followed closely by SCC 264 with 63 cm and SCC 307 with 61 cm, indicating superior vegetative vigour. In terms of tillering ability, SCC 217 showed the maximum number of tillers per clump of 5.6, the highest number of leaves per tiller of 4.5 was recorded in SCC 216. SCC 264 excelled in leaf length of 29 cm, while SCC 216 showed the widest leaves of 8.3 cm.

The evaluation of insect pest and disease incidence revealed that SCC 264 (Sawney) consistently exhibited the least infestation and infection across all parameters, with zero incidence of shoot borer and dry rot and negligible levels of other pests and diseases. In contrast, SCC 214 (Golsey) and SCC 213 (Golsey) recorded the highest levels of rust (2.5% and 2.0%) and blight (1.6%), indicating their susceptibility. National check ICRI Sikkim-1 showed moderate rust (1.6%) but remained free of shoot borer and dry rot, while SCC 216 and SCC 217 (Ramla) displayed low and acceptable levels of pest and disease pressure.

Table 18. Insect Pest and Disease Incidence in Large Cardamom under CVT (2023–24)

Entry	Leaf caterpillar	Shoot borer	Shoot fly	Blight	Rust	Dry rot
SCC 216 (Ramla)	0.2	0	0.3	0.5	0.5	0.1
SCC 217 (Ramla)	0.1	0.3	0.1	0.3	1.3	0
SCC 213 (Golsey)	0	0	0.1	1.6	2	0.1
SCC 214 (Golsey)	0.1	0	0.5	1.6	2.5	0.2
SCC 242 (Ramsey)	0.2	0.2	0.2	1.1	1.3	0.3
SCC 264 (Sawney)	0	0	0.1	0.3	0.5	0
SCC 307 (Varlangey)	0.1	0.1	0.3	0.6	1.2	0.1
ICRI Sikkim-1 (National Check)	0.3	0	0	0.7	1.6	0
Sawney (Local Check)	0.1	0	0.1	0.3	1.5	0.1
Seremna (Zonal Check)	0.1	0.1	0	0.7	1.1	0

Also incidence of viral diseases like chirkey and foorkey disease not observed. These findings suggest that SCC 264 and Ramla group entries (SCC 216 and SCC 217) are promising for pest and disease resilience in large cardamom.



Figure 6. Field Activities under CVT Trials in Sikkim: Planting and Data Recording at ICRI-Gangtok and ICAR-RC Tadong Centres. (a) Planting of CVT at ICRI-Gangtok Centre (b) Data recording at CVT plot, ICRI-Gangtok Centre (c) Planting of CVT at ICAR-RC Tadong Centre (d) data recording by ICAR Sikkim Centre.

Crop Management

LCA/CM/5.1: Effect of mulching on yield of large cardamom

(Centres: ICAR Regional Station, Gangtok, ICRI Regional Research Station, Gangtok)

A field experiment was conducted to evaluate the effect of mulching on yield of large cardamom during *khari* season at Sikkim. The experiment comprising of six treatments (T₁: Leaf mould; T₂: Fresh leaf litter; T₃: Paddy straw; T₄: Paddy husk; T₅: Black polyethylene sheets; T₆: Control) and was laid out in randomised block design (RBD) with four replications.

The results revealed that the plot mulched with leaf mould (T₁) recorded the significant highest plant height (147.4 cm) followed by the plants mulched with fresh leaf litter (143.1 cm). Number of leaves per tallest tiller showed that the leaf mould exhibits significant effect compared to other treatments. Furthermore, treatment T₁ produced highest number of leaves per tiller (9.93 which was statistically at par with T₂ (9.41) and also fresh leaf litter is at par with paddy straw (T₃). The maximum numbers of productive tillers (19.0) was obtained from the T₁ and the lowest (11.0) in T₆ treatment (Table 1). The maximum number of productive tillers/clump (19) was recorded under T₁ that was statistically at par with T₂ and significantly higher than other treatments. The highest number of tillers (40) was obtained in T₁ which was significantly different from the control as well as other treatments. Among the treatments, T₁ had profound effect on yield of large cardamom (442 kg/ha of dry capsules). The highest net returns and B: C ratio (2.52) was recorded under T₁, which was statistically at par with T₂ and significantly higher than remaining treatments respectively.

Table 19. Effect of mulching on yield of large cardamom at farmers field in Dzongu, Sikkim, 2024-25

Treatment	Plant height (cm)	Number of leaves tiller ⁻¹	Number of immature tillers clump ⁻¹	Number of productive tillers clump ⁻¹	Total number of tillers clump ⁻¹	Dry capsule yield (kg ha ⁻¹)	B: C ratio
T ₁ : Leaf mould	147.4±0.39 ^a	9.93±1.58 _a	21.0±2.12 ^a	19.0±1.96 _a	40.0±1.76 ^a	442±5.53 _a	2.52±0.32 _a
T ₂ : Fresh leaf litter	143.1±0.33 ^b	9.41±1.45 _a	19.0±2.09 ^a _b	18.01.91 ^a	37.0±1.65 ^b	430±5.65 _b	2.48±0.37 _a
T ₃ : Paddy straw	140.3±0.35 ^b _c	9.22±1.42 _a	18.0±2.03 ^a _b	15.01.86 ^{ab}	33.0±1.56 ^c	385±5.49 ^c	2.35±0.24 _b
T ₄ : Paddy husk	138.7±0.37 ^c _d	8.89±1.50 _a	17.0±2.16 ^a _b	14.01.83 ^{ab}	31.0±1.62 ^c _d	334±5.58 _d	1.98±0.27 _b
T ₅ : Black polyethylene sheets	137.1±0.31 ^d	8.72±1.53 _a	16.0±2.11 ^a _b	14.01.94 ^{ab}	30.0±1.47 ^d	302±5.61 _e	1.66±0.38 ^c
T ₆ : Control	132.7±0.38 ^e	7.10±1.57 _a	14.0±2.14 ^b	11.01.88 ^b	25.0±1.51 ^e	289±5.63 _f	1.46±0.30 _d
S Em ±	147.4±0.39 ^a	9.93±1.58 _a	21.0±2.12 ^a	19.0±1.96 _a	40.0±1.76 ^a	442±5.53 _a	2.52±0.32 _a
LSD (p=0.05)	143.1±0.33 ^b	9.41±1.45 _a	19.0±2.09 ^a _b	18.01.91 ^a	37.0±1.65 ^b	430±5.65 _b	2.48±0.37 _a

Where, T₁: Leaf mould @ 10 Mg ha⁻¹; T₂: Fresh leaves litters @ 7 Mg ha⁻¹; T₃: Paddy straw @ 8 Mg ha⁻¹; T₄: Paddy husk @ 5 Mg ha⁻¹; T₅: Black polyethylene sheets; T₆: Without mulch (control)



Figure 6. ICAR Sikkim Centre



Figure 7. ICRI RS Tadong

04 Ginger

Genetic Resources

GIN/CI/1.1: Germplasm collection, characterization, evaluation and conservation

(Centres: Barapani, Dholi, Kumarganj, Pundibari, Pottangi, Raigarh, Solan)

Collection, characterization, evaluation and conservation activities of ginger germplasm is being carried out at Barapani, Dholi, Kumarganj, Pottangi, Pundibari, Raigarh, and Solan centres, located in the diverse agro-climatic zones. A total of 459 accessions being conserved and maintained by these AICRPS centres jointly (Table 20).

Table 20. Ginger germplasm collections maintained at various AICRPS centres

Centre	Indigenous			Total
	Cultivated	Wild & related species	Exotic	
Barapani	32	-	-	32
Dholi	42	-	-	42
Kumarganj	66	-	-	66
Pottangi	198	-	-	198
Pundibari	40	-	-	40
Raigarh	41	-	-	41
Solan	40	-	-	40
Total	459	-	-	459

Among the 42 accessions evaluated at Dholi, RG-33 recorded highest yield of (23.91 t ha⁻¹), followed by RG-45 (23.79 t ha⁻¹) and RG-36 (23.61 t ha⁻¹), as compared to the check variety, Nadia (20.61 t ha⁻¹). Of the 66 germplasm accessions evaluated at Kumarganj, NDG-6 (165 g plant⁻¹), followed by NDG-28 (152 g plant⁻¹) and NDG-47 (148 g plant⁻¹) were found to be promising.

Out of 198 ginger germplasm accessions evaluated at Pottangi, 35 accessions yielded more than 5 kg 3m⁻² fresh rhizomes. At Raigarh, out of the 41 genotypes evaluated, the genotypes viz., Indira Ginger -14 (20.0 t ha⁻¹), recorded maximum rhizome yield followed by IG-11 (16.8 t ha⁻¹), and IG-13 (15.7 t ha⁻¹) over two national checks Suruchi (9.5 t ha⁻¹) and Suprabha (8.5 t ha⁻¹). At Solan, out of the forty ginger genotypes, SG19-11 gave the highest fresh rhizome yield of 217.55 g/plant with 3.92% oleoresin content.

Among the 40 germplasm accessions evaluated at Pundibari, highest rhizome yield was recorded in GCP 9 (12.02 t ha⁻¹) followed by GCP 13 (11.45 t ha⁻¹), GCP 37 (11.29 t ha⁻¹) and few lines namely GCP 22, GCP 31, GCP 56, GCP 14, GCP 15, GCP 5, GCP 4 and GCP 3 showed yield more than 10 t ha⁻¹. Lowest rhizome rot and wilt disease incidence were recorded in GCP 5 and GCP 14 (14.29%), followed by GCP 9 (14.44%), GCP-30 (15.33%) and GCP 4 (15.33%).

Thirty two (32) accessions of ginger (IC-584322 to IC-584364) were maintained and evaluated at Barapani. The highest plant height was observed in accession IC-584332, measuring 77.50 cm. The longest leaf length (28.8 cm) and greatest leaf breadth (3.2 cm) were found in IC-584325. Accession IC-584337 exhibited the highest number of tillers, with an average of 6.37. The highest yield per plant (375.60 g) and the highest yield per hectare (16.69 t) were recorded in IC-584363. IC-584346 demonstrated the highest oleoresin content, with a value of 6.20%, while IC-584341 showed the highest dry matter content, at 22.60%.

Crop Improvement

GIN/CI/2 Coordinated Varietal Trial (CVT)

GIN/CI/2.5: Coordinated Varietal Trial (CVT) on disease tolerance trial in ginger

(Centres: Barapani, Chintapalle, Kozhikode, Nagaland, Pottangi, Pundibari, Gangtok, Raigarh)

Coordinated Varietal Trial (CVT) on disease tolerance trial in ginger aims to find out the high yielding ginger genotypes performing well under disease pressure. The trial laid out at 8 AICRPS centres in RBD with nine test genotypes (R 1.25/4, G 1.00/4, HP 05/ 15, HP 0.5/2, V 0.5/2, V1E4 1, V1E4 5, V2E5 2 and Indira Ginger) with one national check (IISR Varada) or local check.

Pooled analysis for three years revealed the mean fresh rhizome yield across locations ranged from 12.9 to 16.5 t ha⁻¹ among the ginger entries tested. The highest yield was recorded in 'Indira Ginger' (16.5 t ha⁻¹), followed by R 1.25/4 (16.2 t ha⁻¹) and IISR Varada (16.2 t ha⁻¹), which was used as the national check. These entries numerically outperformed the check variety, with 'Indira Ginger' showing a 2.19% increase over control (IOC). Location-wise, average yields ranged from 5.9 t ha⁻¹ (BPI) to 30.2 t ha⁻¹ (KOZ), with an overall grand mean of 14.5 t ha⁻¹ across all test locations, indicating a wide variability influenced by genotype-environment interaction (Table 21; Fig. 8).

Table 21. Fresh Rhizome yield (in t ha⁻¹) recorded in CVT on disease tolerance trial in ginger pooled over three year *Kharif* 2021-24, at different locations

Entries	BPI	CP E	GT K	KO Z	NG D	PO T	PU N	RAI	Grand Mean	Ran k	%IO C
R 1.25/4	5.9	11.4	13.0	45.0	10.6	13.5	8.2	18.5	16.2	2	0.38
G 1.00/4	5.9	15.8	11.2	25.6	8.9	14.0	8.3	17.4	13.4	8	-16.97
HP 05/15	7.0	13.8	15.5	20.3	9.1	14.5	8.3	14.8	12.9	10	-20.37
HP 0.5/2	7.9	14.6	10.1	36.2	7.5	12.5	10.3	15.7	14.3	5	-11.21
V 0.5/2	6.9	10.2	10.9	26.7	16.7	16.0	9.0	15.7	14.4	4	-11.01
V1E4 1	4.9	12.2	12.7	32.7	11.0	15.9	8.4	16.2	14.3	7	-11.59
V1E4 5	5.4	13.0	13.1	26.2	8.4	16.2	7.7	24.4	14.3	6	-11.54
V2 E5 2	3.7	15.6	11.7	25.5	10.7	15.5	7.7	16.6	13.4	9	-17.02
Indira Ginger	3.7	12.4	13.8	33.6	13.7	13.6	7.8	29.1	16.5	1	2.19
IISR Varada (control)	6.6	16.5	14.7	29.7	18.2	12.4	8.4	22.5	16.2	3	0.00
Loc MEAN	5.90	13.5	12.6	30.1	11.4	14.4	8.43	19.1	14.5		
		5	7	6	8	1					

Where, BPI: Barapani; CPE: Chintapalle; GTK: Gangtok; KOZ: Kozhikode; NGD: Nagaland; POT: Pottangi; PUN: Pundibari; RAI: Raigarh.

Compared to the national check IISR Varada (mean PDI = 24.1%), three test entries — HP 05/15 (15.8%), V 0.5/2 (18.1%), and HP 0.5/2 (18.4%) — recorded lower average rhizome rot scores. Among these, HP 05/15 (15.8%) was categorized as a resistant genotype (PDI between 6.0 to 15.0%), while V 0.5/2 and HP 0.5/2 fell under the moderately resistant category (PDI between 16.0 to 25.0%). Other entries, including G 1.00/4 (18.7%), V1E4-5 (18.9%), V2 E5 2 (19.9%), Indira Ginger (22.5%), and R 1.25/4 (23.3%), also exhibited moderate resistant, with PDI values comparable to or slightly below the check variety. Notably, V1E4-1 (27.4%) recorded a higher rot incidence than the check and may be considered susceptible (PDI > 25%). (Table 22).

Table 22. Pooled average of rhizome rot incidence (PDI) recorded in CVT on disease tolerance trial in ginger during *Kharif*, 2021-24 at different locations

Entries	BPI	CPE	KOZ	NGD	POT	PUN	Grand Mean	Rank	%OC
R 1.25/4	5.9	11.4	45.0	10.6	13.5	8.2	23.3	8	3.40
G 1.00/4	5.9	15.8	25.6	8.9	14.0	8.3	18.7	4	22.44
HP 05/15	7.0	13.8	20.3	9.1	14.5	8.3	15.8	1	34.47
HP 0.5/2	7.9	14.6	36.2	7.5	12.5	10.3	18.4	3	23.52
V 0.5/2	6.9	10.2	26.7	16.7	16.0	9.0	18.1	2	24.61
V1E4 1	4.9	12.2	32.7	11.0	15.9	8.4	27.4	10	-13.77
V1E4 5	5.4	13.0	26.2	8.4	16.2	7.7	18.9	5	21.29
V2 E5 2	3.7	15.6	25.5	10.7	15.5	7.7	19.9	6	17.13
Indira Ginger	3.7	12.4	33.6	13.7	13.6	7.8	22.5	7	6.44
IISR Varada (control)	6.6	16.5	29.7	18.2	12.4	8.4	24.1	9	0.00
Loc MEAN	20.4	20.1	15.0	33.4	17.0	16.5	20.7		

Where, BPI: Barapani; CPE: Chintapalle; KOZ: Kozhikode; NGD: Nagaland; POT: Pottangi; PUN: Pundibari.

Bacterial wilt was observed only at Gangtok, Kozhikode, Nagaland and Pottangi centres. The mean PDI score ranged from 23.1% in V2 E5 2 to 7.8% in HP 05/15. Compared to the national check IISR Varada (PDI = 16.6%), three test genotypes — HP 05/15 (7.8%), R 1.25/4 (8.6%), and G 1.00/4 (12.4%) — recorded lower average wilt scores, indicating better resistance to bacterial wilt. (Table 23).

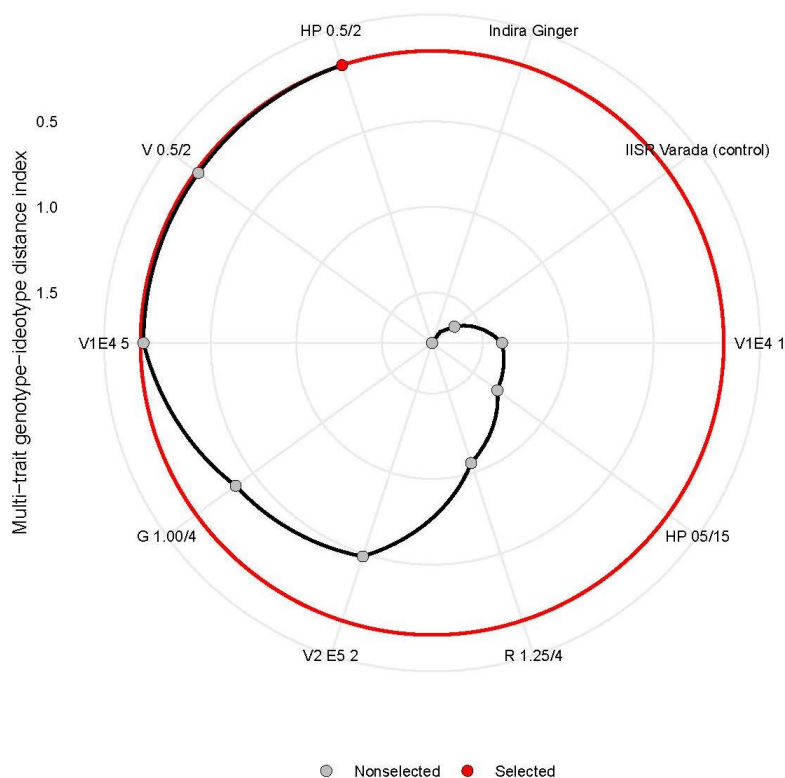
Among these, HP 05/15, with a mean PDI of 7.8%, was the highly resistant entry, followed closely by R 1.25/4 (8.6%), both falling under the resistant category (PDI < 10%). G 1.00/4, with a PDI of 12.4%, may be classified as moderately resistant (PDI between 10–15%). Genotypes such as HP 0.5/2 (13.1%), V 0.5/2 (13.2%), and V1E4 5 (14.3%) also showed moderately resistant responses, performing better than the check. On the other hand, entries like V1E4 1 (15.8%), Indira Ginger (19.6%), IISR Varada (16.6%), and particularly V2 E5 2 (23.1%) recorded higher wilt scores and can be considered moderately susceptible to susceptible depending on the threshold used.

Table 23. Pooled average of bacterial wilt incidence (PDI) recorded in CVT on disease tolerance trial in ginger during *Kharif*, 2021-24 at different locations

Entries	GTK	KOZ	NGD	POT	Grand Mean	Rank	%IOC
R 1.25/4	24.2	0.0	1.7	0.0	8.6	2	48.01
G 1.00/4	27.8	0.0	8.8	0.7	12.4	3	25.18
HP 05/15	18.1	0.0	5.2	0.0	7.8	1	53.25
HP 0.5/2	29.8	0.0	8.4	1.3	13.1	4	20.86
V 0.5/2	34.1	0.0	4.0	1.6	13.2	5	20.47
V1E4 1	39.4	0.0	8.0	0.0	15.8	7	4.87
V1E4 5	22.8	0.0	19.8	0.5	14.3	6	13.59
V2 E5 2	56.8	0.0	12.5	0.0	23.1	10	-39.10
Indira Ginger	22.1	0.0	31.3	5.2	19.6	9	-17.82
IISR Varada (control)	20.2	0.0	23.9	5.7	16.6	8	0.00
Loc MEAN	29.5	0.0	12.4	1.5	14.5		

Where, GTK: Gangtok; KOZ: Kozhikode; NGD: Nagaland; POT: Pottangi.

In order to select ginger varieties that give better yield and can resist rhizome rot and bacterial leaf blight diseases together, a method called the Multi-trait Genotype-Ideotype Distance Index (MGIDI) was used. This method helps select genotypes that come closest to the "ideal" plant—high yielding and multiple disease resistant. Among the tested types, HP 0.5/2, V 0.5/2, and V1E4 5 showed the best results, with lower MGIDI index (≤ 0.1) with HP 0.5/2 performing the best overall got selected at 5% selection intensity. These varieties managed to resist diseases like bacterial wilt and rhizome rot while still giving good yields. Although yield gains were marginally compromised, notable improvements in disease tolerance justified the selection. As a strategic intervention measure, the deployment of HP 0.5/2 genotype having multiple resistance in disease endemic regions where disease is a predictable to escalate, can help farmers to achieve stable and healthy crops.



GIN/CI/2.6: CVT on bold ginger trial Series-2023.

(Centres: Appangala, Kozhikode, Pottangi, Raigarh, Sikkim)

During the 2023–24 season, centres such as Appangala, Pottangi, and Raigarh primarily focused on seed multiplication for initiating replicated trials under the CVT on bold ginger genotypes. At Appangala, sufficient planting material was multiplied during 2024–25, the replicated trial has been established with three replications. Similarly, at Pottangi, seed multiplication was completed in 2023–24, and the trial has now been initiated in replication during 2024–25. In Raigarh, the trial was newly started in *Kharif* 2023. Planting materials of all genotypes were multiplied through protrait techniques after disease screening, and evaluation of growth and yield traits will be taken up during *Kharif* 2024 in 3 × 1 m plots.

Centres that conducted replicated trials during 2024–25 include Kozhikode and Sikkim. At Kozhikode, the CVT on bold ginger genotypes has been planted as a replicated trial. At Gangtok (Sikkim), ten bold ginger genotypes (G2023-01 to G2023-10) were evaluated under organic management conditions. Among the genotypes, G2023-6 recorded the highest fresh rhizome yield (12.3 t ha⁻¹), which was statistically at par with G2023-2 and G2023-3 but significantly superior to the remaining entries. Overall, G2023-6, followed by G2023-2 and G2023-3, exhibited promising performance under the organic production system in the Sikkim Himalayan region.

GIN/CI/2.7: CVT on high essential oil ginger genotypes

(Centres: Appangala, Kozhikode, Nagaland, Pottangi, Umiam)

Coordinated Varietal Trial (CVT) on high essential oil ginger genotypes was initiated in 2023 with for project duration of three years. The trial is being conducted across five centres, 9 genotypes laid out in a Randomized Block Design (RBD) with three replications.

During the 2023–24 season, centres like Appangala and Pottangi were primarily engaged in seed multiplication to ensure sufficient planting material for initiating replicated trials. At Appangala, planting material was successfully multiplied in 2023–24, and in the *Kharif* season (2024–25), the trial has been established with three replications. Similarly, Pottangi completed seed multiplication last year and has now initiated the replicated trial during 2024–25.

On the other hand, several centres undertook replicated trials. At Kozhikode, the CVT trial has been planted as a replicated experiment. In Nagaland, sowing of the replicated trial on high essential oil genotypes was completed, and data recording was done. Barapani evaluated ten accessions—including nine high essential oil genotypes (G2023-11 to G2023-19) and a local check—under a replicated design during 2023–24. Among the genotypes, G2023-14 showed the highest sprouting percentage (90.37%), while G2023-16 recorded the tallest plants (64.87 cm). The local check performed best in terms of fresh clump weight (300.87 g) and yield (11.29 t ha⁻¹). Notably, G2023-14 registered the highest oleoresin content (5.03%), and G2023-13 recorded the highest essential oil content (2.50%).

GIN/CI/4.3: Evaluation of genotypes of ginger for vegetable purpose

(Centres: Kozhikode, Mizoram, Nagaland, Gangtok, Pundibari, Pottangi, Chintapalle)

The trial on evaluation of genotypes of ginger for vegetable purpose aims to identify the bold ginger genotypes suitable for vegetable purposes. The trial laid out at 7 AICRPS centres in

RBD with seven test genotypes, viz., Gorubathan, Bold Nadia, Bhaise, John's ginger, PGS 121, PGS 95 and PGS 102 with three replications. The trial was initiated during *khari*, 2018-19.

Table 24. Pooled fresh rhizome yield recorded in ginger genotypes evaluated for vegetable purpose across Locations (2020–2023)

Entries	CPE	MZM	NGD	POT	PUN	SKM	KOZ	Grand Mean	Rank	% IOC
Bold Nadia	14.69	7.15	17.21	15	12.93	8.81	9.65	12.21	1	9.12
PGS-95	12.87	4.44	12.12	15.53	9.4	10.04	12.33	10.91	7	-2.5
PGS-102	14.26	8.5	10.96	15.4	11	8.88	8.13	11.02	6	-1.52
PGS-121	12.26	6.83	13.36	17.33	10.88	11.48	12.88	12.14	2	8.49
Bhaise (Check)	13.13	6.47	10.83	14.95	11.45	11.18	10.35	11.19	5	0
Gurubathani	13.97	7.19	11.83	14.33	11.84	12.28	9.48	11.56	4	3.31
John's ginger	13.99	5.25	13.46	16.43	10.62	9.21	15.23	12.02	3	7.42
Loc. Mean	13.60	6.55	12.82	15.57	11.16	10.27	11.15	11.54		

After the completion of four year (*Khari*, 2019-23) evaluation, the pooled analysis was conducted to choose suitable candidate variety for vegetable purpose. The mean fresh rhizome yield among genotypes ranged from 10.91 to 12.21 t ha⁻¹. The highest yield was recorded in Bold Nadia (12.21 t ha⁻¹), followed closely by PGS-121 (12.14 t ha⁻¹) and John's Ginger (12.02 t ha⁻¹), all of which surpassed the trial mean of 11.54 t ha⁻¹. Among locations, Pottangi recorded the highest mean yield (15.57 t ha⁻¹), while Mizoram showed the lowest (6.55 t ha⁻¹), highlighting the influence of agro-climatic variability. Over four years of trial, pooled analysis revealed that Bold Nadia emerged as the most consistent top performer with a 9.12% increase over check, followed by PGS-121 (8.49%) and John's Ginger (7.42%), suggesting their suitability for vegetable-type ginger production. These genotypes demonstrated stable performance across multiple locations, making them strong candidates for wider recommendation under varying agro-ecologies.

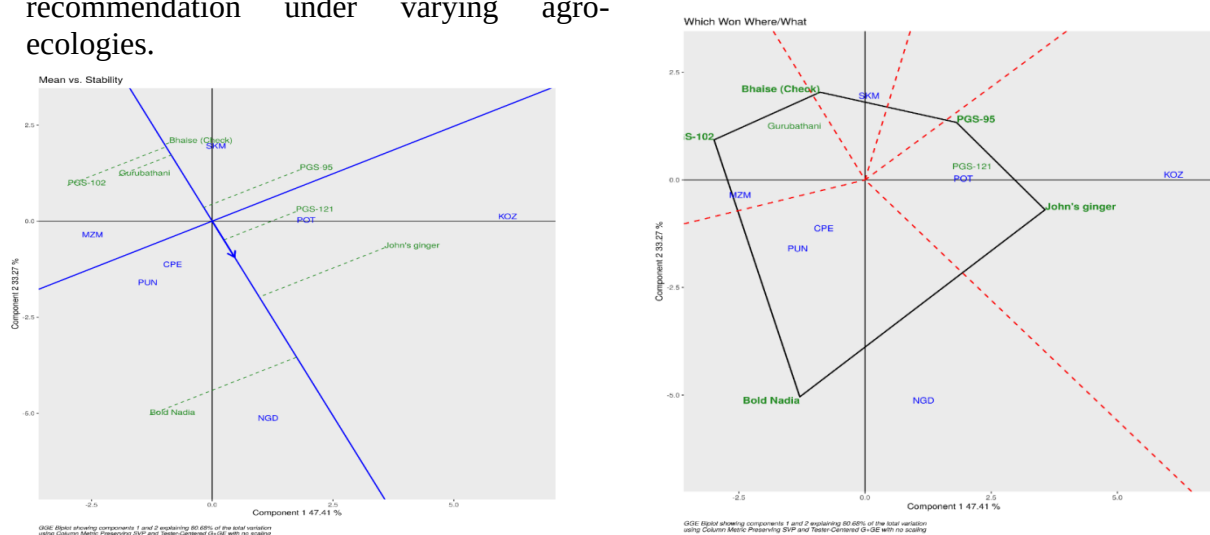


Figure 8: GGE Biplot Analysis of Ginger Genotypes for Vegetable Purpose (2019–2023): (a) Mean vs Stability, (b) Which-Won-Where

Crop Management

GIN/CM/4.1: Evaluation of different ginger-based intercropping systems for higher yield and income

(Centres: Chintapalle, Dholi, ICAR Gangtok, Kalyani, Mizoram, Nagaland, Pottangi, Pundibari, Solan)

The aim of the experiment was to assess the different ginger based intercropping systems for higher yield and income under organic management condition. This experiment was initiated during 2021-22 (*kharif/rabi*) with eight treatments: T₁- Sole ginger; T₂- Ginger + Fenugreek (2:2); T₃- Ginger + Coriander + Leafy veg. (2:2); T₄- Ginger + Maize (2:2); T₅- Ginger + French Bean (2:2); T₆- Ginger + Arhar (3:1) and T₇- Ginger + Elephant foot yam (2:2).

In Dholi, among different intercrops viz., coriander, fenugreek, french bean, pigeonpea, maize, leafy vegetables and elephant foot yam taken with ginger, highest yield of ginger (9.12 t/ha) was recorded in plot intercropped with Arhar followed by elephant foot yam (6.84 t/ha). Yield of ginger as sole crop was found 16.85 t/ha. But, the B:C ratio was found higher in Ginger+Arhar (2.88) intercropping system followed by sole ginger. In Pottangi centre, it was revealed from analyzed data that, highest fresh rhizome yield including ginger equivalent yield obtained by return from intercrops (14.6 Kg/plot) was in the treatment T₁ (Ginger sole crop) followed by T₃ (Leafy coriander & Leafy vegetables intercropped with ginger) with 13.0 Kg/plot and T₆ (13.0 Kg/plot). However, the B:C ratio was highest (7.0) in T₃ followed by T₄ and T₆ (4.7). In Pundibari, results showed that maximum yield (12.86 t/ha) of the main crop i.e. ginger was obtained in T₁ treatment (sole ginger) and based on the B: C ratio of this trail, the maximum B: C ratio (3.16) was recorded in T₇ treatment (T₇: Ginger + EFY - 2:2) followed by T₅ treatment (2.43) and T₃ treatment (2.41). Solan centre reported that Ginger intercropped with sweet corn three crops, *Summer*, *Kharif* and *Rabi* with planting ratio 2:2 gave the highest yield of ginger (18.33 t/ha) and sweet corn (43.64 t/ha) along with maximum net returns per hectare and B:C ratio (1.80) under mid hill conditions of Himachal Pradesh. In Chintapalli, among different cropping systems, plant height (65.32 cm) was more in Ginger + Fenugreek (2:2) based cropping system, whereas number of tillers (11.40) were more in Ginger + Elephant foot yam (2:2). The highest fresh rhizome yield (14.75 t/ha) was recorded in ginger grown as sole crop followed by Ginger + Arhar (3:1) cropping system (10.51 t/ha). The highest benefit cost ratio (13.48) was recorded in Ginger + Elephant foot yam followed by Sole Ginger (12.54). In ICAR-Gangtok centre, results showed that among all the treatments, T₃ showed the maximum ginger equivalent yield (13.0) and significantly higher system productivity, system gross returns, system net returns and system B: C ratio was recorded in T₃ as compared to other intercropping systems. Thus, ginger + coriander based production systems under organic management hold great promises for sustaining livelihood of organic growers of Sikkim Himalayas and similar agro eco-regions. In Nagaland centre, among different treatments, sprouting was recorded highest in T₁ (78.78%) and lowest in T₅ (61.50%). The highest plant population was recorded in T₁ (19.67) followed by T₆ (19.00). The projected yield of ginger was recorded highest T₁ (9.80 t/ha) and followed by T₇ (6.73 t/ha) whereas, lowest yield was recorded in T₅ (4.73 t/ha). BCR was recorded high in T₄ (4.04) and lowest in T₁ (1.03). Mizoram centre reported that maximum ginger plant height (80.59 cm) was recorded in ginger + taro (2:2) intercropping. Maximum fresh weight of clump was recorded in ginger + coriander (2:2) intercropping (332.00 g) while the minimum was recorded in ginger + taro intercropping (267.83 g). The number of rhizomes was significantly highest in ginger + maize (8.83). Maximum rhizome yield was obtained in Ginger sole (7.67 t/ha) and significant highest intercrop fresh yield was recorded in ginger + taro (7.04 t/ha). The highest B:C ratio was

recorded in ginger + maize (T₄) (3.02) followed by ginger + French bean (T₅) (2.98) and T₂ - ginger + fenugreek (2.96). The trial at Kalyani centre reported the highest B:C ratio in T₅-Ginger + French bean (2:2) (4.16) followed by T₇-Ginger + French Bean (3.99).

Table 25. Ginger crop equivalent yield (q/ha) between centres - ginger based intercropping systems (2024-25)

Treatments	Chintapalli			ICAR-Gangtok			Nagaland		Pottangi		
	Yield (t/ha)	GEY	BCR	Yield (t/ha)	GEY	BCR	Yield (t/ha)	BCR	Yield (Kg/plot)	GEY	BCR
Sole ginger	14.75	15.24	12.54	9.33	0	1.74	9.80	1.71	14.6	0.00	3.4
Ginger + Fenugreek (2:2)	8.39	9.22	9.80	5.32	5.52	2.01	5.12	1.59	-	-	-
Ginger + Coriander + Leafy veg. (2:2)	7.25	8.82	8.33	5.11	13.0	2.67	6.46	2.27	13.0	4.4	7.0
Ginger + Maize (2:2)	5.35	7.74	6.93	5.01	7.66	2.06	5.76	4.04	11.6	2.8	4.7
Ginger + French Bean (2:2)	7.29	8.83	8.88	4.94	7.04	1.90	4.73	2.07	10.4	3.6	5.1
Ginger + Arhar (3:1)	10.51	11.11	10.03	5.45	5.36	1.87	6.40	2.02	13.0	2.8	4.7
Ginger + Elephant foot yam (2:2)	6.98	16.58	13.48	4.98	4.79	1.79	6.73	1.91	11.0	1.3	4.6
CD (5%)	1.74			0.68			-		0.36		
SE(m)	0.56			0.23			-		0.12		
CV	11.19			-			-		9.8		

Treatments	Pundibari			Solani			Dholi			Mizoram			Kalyani	
	Yield (t/ha)	GEY (t/ha)	BCR	Yield (t/ha)	GEY (t/ha)	BCR	Yield (t/ha)	GEY (t/ha)	BCR	Yield (t/ha)	GEY (t/ha)	BCR	Yield (t/ha)	BCR
Sole ginger	12.86	0.00	2.17	18.50	-	0.96	16.85	0.00	2.68	7.67	7.67	2.69	15.41	2.05
Ginger + Fenugreek (2:2)	9.73	1.09	1.72	17.87	3.67	0.46	5.35	5.75	1.27	5.43	7.40	2.96	14.74	1.98
Ginger + Coriander + Leafy veg. (2:2)	9.45	3.85	2.41	17.53	5.93	0.74	5.72	5.15	1.40	4.33	5.58	2.40	16.85	3.11
Ginger + Maize (2:2)	8.97	2.57	1.89	18.30	21.82	1.80	5.875	18.3	1.49	6.46	7.71	3.02	13.65	2.15
Ginger + French Bean (2:2)	8.06	5.03	2.43	17.80	7.15	0.70	5.17	12.53	1.13	5.06	7.44	2.98	18.45	4.16
Ginger + Arhar (3:1)	9.51	3.09	2.18	16.20	1.75	0.89	9.12	6.94	2.88	5.15	7.25	2.91	14.74	2.35
Ginger + Elephant foot yam (2:2)	6.24	3.05	3.16	17.37	9.20	0.78	6.84	19.05	2.50	4.02	6.95	2.81	18.02	3.99
CD (5%)	0.75			-	-		-			N.S			0.653	
SE(m)	0.24			-	-		-			0.76			0.2	
CV	4.51			-	-		-			24.14				

Crop Management

GIN/CM/5.1: Evaluation of Plant Growth Promoting Rhizobacteria, *Bacillus safensis* for Phosphorus (P) Solubilization Potential in ginger

(Centres: Ambalavayal, Chintapalli, Kalyani, Kammarpally, Kumarganj, Pasighat, Pottangi, Pundibari, Raigarh)

Among different centres, the treatment T₃ (75 % phosphorus fertilizer and *Bacillus safensis*) was found to be effective in all centres except Raigarh. Ambalavayal reported the highest fresh rhizome yield (32.22 t/ha) under T₃, followed by Kalyani (17.95 t/ha), Pundibari (17.89 t/ha). Other centres reported the highest yield under T₃ are as follows: Pottangi (17.5 t/ha); Pasighat (12.88 t/ha); Chintapalli (12.33 t/ha) and Kumaraganj (8.5 t/ha). The Raigarh centre reported the highest fresh rhizome yield in T₁ (14.12 t/ha). In Kumaraganj, among the 7 different treatments tested for Evaluation of plant growth promoting rhizobacteria, *Bacillus safensis* for phosphorus (P) solubilization potential in ginger, Treatment T₃ (75% phosphorus fertilizer and *Bacillus safensis*) gave highest yield 8.5 t/ha followed by in treatment T₁ (100 % recommended phosphorus (P) fertilizer) 7.9 t/ha and the treatment T₅ (50% phosphorus fertilizer and *Bacillus safensis*) has given yield of 7.75 t/ha. The Pottangi centre reported highest fresh rhizome yield (17.5t/ha) in the treatment T₃ (75% P+ *Baccillus safensis*) followed by T₅ (50% P+ *Baccillus safensis*) with 16.7 t/ha. In Pundibari centre, maximum fresh yield (17.93 t/ha) were recorded in T₃ (75% recommended phosphorus fertilizer and *Bacillus safensis*) followed by T₁ (100% recommended phosphorus fertilizer) T₅ (50% recommended phosphorus fertilizer and *Bacillus safensis*). Whereas, all the parameters were found to be lowest in T₇ (Control i.e. without P fertilizer). Raigarh centre also reported the maximum fresh rhizome yield of 14.12 t/ha in T₃. Among different treatments in Chintapalli centre, T₃ (75% phosphorus (P) fertilizer and *Bacillus safensis*) recorded highest fresh rhizome yield per hectare (12.33 t/ha) followed by T₁ (11.49 t/ha) and T₅ (11.18 t/ha). Ambalavayal centre reported the highest fresh rhizome yield in T₃ (32.22 t/ha), followed by T₁ (31.9 t/ha) and T₅ (30.65 t/ha). In Kalyani, result showed that T₃ (75% phosphorus (P) fertilizer and *Bacillus safensis*) is found to be the best (17.95 t/ha) followed by T₅ (16.72 t/ha) and T₁ (15.25 t/ha). In Pasighat the experiment was conducted with Nadia variety and among the treatments, highest yield (12.89 t/ha) was found in T₃ the lowest yield in control (7.87 t/ha).

Table 26. Fresh rhizome yield (t/ha) of the centres on evaluation of plant growth promoting Rhizobacteria for phosphorus solubilization potential in Ginger

Treatments	ABL	CPE	KAL	KUM	PASI	PUN	POT	RAI	Mean
T ₁ -100% P	31.9	11.49	15.25	7.91	11.97	16.46	16.1	14.12	15.65
T ₂ -75% P	30.65	10.08	14.65	7.5	9.95	14.75	14.5	12.01	14.26
T ₃ -75% P + <i>Bacillus safensis</i>	32.23	12.33	17.95	8.5	12.89	17.89	17.5	12.23	16.44
T ₄ -50% P	25.98	9.77	13.89	7.2	8.73	13.64	13.9	11.60	13.09
T ₅ -50% P + <i>Bacillus safensis</i>	30.65	11.18	16.72	7.75	10.73	15.87	16.7	10.60	15.03
T ₆ - <i>Bacillus safensis</i> alone	25.65	8.15	13.35	7.12	8.25	12.73	15.5	9.38	12.52
T ₇ -Control without P	25.33	7.92	12.48	6.54	7.87	11.52	13.8	8.34	11.73
CD (5%)	1.30	2.97	0.604	1.01	0.91	1.17	0.4	0.58	1.12
SE(m)	-	0.95	0.194	0.33	0.30	0.57	1.1	-	0.57
CV	7.20	16.28	2.252	8.93	6.09	4.82	5.8	-	7.34

Treatments	ABL	CPE	KAL	KUM	PASI	PUN	POT	RAI	Mean
T ₁ -100% P	31.9	11.49	15.25	7.91	11.97	16.46	16.1	14.12	15.65
T ₂ -75% P	30.65	10.08	14.65	7.5	9.95	14.75	14.5	12.01	14.26
T ₃ -75% P + <i>Bacillus safensis</i>	32.23	12.33	17.95	8.5	12.89	17.89	17.5	12.23	16.44
T ₄ -50% P	25.98	9.77	13.89	7.2	8.73	13.64	13.9	11.60	13.09
T ₅ -50% P + <i>Bacillus safensis</i>	30.65	11.18	16.72	7.75	10.73	15.87	16.7	10.60	15.03
T ₆ - <i>Bacillus safensis</i> alone	25.65	8.15	13.35	7.12	8.25	12.73	15.5	9.38	12.52
T ₇ -Control without P	25.33	7.92	12.48	6.54	7.87	11.52	13.8	8.34	11.73
CD (5%)	1.30	2.97	0.604	1.01	0.91	1.17	0.4	0.58	1.12
SE(m)	-	0.95	0.194	0.33	0.30	0.57	1.1	-	0.57
CV	7.20	16.28	2.252	8.93	6.09	4.82	5.8	-	7.34

GIN/CM/5.2: Evaluation of Plant Growth Promoting Rhizobacteria, *Bacillus safensis* for zinc (Zn) solubilization potential in ginger

(Centres: Chintapalle, Kalyani, Kammarapally, Kumarganj, Pasighat, Pottangi, Raigarh)

The experiment was conducted with the following treatments: T₁-100 % recommended zinc (Zn) fertilizer; T₂-50 % Zn fertilizer and *Bacillus safensis*; T₃-50% zinc (Zn) fertilizer alone; T₄- *Bacillus safensis* alone; T₅- Control without Zn.

All centres except Raigarh has reported higher fresh rhizome yield in T₂ among all treatments. In Kumarganj, out of 5 different tested treatments, treatment T₂ (50 % Zn fertilizer and *Bacillus safensis*) gave highest yield (8.67 t/ha) followed by T₁ (100 % recommended zinc (Zn) fertilizer) 7.83 t/ha and T₃ (50% zinc (Zn) fertilizer alone) 7.27 t/ha. Pottangi centre recorded the highest fresh rhizome yield (15.2 t/ha) in T₂ (50% Zn+ *Bacillus safensis*) followed by T₁ (100%Zn) with 14.4 t/ha. In Raigarh, the highest rhizome yield was observed in T₁ (12.5 t/ha) followed by T₂ (10.64 t/ha). In Chintapalli, it was observed that among different treatments in ginger, T₂ (50% Zinc fertilizer and *Bacillus safensis*) recorded highest fresh rhizome yield (13.03 t/ha). In Pasighat, the experiment was conducted with Nadia variety and among the treatments, highest yield was found in T₂ (12.13 t/ha) and the lowest yield in control (8.95 t/ha). The Kalyani centre reported the highest rhizome yield in T₂ (50% zinc (Zn) fertilizer and *Bacillus safensis*) is found the best combination (17.93 t/ha) followed by T₁ (16.59 t/ha) and T₃ (15.22 t/ha). In Kammarapally, the highest yield was reported in T₂- 50% Zinc (Zn) fertilizer and *Bacillus safensis* (11.22 t/ha) followed by T₁-100% recommended Zinc (Zn) fertilizer (9.8 t/ha) as compare to control (3.96 t/ha).

Table 27. Fresh rhizome yield (t/ha) of the centres on evaluation of plant growth promoting Rhizobacteria for zinc solubilization potential in Ginger

Treatments	CPE	KAL	KMP	KUM	PASI	POT	RAI	Mean
T ₁ -100% Zinc	11.98	16.59	9.8	7.83	11.27	14.4	12.50	12.05
T ₂ -50% Zinc + <i>Bacillus safensis</i>	13.03	17.93	11.22	8.67	12.13	15.2	10.64	12.69
T ₃ -50% Zinc fertilizer alone	10.24	15.22	8.58	7.27	10.38	13.5	9.4	10.66
T ₄ - <i>Bacillus safensis</i> alone	11.50	14.58	7.04	6.63	9.93	14.1	9.03	10.4
T ₅ -Control without Zinc	8.12	12.19	6.21	6.25	8.95	12.9	8.2	8.97
CD (5%)	3.14	0.896	0.275	0.328	0.90	0.6	0.838	1.00
SE(m)	1.01	0.271	0.091	0.992	0.301	0.2	-	0.48
CV	18.38	3.060	2.501	10.009	6.38	7.0	-	7.89

Crop Protection and Food Safety

GIN/CP/5.1: Priming of rhizomes for enhanced germination, vigour and storage rot suppression in ginger

(Centres: Chintapalle, Dholi, Barapani, Kammarpally, Pundibari, Raigarh, Solan, Kalyani, Kanke, Ambalavayal, Pasighat, Nagaland, Pottangi)

Among different centres, the treatment A comprehensive multi-location trial on ginger suppression of rot disease was initiated in 2020 and concluded during 2024-25. The experiment involved four distinct treatment protocols to evaluate their effectiveness in germination, yield, and disease suppression: **T₁**-Rhizome treatment with *Trichoprime*; **T₂**: Rhizome treatment with Metalaxyl-Mancozeb (1.25 g L⁻¹) + Imidacloprid (0.5 mL L⁻¹) for 30 minutes; **T₃**: Rhizome treatment with Tebuconazole (1 mL L⁻¹) + Imidacloprid (0.5 mL L⁻¹) for 30 minutes; **T₄**: Standard recommended state package of practices. Each treatment was replicated six times across the trial sites.

At 30 days after planting (DAP), the highest percentage of germination was observed in **T₁** across all centres, except for Dholi, Raigarh, and Solan. Maximum yield was recorded in **T₁** at all centres except Dholi and Solan, indicating the superior effectiveness of *Trichoprime* in promoting ginger growth. The lowest incidence of storage rot was reported from Barapani, Kalyani, Kanke, Medziphema (Nagaland), and Pundibari, suggesting improved post-harvest quality in these regions. The lowest percentage of rhizome rot at both 60 and 90 days after planting was observed in Barapani, Kalyani, Kammarapally, Medziphema (Nagaland), Pasighat, and Pottangi.



This indicates the effectiveness of certain treatments in managing early-stage rhizome diseases. Solan and Ambalavayal recorded lowest disease incidence in **T₃**, whereas Dholi centre reported **T₄** showed maximum reduction in disease.

The findings from this multi-location study highlight the potential of *Trichoprime* (**T₁**) in enhancing germination rates and increasing yield while effectively reducing storage rot and rhizome rot in ginger. However, variations in performance across different regions indicate the need for site-specific recommendations and further research to optimize disease suppression strategies.



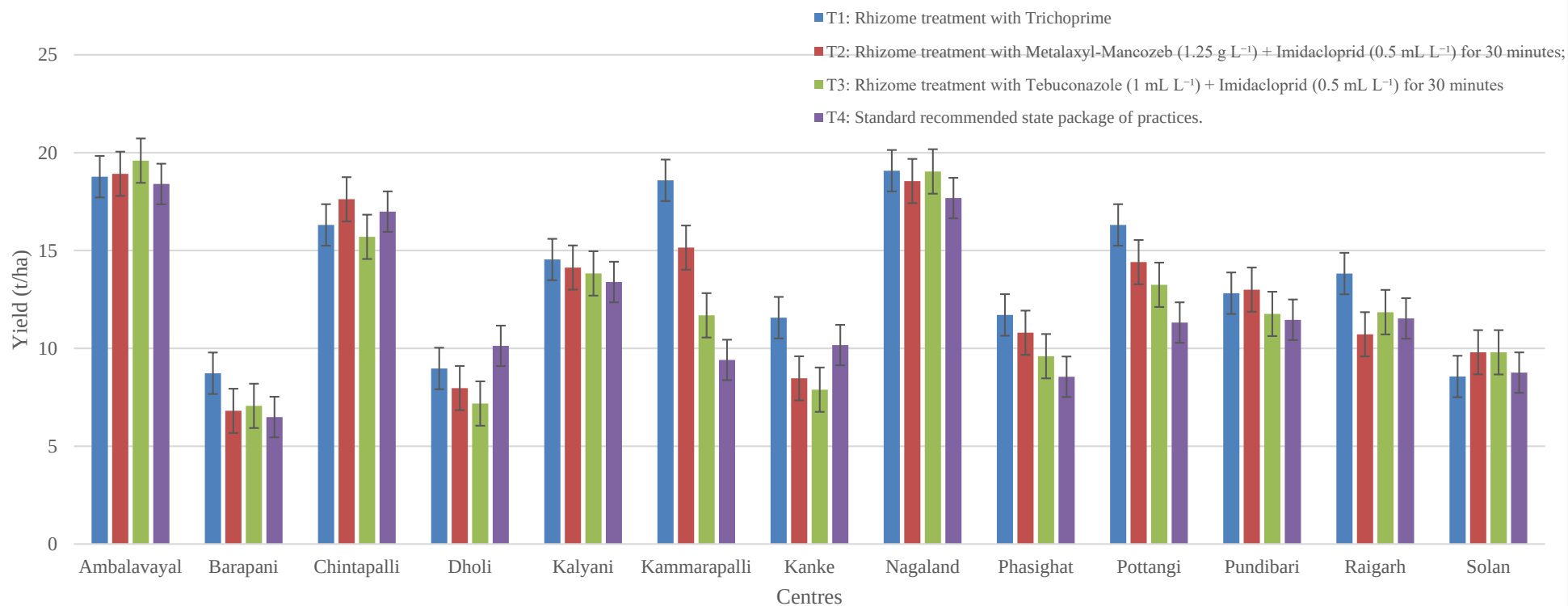
Figure 9. Field view of Pottangi and Kamarapally centre

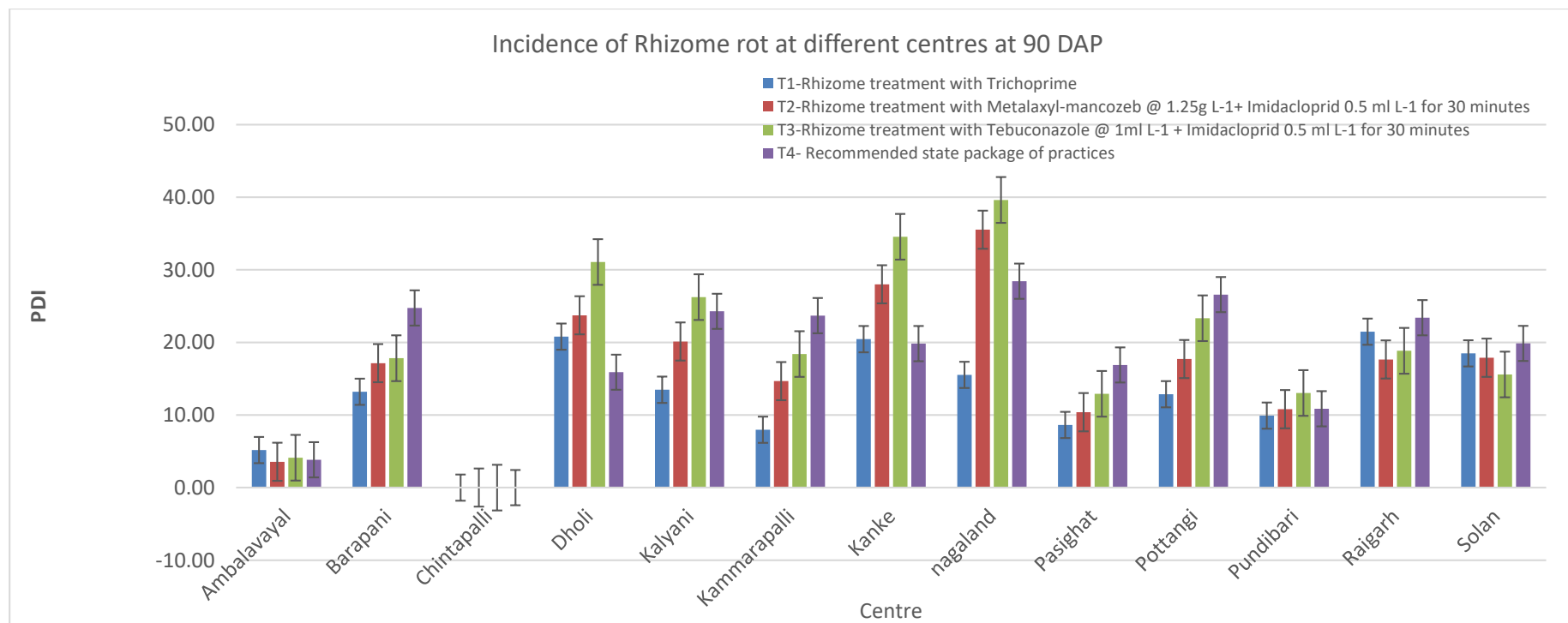
Table 28. Effect of Priming of rhizomes on germination at 30 DAP (Pooled data for three years)

Treatments	ABY	BPI	CTP	DHL	KLY	KMP	KNK	NGL	PSG	PTG	PDB	RGH	SLN	Grand mean
T ₁	94.56	91.70	91.54	74.44	49.34	86.17	71.56	77.79	83.13	87.22	82.84	93.55	84.17	82.15
T ₂	94.78	89.79	90.25	70.69	48.41	77.94	64.45	67.93	84.56	79.58	86.31	93.92	85.75	79.57
T ₃	94.33	85.52	90.44	65.42	47.93	76.06	61.28	68.76	82.98	73.61	82.22	95.43	86.67	77.74
T ₄	94.83	85.99	91.17	85.28	47.64	66.57	69.22	70.12	81.82	83.61	78.82	92.25	82.17	79.19
CD (5%)	2.95	1.36	4.45	4.45	0.35	5.62	6.10	1.08	5.48	4.26	8.54	0.38	1.36	
CV (%)	2.52	7.02	3.91	3.9	1.92	6.18	7.42	0.99	4.87	4.16	7.98	0.33	1.24	
SE (m)	1.38	0.64	2.09	2.09	0.16	2.64	2.86	0.51	2.57	1.9	4.01	0.18	0.64	

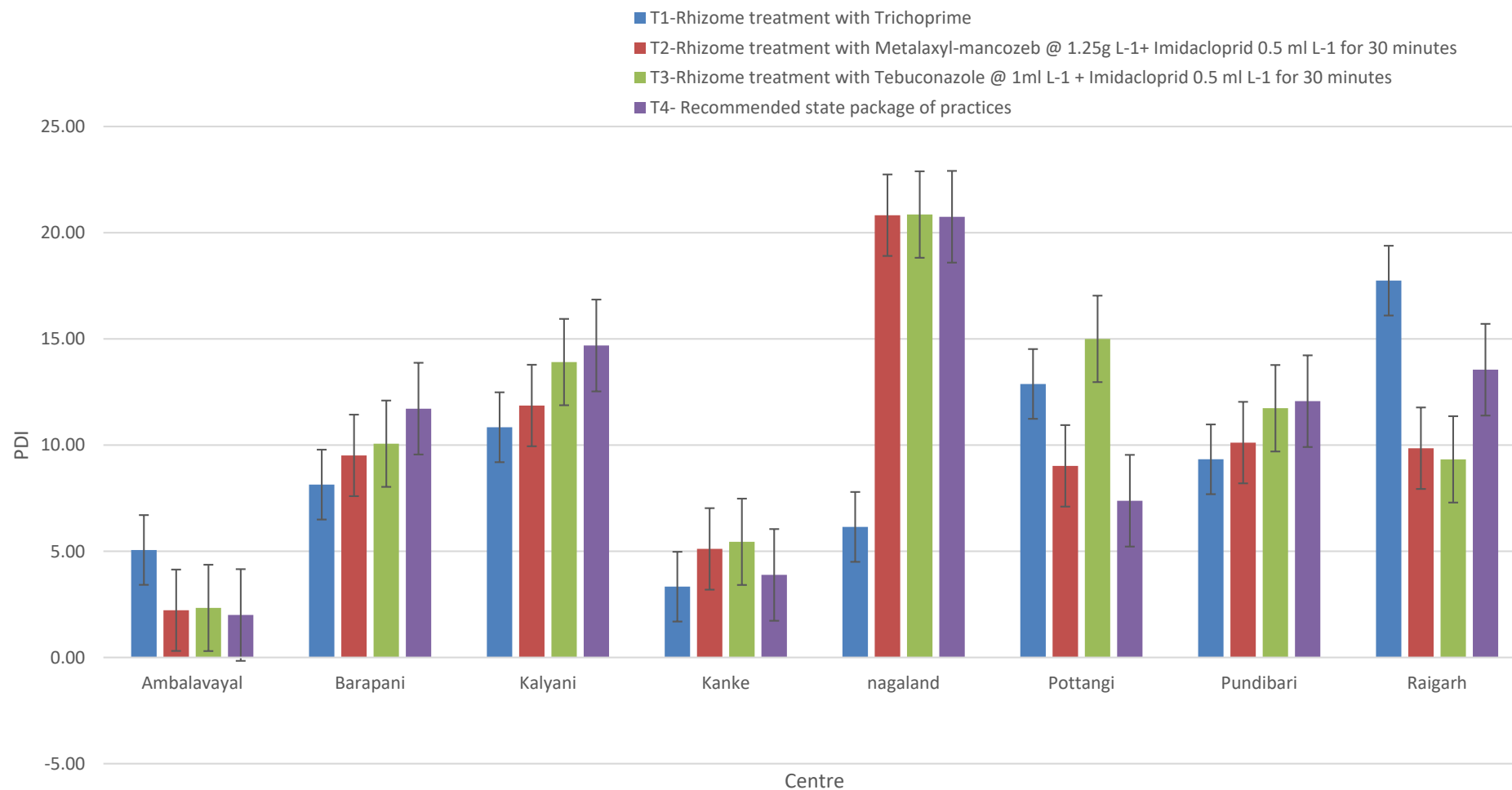
ABY-Ambalavayal, BPI-Barapani, CTP-Chintapalli, DHL-Dholi, KLY-Kalyani, KMP-Kammarapalli, KNK-Kanke, NGL-Nagaland, PSG-Pasighat, PTG-Pottangi, PDB-Pundibari, RGH-Raigarh, SLN-Solan

Influence of priming of ginger rhizomes on Yield (t/ha) (Pooled data for three years)





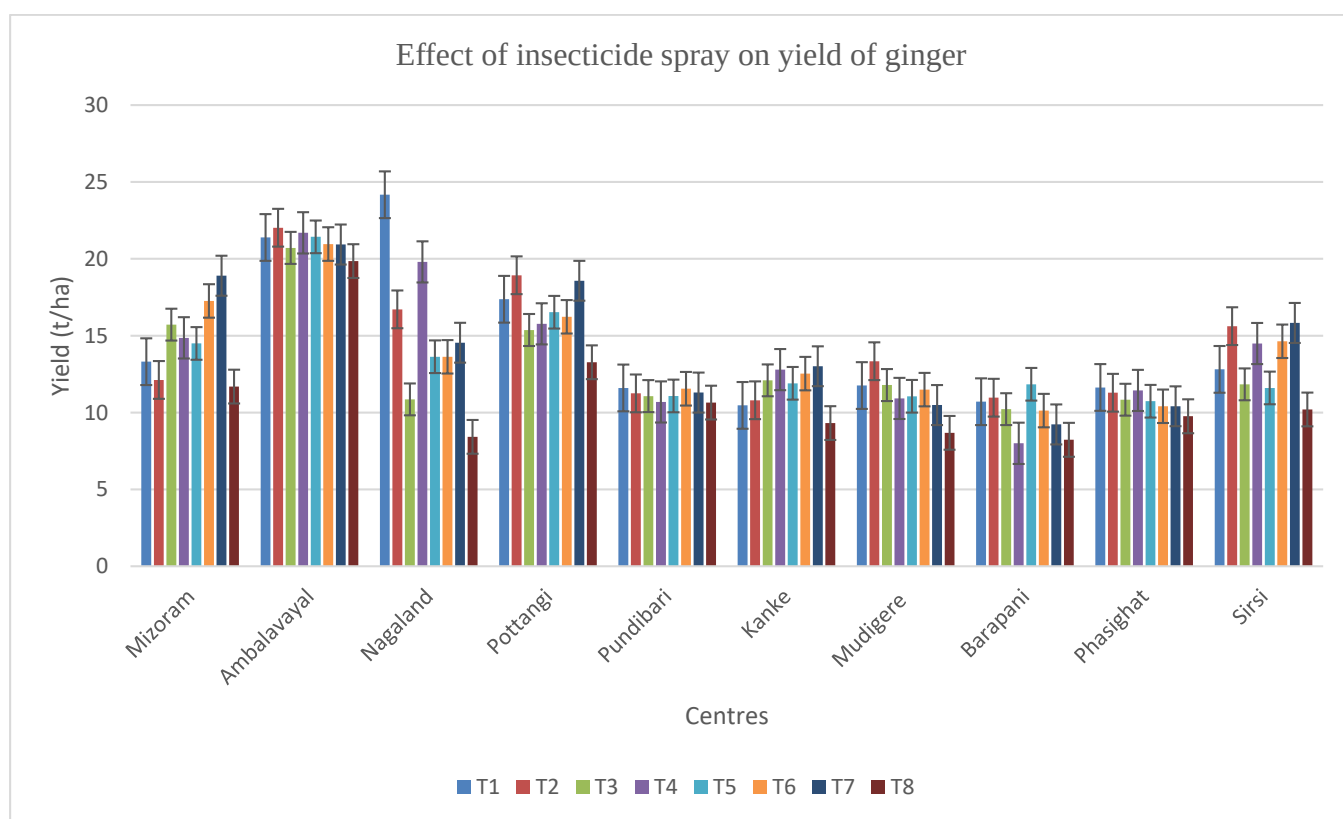
Effect of rhizome priming on stroage rot incidence

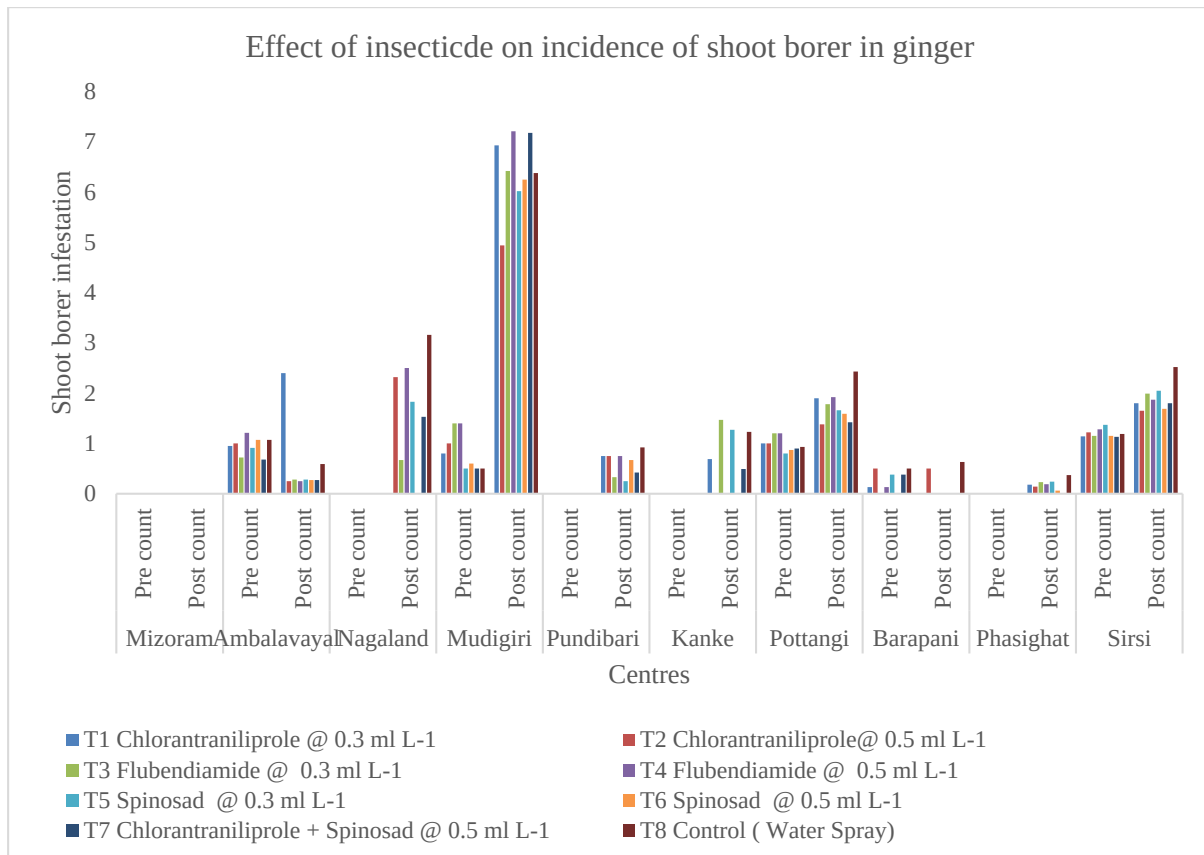


GIN/CP/7.1: Spray schedule optimization of effective insecticides for shoot borer (*Conogethes punctiferalis*) in ginger

(Centres: Ambalavayal, Barapani, Kanke, Mizoram, Mudigere, Nagaland, Pasighat, Pottangi, Pundibari, Sirsi)

Among the various research centres, the incidence of pest infestation was notably low in Mizoram, Barapani and Pasighat, indicating a relatively lower pest pressure in these regions. Application of T₂ - Chlorantraniliprole @ 0.5 ml L⁻¹ was particularly effective in reducing shoot borer infestation at the Ambalavayal, Kanke, Mudigere, and Sirsi centres. This treatment consistently resulted in a significant decline in pest populations across these locations. In contrast, the treatment T₁ - Chlorantraniliprole @ 0.3 ml L⁻¹ exhibited the lowest levels of pest infestation in Nagaland, demonstrating its efficacy in that specific region. Additionally, the treatments T₅ and T₇ were observed to be highly effective in controlling pest infestations at Punibari and Pottangi, respectively. These findings highlight the varying effectiveness of different treatments across different geographical locations, emphasizing the need for region-specific pest management strategies. The pooled yield data for three years showed that, the yield ranged from 8.23 t/ha to 24.17 t/ha with the maximum yield in Nagaland centre for the treatment T₁. Consistently, control in all the centres recorded the lowest yield.





GIN/CP/7.1: Observational trial on the efficacy of *Trichoderma asperellum* and *Pochonia chlamydosporia* for the management of rhizome rot and nematodes in ginger
(Centres: Barapani, Chintapalli, Kozhikode, Pottangi)

Field trial was conducted during the year 2024–25 following a randomized block design (rbd) with five treatments and four replications across four different centres. The results of the trial revealed significant variations in disease incidence among the different treatments and locations. In the untreated control plots, disease incidence ranged from 15.25% at Barapani to as high as 59.5% at Kozhikode. Among the treatments, T₂: *T. asperellum* talc formulation, which involved mass multiplication in a cow dung and neem cake mixture (9:1 ratio) and application at a rate of 1–2 kg per 100 kg mixture (with 2–5 kg of the mass-multiplied formulation applied per plant), demonstrated the lowest disease incidence in both Barapani and Kozhikode. Additionally, at the Kozhikode and Chintapalle centres, T₃: Metalaxyl-Mancozeb (0.125% drench application) was found to be the most effective treatment in managing the disease. Regarding nematode infestation, no incidence was recorded in the Barapani and Chintapalle centres. However, in Kozhikode, nematode infestation was highest in the control plots (71.33%), while the lowest infestation was observed in T₅: PoP recommended nematicide treatment. Furthermore, a significant reduction in nematode egg masses was reported from the Pottangi centre. Yield analysis across locations indicated that T₂ recorded the highest yield in Pottangi, Chintapalle, and Kozhikode. However, in Barapani, the maximum yield was obtained in T₄. Additionally, at Kozhikode, treatments T₃ and T₄ also showed yield levels comparable to T₂, indicating their effectiveness in enhancing productivity.

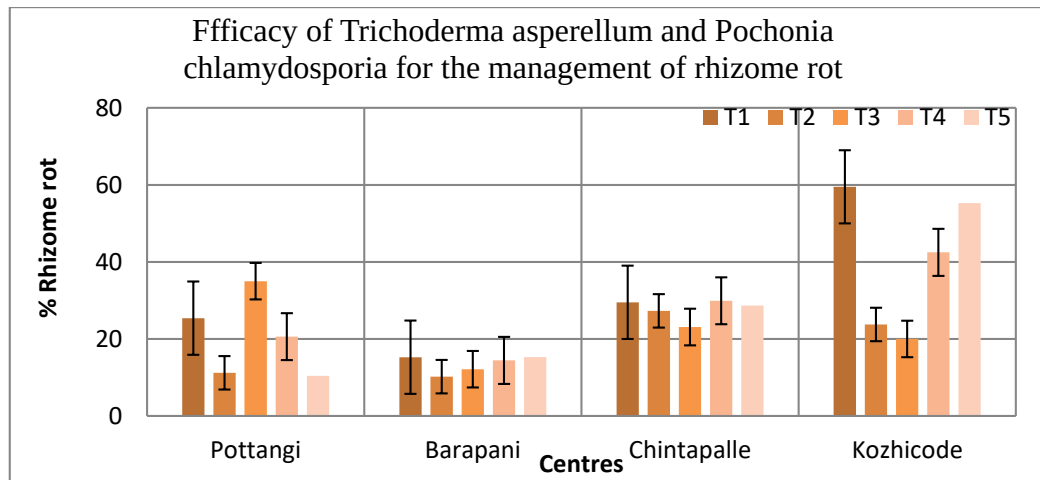
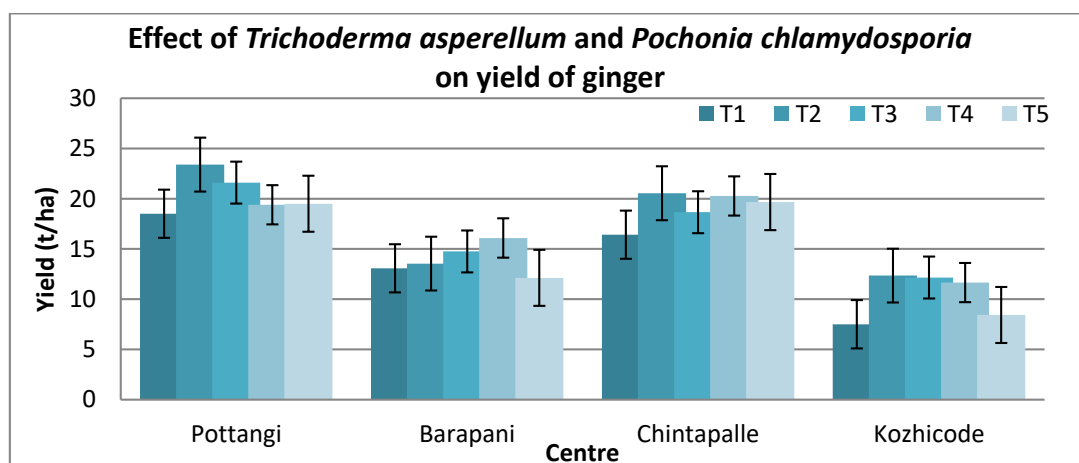


Table 29. Effect of *Trichoderma asperellum* and *Pochonia chlamydosporia* on nematode population

Treatment	Pottangi (Mean egg mass)	Barapani	Chintapalle	Kozhicode (Soil nematode population)
T1	12.8	No nematode incidence	No nematode incidence	71.3a
T2	2.5			20.45c
T3	3.3			46.03b
T4	1.5			11.65d
T5	2.0			6.1e
C.D. (5%)	---			---
SE(m)	---			---
CV%	---			---

Effect of *Trichoderma asperellum* and *Pochonia chlamydosporia* on yield of ginger



05 Turmeric

Genetic Resources

TUR/CI/1.1: Germplasm collection, characterization, evaluation and conservation

(Centres: Barapani, Coimbatore, Dholi, Guntur, Kammarpally, Kumarganj, Pasighat, Pottangi, Pundibari, Raigarh, Solan)

The rich genetic diversity plays a great role in varietal improvement of any crop and turmeric, being a vegetative propagated crop, the importance of variability is further accentuated for its possible exploitation in clonal selection. Collection, characterization, evaluation and conservation activities in the crop is being carried out at Barapani, Coimbatore, Dholi, Guntur, Kammarpally, Kumarganj, Pasighat, Pottangi, Pundibari, Raigarh and Solan, located in the diverse agro-climatic zones. A total of 1749 accessions of cultivated and wild forms and relatives being conserved and maintained by these AICRPS centres jointly (Table 19).

Table 30. Turmeric germplasm collections maintained at various AICRPS centres

	Indigenous		Exotic	Total
	Cultivated	Wild & related species		
Barapani	29	7	-	36
Coimbatore	271	7	-	278
Dholi	70	4	-	74
Guntur	250	4	-	254
Kammarpally	318	-	-	318
Kumarganj	180	2	-	182
Pasighat	75	-	-	75
Pottangi	168	1	2	169
Pundibari	179	3	-	182
Raigarh	137	4	-	141
Solan	40	-	-	40
Total	1717	32	2	1749

A total of 29 turmeric accessions were evaluated at Barapani. Among them, the highest plant height was observed in IC-586753, measuring 108.10 cm. This accession also exhibited the longest leaf length (53.40 cm), the widest leaf breadth (17.57 cm), and the greatest number of leaves (16.17). The highest yield per hectare was recorded in IC-586767, with a yield of 15.77 tonnes. The accession IC-586777 demonstrated the highest curcumin content, reaching 5.86%, while IC-586771 showed the highest dry matter content at 22.3%. Out of 278 genotypes were maintained in the germplasm at Coimbatore under field condition during 2024-25. A total of 200 genotypes were evaluated for fresh rhizome yield per plant, dry rhizome yield per plant, dry recovery per cent and total curcuminoid content. Among the genotypes evaluated, CL 180 recorded the highest fresh rhizome yield per clump (630.50 g) followed by CL 171 (624.10 g), CL 161 (605.10 g). The highest dry recovery was recorded in CL 9 (25.50 %) which was followed by CL209 (24.20 %), CL154 (24.16 %), CL 258 (24.06 %) and CL 5 (22.80 %). The total curcuminoid content (ASTA) among the genotypes also varied significantly. The highest total curcuminoid content was registered in CL 272 (5.84). This was followed by CL 253 (5.70

%), CL 257 (5.18 %), CL 242 (5.10 %) and CL 258 (5.06 %). Among 70 turmeric accessions evaluated at Dholi, accession RH-432 recorded highest yield (54.82 t ha⁻¹) when compared to the check variety, Rajendra Sonali (47.73 t ha⁻¹).

A total of 250 germplasm lines are being maintained at HRS, Lam, Guntur. Among the 72 genotypes evaluated at Guntur, the genotypes viz., LTS-68 (1092 g), LTS-88 (804.8 g), LTS-87 (798.1 g), LTS-81 (787 g) and LTS-34 (741.9 g) recorded significantly higher fresh clump weight over the best checks BSR-2 (569.2 g) and Mydukuru (526.1 g). At Kammarpally, 318 lines were maintained and evaluated for their growth and yield attributes. Among these lines 50 top yielders were selected for further estimation of dry recovery and cucumin content. Among the selected 50 lines, the genotype PTS-16 has recorded maximum yield of 42.79 t ha⁻¹ followed by No-95-02 (41.59 t ha⁻¹) when compared to local check Duggirala Red and national check IISR Prathibha. Maximum dry recovery (29.33 %) was observed in JTS-13 followed by JTS-329 (28.5 %). A total of 180 germplasm collections were maintained and evaluated at Kumarganj. Among the 33 early maturing genotypes, NDH-74 (290 g plant⁻¹), NDH-88 (282 g plant⁻¹), and NDH-173 (274 g plant⁻¹) exhibited the highest yields. In the group of 116 medium maturing genotypes, NDH-14 (272 g plant⁻¹), NDH-135 (270 g plant⁻¹), and NDH-147 (275 g plant⁻¹) recorded the highest yields. For the 37 late maturing genotypes, NDH-11 (280 g plant⁻¹), NDH-56 (265 g plant⁻¹), and NDH-93 (270 g plant⁻¹) performed best.

Out of the 168 *Curcuma longa* accessions evaluated at HARS, Pottangi, 75 accessions recorded more than 5 kg 3m⁻² and 25 genotypes recorded more than 10 kg 3m⁻² fresh rhizome yield during 2023-24. The fresh rhizome yield per plot in *C. longa* varied from 2.2 kg 3 m⁻² (TU-4) to 22.9 kg 3m⁻² (PTS-3), with an average yield of 6.8 kg 3m⁻² among the tested germplasms. The highest yielding varieties were PTS-3 (22.9 kg 3m⁻²), PTS-47 (21.4 kg 3m⁻²), and Kuchipudi (21.0 kg 3m⁻²). The projected yield ranged from 4.88 t ha⁻¹ (TU-4) to 50.8 t ha⁻¹ (PTS-3), with a mean of 15.0 t ha⁻¹. Out of the total 179 genotypes evaluated at Pundibari, 32 genotypes exhibited yields above 35 t ha⁻¹, 15 genotypes showed yields ranging from 30 t ha⁻¹ to 35 t ha⁻¹, and 17 genotypes recorded yields between 25 t ha⁻¹ and 30 t ha⁻¹. Two new turmeric genotypes, TCP 285 and TCP 286, were collected in 2023-24 from the Malda and Kalimpong districts of West Bengal and are being evaluated during the 2024-25 season. Regarding disease resistance, 62 genotypes demonstrated low leaf blotch disease incidence (PDI 0.00 to 10), indicating high resistance to leaf blotch. Additionally, 65 genotypes exhibited low leaf spot disease incidence (PDI 0.00 to 10), showing high resistance to leaf spot. A total 114 germplasm lines (97 *Curcuma longa*, 7 *Curcuma amada*, 5 black turmeric and 5 released varieties) of turmeric are maintained at CARS, Raigarh. Evaluation of turmeric germplasm revealed significant diversity among all the genotypes for rhizome yield and yield attributing traits. The highest rhizome yield recorded in IT 50 (58.3 t ha⁻¹) followed by IG-55 (49.7 t ha⁻¹), IT 51 (46.3 t ha⁻¹) and IG-39 (48.7 t ha⁻¹) over the promising checks CG RH 3 (29.2 t ha⁻¹), Prathibha (24.5 t ha⁻¹), CGHaldi-2 (22.5 t ha⁻¹) and BSR 2 (17.8 t ha⁻¹). At Solan, out of 40 genotypes evaluated, ST19-27 gave the highest fresh rhizome yield of 393.13 g plant⁻¹ with 4.08% curcumin content.

Crop Improvement

TUR/CI/2 Coordinated Varietal Trial (CVT)

TUR/CI/2.8: CVT on high yield and high curcumin turmeric

(Centres: Coimbatore, Guntur, Kammarpally, Kanke, Kozhikode, Navsari, Pasighat, Pottangi, Raigarh)

Coordinated Varietal Trial (CVT) on high yield and high curcumin turmeric aims to find out the high yielding turmeric genotypes with high curcumin content. The trial laid out at 9 AICRPS centres in RBD with 8 test genotypes (RRN 1, CL 258, CL 272, PTS 47, PTS 6, IT 26, NVST 56, NVST 84 as test entries and) with IISR Pratibha, IISR Pragati and CIM Pitamber as Checks. This trial assessed different turmeric genotypes for fresh rhizome yield along with curcumin content across multiple locations and years (2020–2023), aiming to identify varieties harbouring high yield as well as high curcumin content tailored for industrial purpose.

Pooled analysis for three years revealed the mean fresh rhizome yield across locations ranged from 19.3 to 28.7 t ha⁻¹ among the turmeric entries tested. NVST 56 emerged as the highest-yielding genotype with a grand mean of 28.7 t ha⁻¹, ranking 1st with a positive index of competition with best check, IISR Pragati (%IOC) of 0.1% giving the top three performance in 9 out of 26 experiments. Potential yield of NVST 56 is the highest at 73.6 t ha⁻¹ recorded in 2021 at Coimbatore (CBE-21). IISR Pragati, national check used was the second-best performer with a yield of 28.2 t ha⁻¹. NVST 56 has also shown the highest dry rhizome yield performance at 20.6 t ha⁻¹. Curcumin content varied significantly across different locations and year, the mean fresh rhizome yield across locations ranged from 2.70 to 3.99% among the turmeric entries tested. Among the entries, IISR Pratibha (Check) recorded the highest mean curcumin content at 3.990%, securing the top position followed by CL 272, which ranked second with a mean of 3.845%.

The selection of genotypes using the MGIDI index shows a balance between curcumin content and yield traits. PTS 47 have very low MGIDI values, got selected while exerting 10% selection intensity suggesting they are closer to the ideal genotype. These are the most desirable selections for both high yield and curcumin traits. Although the selection process slightly reduced yield, the substantial gains in curcumin indicate that these genotypes are well-suited for industrial usage.

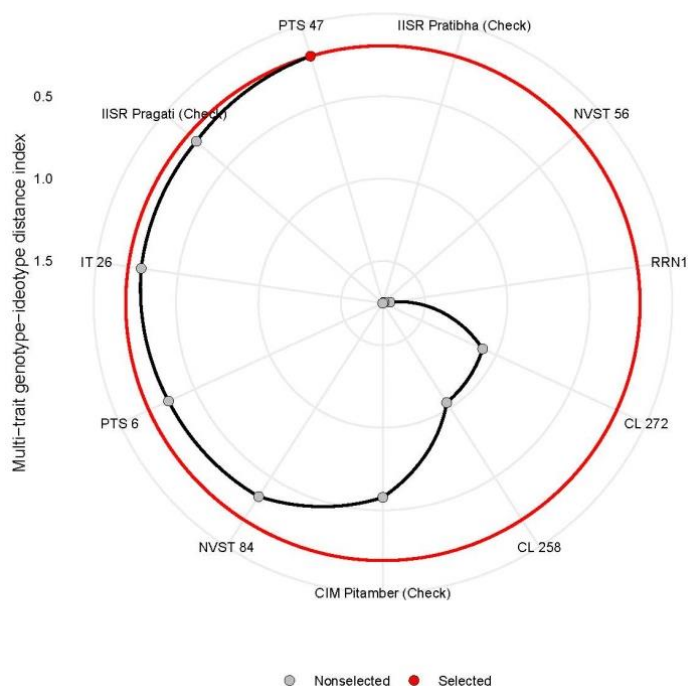


Table 31. Fresh Rhizome yield (in t ha⁻¹) recorded in CVT on high yield and high curcumin turmeric trial pooled over three year *Kharif* 2021-24, for various locations

Entries	BPI	CPE	GTK	KOZ	NGD	POT	PUN	RAI	Grand Mean	Rank	%IOC
R 1.25/4	5.9	11.4	13.0	45.0	10.6	13.5	8.2	18.5	16.2	2	0.38
G 1.00/4	5.9	15.8	11.2	25.6	8.9	14.0	8.3	17.4	13.4	8	-16.97
HP 05/15	7.0	13.8	15.5	20.3	9.1	14.5	8.3	14.8	12.9	10	-20.37
HP 0.5/2	7.9	14.6	10.1	36.2	7.5	12.5	10.3	15.7	14.3	5	-11.21
V 0.5/2	6.9	10.2	10.9	26.7	16.7	16.0	9.0	15.7	14.4	4	-11.01
V1E4 1	4.9	12.2	12.7	32.7	11.0	15.9	8.4	16.2	14.3	7	-11.59
V1E4 5	5.4	13.0	13.1	26.2	8.4	16.2	7.7	24.4	14.3	6	-11.54
V2 E5 2	3.7	15.6	11.7	25.5	10.7	15.5	7.7	16.6	13.4	9	-17.02
Indira Ginger	3.7	12.4	13.8	33.6	13.7	13.6	7.8	29.1	16.5	1	2.19
IISR Varada (control)	6.6	16.5	14.7	29.7	18.2	12.4	8.4	22.5	16.2	3	0.00
Loc MEAN	5.90	13.55	12.67	30.16	11.48	14.4	8.43	19.1	14.5		

Where, BPI: Barapani; CPE: Chintapalle; GTK: Gangtok; KOZ: Kozhikode; NGD: Nagaland; POT: Pottangi; PUN: Pundibari; RAI: Raigarh.

Compared to the national check IISR Varada (mean PDI = 24.1%), three test entries — HP 05/15 (15.8%), V 0.5/2 (18.1%), and HP 0.5/2 (18.4%) — recorded lower average rhizome rot scores. Among these, HP 05/15 (15.8%) was categorized as a resistant genotype (PDI between 6.0 to 15.0%), while V 0.5/2 and HP 0.5/2 fell under the moderately resistant category (PDI between 16.0 to 25.0%). Other entries, including G 1.00/4 (18.7%), V1E4-5 (18.9%), V2 E5 2 (19.9%), Indira Ginger (22.5%), and R 1.25/4 (23.3%), also exhibited moderate resistant, with PDI values comparable to or slightly below the check variety. Notably, V1E4-1 (27.4%) recorded a higher rot incidence than the check and may be considered susceptible (PDI > 25%). (Table 32).

Table 32. Pooled average of rhizome rot incidence (PDI) recorded in CVT on disease tolerance trial in ginger during *Kharif*, 2021-24 at different locations

Entries	BPI	CPE	KOZ	NGD	POT	PUN	Grand Mean	Rank	%IOC
R 1.25/4	5.9	11.4	45.0	10.6	13.5	8.2	23.3	8	3.40
G 1.00/4	5.9	15.8	25.6	8.9	14.0	8.3	18.7	4	22.44
HP 05/15	7.0	13.8	20.3	9.1	14.5	8.3	15.8	1	34.47
HP 0.5/2	7.9	14.6	36.2	7.5	12.5	10.3	18.4	3	23.52
V 0.5/2	6.9	10.2	26.7	16.7	16.0	9.0	18.1	2	24.61
V1E4 1	4.9	12.2	32.7	11.0	15.9	8.4	27.4	10	-13.77
V1E4 5	5.4	13.0	26.2	8.4	16.2	7.7	18.9	5	21.29
V2 E5 2	3.7	15.6	25.5	10.7	15.5	7.7	19.9	6	17.13
Indira Ginger	3.7	12.4	33.6	13.7	13.6	7.8	22.5	7	6.44
IISR Varada (control)	6.6	16.5	29.7	18.2	12.4	8.4	24.1	9	0.00
Loc MEAN	20.4	20.1	15.0	33.4	17.0	16.5	20.7		

Where, BPI: Barapani; CPE: Chintapalle; KOZ: Kozhikode; NGD: Nagaland; POT: Pottangi; PUN: Pundibari.

Bacterial wilt was observed only at Gangtok, Kozhikode, Nagaland and Pottangi centres. The mean PDI score ranged from 23.1% in V2 E5 2 to 7.8% in HP 05/15. Compared to the national check IISR Varada (PDI = 16.6%), three test genotypes — HP 05/15 (7.8%), R 1.25/4 (8.6%), and G 1.00/4 (12.4%) — recorded lower average wilt scores, indicating better resistance to bacterial wilt. (Table 30).

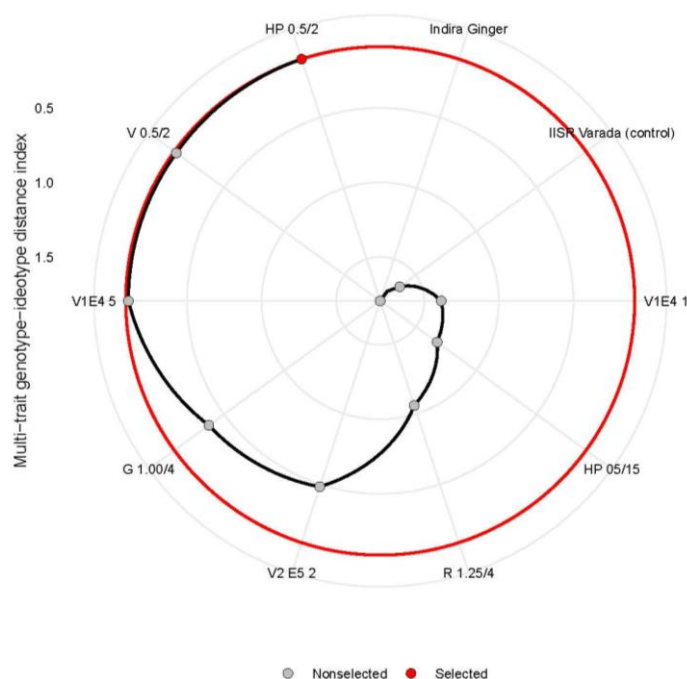
Table 33. Pooled average of bacterial wilt incidence (PDI) recorded in CVT on disease tolerance trial in ginger during *Kharif*, 2021-24 at different locations

Entries	GTK	KOZ	NGD	POT	Grand Mean	Rank	%IOC
R 1.25/4	24.2	0.0	1.7	0.0	8.6	2	48.01
G 1.00/4	27.8	0.0	8.8	0.7	12.4	3	25.18
HP 05/15	18.1	0.0	5.2	0.0	7.8	1	53.25
HP 0.5/2	29.8	0.0	8.4	1.3	13.1	4	20.86
V 0.5/2	34.1	0.0	4.0	1.6	13.2	5	20.47
V1E4 1	39.4	0.0	8.0	0.0	15.8	7	4.87
V1E4 5	22.8	0.0	19.8	0.5	14.3	6	13.59
V2 E5 2	56.8	0.0	12.5	0.0	23.1	10	-39.10
Indira Ginger	22.1	0.0	31.3	5.2	19.6	9	-17.82
IISR Varada (control)	20.2	0.0	23.9	5.7	16.6	8	0.00
Loc MEAN	29.5	0.0	12.4	1.5	14.5		

Where, GTK: Gangtok; KOZ: Kozhikode; NGD: Nagaland; POT: Pottangi.

Among these, HP 05/15, with a mean PDI of 7.8%, was the highly resistant entry, followed closely by R 1.25/4 (8.6%), both falling under the resistant category (PDI < 10%). G 1.00/4, with a PDI of 12.4%, may be classified as moderately resistant (PDI between 10–15%). Genotypes such as HP 0.5/2 (13.1%), V 0.5/2 (13.2%), and V1E4 5 (14.3%) also showed moderately resistant responses, performing better than the check. On the other hand, entries like V1E4 1 (15.8%), Indira Ginger (19.6%), IISR Varada (16.6%), and particularly V2 E5 2 (23.1%) recorded higher wilt scores and can be considered moderately susceptible to susceptible depending on the threshold used.

In order to select ginger varieties that give better yield and can resist rhizome rot and bacterial leaf blight diseases together, a method called the Multi-trait Genotype-Ideotype Distance Index (MGIDI) was used. This method helps select genotypes that come closest to the "ideal" plant—high yielding and multiple disease resistant. Among the tested



types, HP 0.5/2, V 0.5/2, and V1E4 5 showed the best results, with lower MGIDI index (≤ 0.1) with HP 0.5/2 performing the best overall got selected at 5% selection intensity

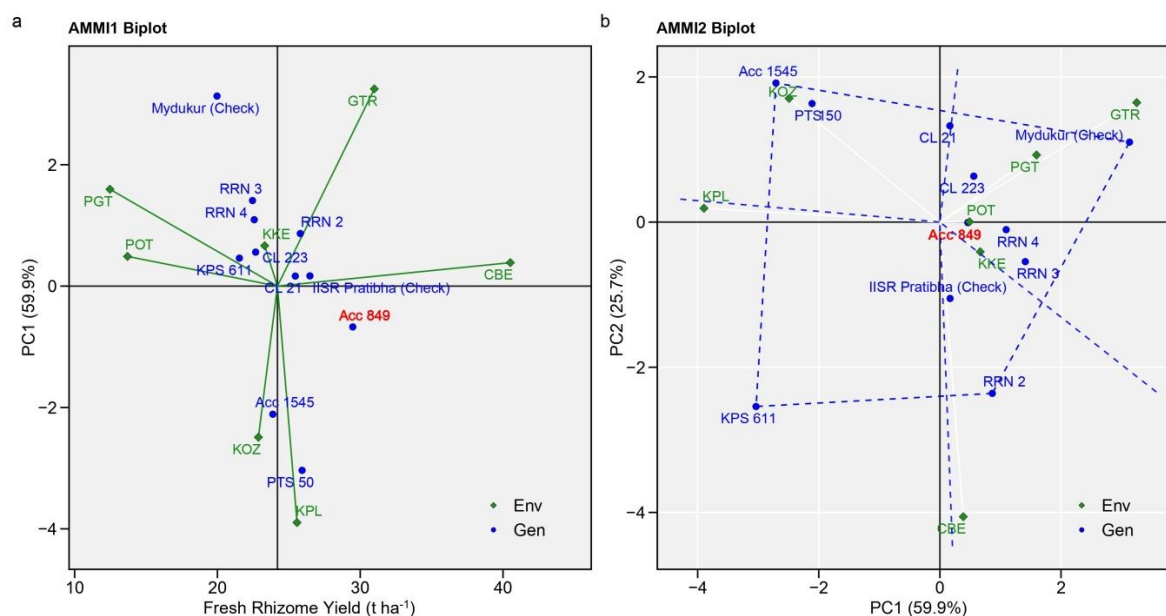
These varieties managed to resist diseases like bacterial wilt and rhizome rot while still giving good yields. Although yield gains were marginally compromised, notable improvements in disease tolerance justified the selection. As a strategic intervention measure, the deployment of HP 0.5/2 genotype having multiple resistance in disease endemic regions where disease is a predictable to escalate, can help farmers to achieve stable and healthy crops.

TUR/CI/2.9: CVT on light yellow colour turmeric for speciality market

(Centres: Coimbatore, Guntur, Kammarpally, Kanke, Kozhikode, Pasighat, Pottangi)

Coordinated Varietal Trial (CVT) on light yellow colour turmeric for speciality market aims identify varieties harbouring high yield as well as light yellow colour and low curcumin content tailored for export potential. The trial laid out at 7 AICRPS centres in RBD with nine test entries (five from ICAR-IISR, two from TNAU, one each from Pottangi and Kammarpally) along with national check, IISR Prathiba and Mydukur are being evaluated since 2020-21.

Upon pooled analysis, mean fresh rhizome yield recorded across test locations ranged from 20.4 t ha⁻¹ (Mydukur) to 29.1 t ha⁻¹ (Acc 849). All the genotypes recorded significantly higher yield than the check Mydukur. Among the genotypes Acc 849 surpassed the best performing check, IISR Prathiba (28.4 t ha⁻¹) achieved an average increment of fresh rhizome yield of 10.9%, with Acc 849 appearing in 14 out of 20 top-three instances. The variety Acc 849 contains 3.00% mean curcumin content shown stable performance for both curcumin as well as yield through AMMI analysis.



TUR/CI/2.11: CVT on black turmeric *Curcuma caesia*

(Centres: Barapani, Coimbatore, Kozhikode, Kumarganj, Mizoram, Navsari, Pottangi, Pundibari)

Coordinated Varietal Trial (CVT) on black turmeric (*Curcuma caesia*) aims to identify varieties harbouring high yield tailored for pharmaceutical use. The trial laid out at 8 AICRPS centres in RBD with seven test entries. After confirming the botanic identity of entries to

Curcuma caesia the trial during 2023-24 was initiated during the planting season 2024-25 at all centre.

Crop Management

TUR/CM/5.1: Evaluation of Plant Growth Promoting Rhizobacteria, *Bacillus safensis* for phosphorus (P) solubilization potential in turmeric

(Centres: Chintapalle, Coimbatore, Kahikuchi, Kalyani, Kammarpally, Kozhikode, Pasighat, Pottangi, Pundibari, Raigarh, Solan)

The experiment was conducted in 11 centres with the following treatments: T₁- 100 % recommended phosphorus (P) fertilizer; T₂- 75 % phosphorus (P) fertilizer; T₃ - 75 % phosphorus (P) fertilizer and *Bacillus safensis*; T₄ - 50 % phosphorus (P) fertilizer; T₅ - 50 % phosphorus (P) fertilizer and *Bacillus safensis*; T₆ - *Bacillus safensis* alone; T₇ – Control without Phosphorus application.

In Chintapalli centre, it was observed that among different treatments, T₃ (75% phosphorus (P) fertilizer and *Bacillus safensis*) recorded more number of tillers per clump (1.67), highest fresh weight of clump (248.70 g), fresh rhizome yield per hectare (26.42 t/ha) and maximum available Phosphorus content (53.00 kg/ha) in the soil at 150 DAS. In Coimbatore, among the seven treatments T₃ recorded (75% Phosphorus fertiliser + *Bacillus safensis*) more fresh weight per clump (299 g) and fresh rhizome yield per hectare (24.95 t/ha) followed by T₅ (23.32 t/ha) and T₆ (22.80 t/ha) (50% Phosphorus fertiliser + *Bacillus safensis*). Kahikuchi center reported the highest rhizome yield in T₃ (29.15 t/ha), followed by T₁ (28.53 t/ha) and T₂ (25.38 t/ha). Kalyani centre reported that T₃ (75% phosphorus (P) fertilizer and *Bacillus safensis*) is found to be the best treatment followed by T₅ (50% phosphorus (P) fertilizer and *Bacillus safensis*) and T₁ (100% recommended phosphorus (P) fertilizer). Likewise, Kammarpally centre reported the highest rhizome yield in T₃- 75% phosphorus(P) fertilizer and *Bacillus safensis* (29.38 t/ha) followed by T₁-100% recommended phosphorus(P) fertilizer (28.53 t/ha) when compare to control (15.58 t/ha). At Kozhikode centre, T₃ has given the highest fresh rhizome yield of 33.64 t/ha followed by T₅ (27.6 t/ha) and T₁ (27.32 t/ha).

In Pasighat, among the treatments, the highest plant height (103.02 cm) at 120 days after planting was recorded in T₃ (75% P + *Bacillus safensis*) followed by T₁ (100% P) with a plant height of 98.09 cm 120 DAP. Number of tillers/clump (4.05) and number of leaves (8.05) were also found to be highest in T₃. As far as yield parameters is concerned, T₃ was given the highest rhizome yield (21.82 t/ha) and the lowest yield in control (13.68 t/ha).

Pottangi centre reported the highest fresh rhizome yield (17.8 t/ha) was observed in the treatment T₃ (75% P+ *Bacillus safensis*) followed by T₅ (50% P+ *Bacillus safensis*) with 17.0 t/ha in turmeric. The Pundibari centre reported that the maximum plant height (99.1 cm), highest number of tillers per plant (3.10) and fresh rhizome yield (28.37 t/ha) were recorded in T₃ (75% recommended phosphorus fertilizer and *Bacillus safensis*) followed by T₁ (100% recommended phosphorus fertilizer) and T₅ (50% recommended phosphorus fertilizer and *Bacillus safensis*). Whereas, all the parameters were found to be lowest in T₇ (Control i.e. without phosphorus fertilizer). Maximum Plant height 45 DAS and 120 DAS and maximum yield 23.27 t/ha found in treatment T₃ in Raigarh centre. Turmeric cv. *Palam Lalima* drenched with plant growth promoting rhizobacteria *Bacillus safensis* and application of 37.5 kg/ha P₂O₅ fertilizer gave the highest yield (261.67 q/ha) along with maximum net returns (₹ 3,80,096) and B:C ratio (1.38) under mid hill conditions of Himachal Pradesh as reported by Solan centre.

Table 34: Fresh rhizome yield (t/ha) of the centres on evaluation of plant growth promoting Rhizobacteria for phosphorus solubilization potential in turmeric

Treatments	CPE	COI	KAHI	KAL	KOZ	KPE	PASI	POT	PUN	RAI	SOL	Mean
T ₁ -100% P	21.90	21.02	22.76	25.52	27.32	28.53	20.50	13.8	25.48	20.13	23.25	22.75
T ₂ -75% P	20.52	22.25	20.87	22.98	24.2	25.38	15.86	14.5	23.50	21.75	21.63	21.22
T ₃ -75% P + <i>B. safensis</i>	26.42	24.95	29.19	30.24	33.64	29.28	21.82	17.8	28.37	23.27	26.17	26.47
T ₄ -50% P	19.64	22.45	22.03	20.91	18.0	25.19	14.92	13.9	20.76	19.86	20.13	19.8
T ₅ -50% P + <i>B. safensis</i>	24.45	23.32	27.13	26.83	27.6	23.71	17.23	17.0	25.37	20.06	22.23	23.18
T ₆ - <i>B. safensis</i> alone	23.20	22.80	20.89	21.65	24.2	20.83	13.94	14.6	19.79	18.46	18.50	19.9
T ₇ -Control without P	17.25	21.65	19.80	18.86	14.14	15.58	13.68	13.2	18.78	18.03	18.00	17.18
CD (5%)	4.79	0.85	1.97	0.95	2.65	1.03	1.15	2.0	2.73	0.728	4.95	2.11
SE(m)	1.54	0.28	0.95	0.306	0.41	0.34	0.387	0.67	0.91	0.25	2.25	0.85
CV	12.16	2.52	3.45	2.22	3.58	2.88	4.60	6.9	7.87	6.23	5.89	5.59

TUR/CM/5.2: Evaluation of Plant Growth Promoting Rhizobacteria, *Bacillus safensis* for zinc (Zn) solubilization potential in turmeric

(Centres: Chintapalle, Coimbatore, Dholi, Kahikuchi, Kalyani, Kammarpally, Kanke, Kozhikode, Kumarganj, Pasighat, Pottangi, Pundibari, Raigarh)

The experiment to evaluate the effect of Plant Growth Promoting Rhizobacteria, *Bacillus safensis* for zinc (Zn) solubilization potential in turmeric was conducted with 13 AICRPS centre with the following treatments: The experiment was conducted with the following treatments: T₁-100 % recommended zinc (Zn) fertilizer; T₂-50 % Zn fertilizer and *Bacillus safensis*; T₃-50% zinc (Zn) fertilizer alone; T₄- *Bacillus safensis* alone; T₅- Control without Zn.

All the doses of bacterial application were done by soil drenching at the time of planting, 30 Dap and 60 DAP as per the treatment schedule. In Chintapalli, among different treatments in T₂ recorded more number of tillers per clump (1.48), fresh weight of clump in grams (262.51 g), fresh rhizome yield (24.10 t/ha) and maximum DTPA extractable Zinc content (1.82 ppm) at 150 DAS.

In Coimbatore, among treatments, T₂ recorded more fresh weight per clump (215.84) and fresh rhizome yield per hectare (22.66t/ha) followed by T₁ (21.66 t/ha) and T₃ (21.38 t/ha). Dholi centre reported highest significant yield of 54.89 t/ha in the treatment, T₁ over control (44.45 t/ha). In Kahikuchi, the treatment T₂ recorded the highest rhizome yield (24.36 t/ha) followed by T₄ (23.54 t/ha) and T₁ (21.64 t/ha). In Kalyani, result showed that T₂ was found to be more efficient (32.25 t/ha) followed by T₁ (29.24 t/ha) and T₄ (28.31 t/ha). The trial at Kammarpally centre recorded that the treatment T₂ has given the highest yield (39.52 t/ha) followed by T₁ (38.49 t/ha) when compare to control (17.85 t/ha). Kumarganj centre reported the highest yield in treatment T₂ (32.73 t/ha) followed by T₁ (31.07 t/ha). In Kanke centre, fresh rhizome yield was found maximum (36.48 t/ha) by application of 5 Kg/ ha Zinc sulfate (hydrated) as recommended dose which was at par with T₂ and as 34.09 t/ha and use of *Bacillus safensis* alone (T₄) as 32.84 t/ha. In Kozhikode, T₂ has given the highest rhizome yield of 27.15 t/ha followed by T₁ (25.45 t/ha) and T₄ (21.65 t/ha).

In Pasighat, the experiment was conducted with NDH-98 variety and treatments were applied as per the technical programme. Among the treatments, the highest plant height (96.19 cm) at 120 days after planting was recorded in T₂ followed by T₁ with a plant height of 92.08 cm at 120 DAP. Number of tillers per clump was maximum in T₂ with 3.64 tillers/clump at 120 DAP. Similarly, number of leaves was also found to be highest in T₂ with 7.96 number of leaves 120

DAP. As far as yield, highest yield (18.49 t/ha) was found in T₂ and the lowest yield was observed in control (11.77 t/ha). In Pottangi centre, highest fresh rhizome yield (20.8 t/ha) was observed in the Zn treatment in T₄ followed by T₁ with 19.2 t/ha in turmeric. Pundibari centre reported the highest number of tillers per clump (3.12) and fresh yield (28.01 t/ha) in T₂ followed by T₁. In Raigarh, maximum yield of 24.10 t/ha was recorded in treatment T₂.

Table 35. Fresh rhizome yield (t/ha) of the centres on evaluation of plant growth promoting Rhizobacteria for zinc solubilization potential in turmeric

Treatments	CPE	COI	DHL	KAHI	KAL	KKE	KPE	KOZ	KUM	PASI	POT	PUN	RAI	Mean
T ₁ -100% Zn	22.2	21.7	54.9	21.6	29.2	36.5	38.5	31.1	25.5	17.8	19.2	26.7	22.2	28.22
T ₂ -50% Zn + <i>B. safensis</i>	24.1	22.7	48.5	24.4	32.3	34.1	39.5	32.7	27.2	18.5	18.9	28.0	24.1	28.84
T ₃ -50% Zn	21.1	21.4	48.2	19.8	26.4	31.3	33.1	29.9	15.8	15.8	18.4	24.0	21.1	25.08
T ₄ - <i>B. safensis</i> alone	22.0	20.7	47.8	23.5	28.3	32.8	28.8	29.1	21.7	14.0	20.8	25.1	22.0	25.89
T ₅ -Control without Zn	19.8	19.6	44.5	21.1	23.8	28.1	17.9	27.5	12.3	11.8	18.2	23.1	19.8	22.11
CD (5%)	1.52	0.46	4.72	1.69	1.254	1.69	0.96	21.885	5.23	0.87	0.6	1.67	1.52	3.38
SE(m)	0.50	0.22	1.52	0.71	0.379	1.66	0.31	7.238	0.69	0.29	0.2	0.81	0.50	1.19
CV	5.16	1.64	7.89	4.65	2.437	10.25	2.25	5.383	5.38	4.19	7.0	3.90	5.16	4.12

Crop Protection and Food Safety

TUR/CP/7.8: Priming of rhizomes for enhanced germination, vigour and storage rot suppression in turmeric

(Centres: Ambalavayal, Chintapalli, Coimbatore, Dholi, Kammarpally, Kahikuchi, Kanke, Kumarganj, Mizoram, Pasighat, Pottangi, Pundibari, Raigarh, Solan)

A comprehensive multi-location trial on turmeric suppression of rot disease was initiated in 2020 and concluded during 2024-25. The experiment involved four distinct treatment protocols to evaluate their effectiveness in germination, yield, and disease suppression: **T₁**-Rhizome treatment with *Trichoprime*; **T₂**: Rhizome treatment with Metalaxyl-Mancozeb (1.25 g L⁻¹) + Imidacloprid (0.5 mL L⁻¹) for 30 minutes; **T₃**: Rhizome treatment with Tebuconazole (1 mL L⁻¹) + Imidacloprid (0.5 mL L⁻¹) for 30 minutes; **T₄**: Standard recommended state package of practices. Each treatment was replicated six times across the trial sites.



Maximum germination was recorded in treatment T₁ at Ambalavayal, Chintapalli Coimbatore, Kammarapalli, Kumarganj, Mizoram, Pasighat, Pottangi, Pundibari centre, where the germination percentage ranged from 81.50 % to 97.33%.

Among the centres tested, maximum germination was recorded in Ambalavayal (97.33%), followed by Coimbatore (96.40). In Dholi centre the treatment T₄ recorded maximum germination (99.58 %), Raigarh and Solan centres recorded maximum germination in T₃. Centres such as Coimbatore, Kammarapalli, Kumarganj, Mizoram, Pasighat, Pottangi, Pundibari reported maximum yield in T₁, the yield ranged from 21.03 t/ha to 34.84 t/ha with maximum yield at Coimbatore centre. All the treatment were on par at Ambalavayal centre, Chintapalle centre reported maximum yield in T₂, Dholi centre recorded maximum yield T₄, whereas Dholi and Solan reported maximum yield in T₃.

The lowest incidence of rhizome rot was recorded in T₁ at Coimbatore and Kumarganj centre with incidence of 0.00 % and 2.28 %. In general the disease incidence ranged from 0.00 % to 20.98% with maximum recorded in Pottangi centre in T₄. The rhizome rot disease incidence ranged between 0.06 % to 14.09%. Centres such as Coimbatore, Pundibari and Pottangi recorded lowest disease incidence, Ambalavayal centre reported least disease incidence in treatment T₃



Figure 10. Field view of Pottangi and kumarganj centre

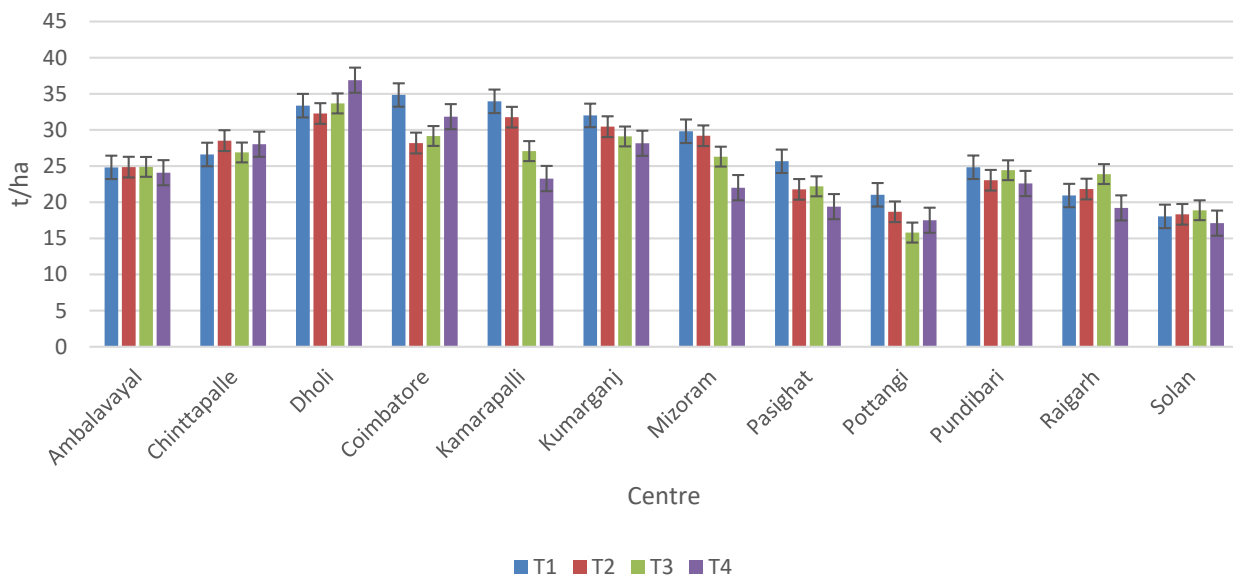
Table 36. Effect of Priming of rhizomes on germination at 30 DAP (Pooled data for three years)

	ABY	CTP	DHL	CBE	KMP	KGJ	MZM	PSG	PTG	PDB	RGH	SLN	Grand mean
T ₁	97.33	94.72	98.33	96.40	90.17	81.50	93.69	92.09	95.83	79.17	94.98	86.69	84.17
T ₂	97.44	94.72	97.36	94.08	86.78	75.67	92.79	92.19	87.08	78.72	95.46	88.64	83.15
T ₃	97.67	94.86	97.36	92.90	81.17	69.86	85.93	92.39	75.00	77.61	96.47	89.92	80.86
T ₄	97.83	95.97	99.58	94.33	77.22	69.78	78.06	90.13	90.56	76.72	94.06	83.72	80.61
CD (5%)	1.70	5.83	1.81	1.94	4.27	2.31	9.59	4.83	2.61	3.69	1.12	1.47	
CV (%)	1.41	5.12	1.49	1.65	3.64	2.45	9.35	4.18	2.40	8.79	0.96	1.38	
SE (m)	0.80	2.73	0.85	0.91	2.00	1.08	4.50	2.26	1.22	1.73	0.53	0.69	

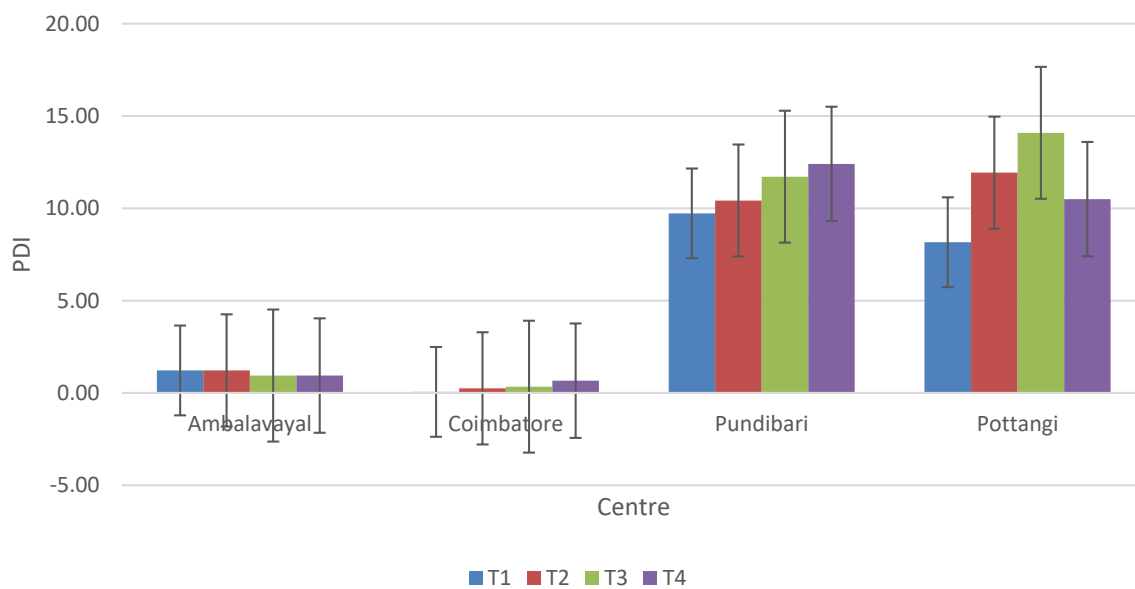
ABY-Ambalavayal, BPI-Barapani, CTP-Chintapalli, DHL-Dholi, KLY-Kalyani, KMP-Kammarapalli, KNK-Kanke, NGL-Nagaland, PSG-Pasighat, PTG-Pottangi, PDB-Pundibari, RGH-Raigarh, SLN-Solan

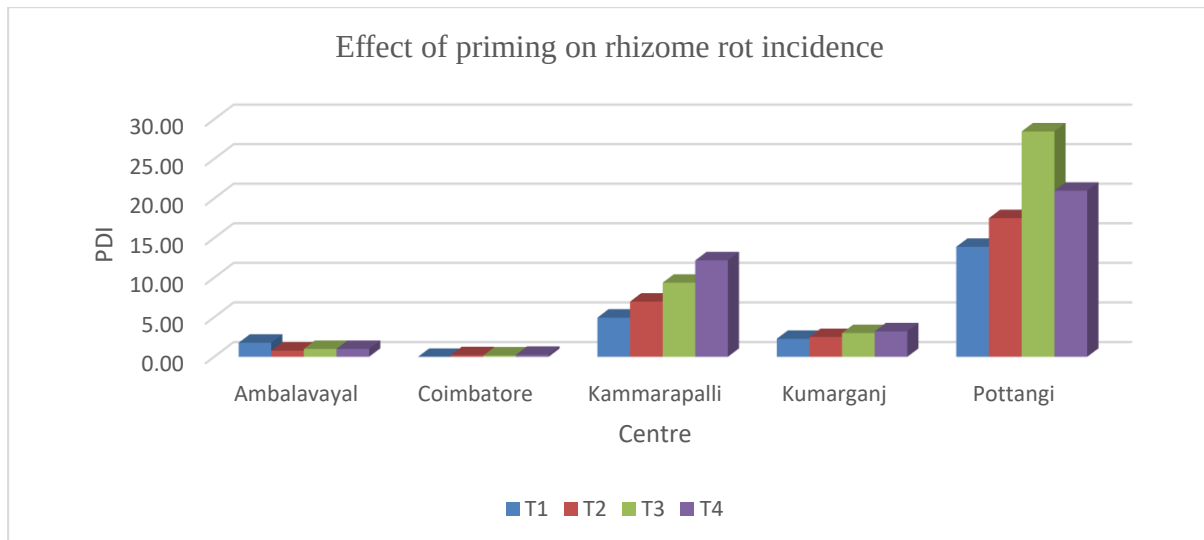
The multi-location trial has provided valuable insights into the efficacy of different rhizome treatments for turmeric cultivation. Trichoprimering of seed rhizome (T₁) emerged as the most promising approach, consistently demonstrating higher germination rates, improved yield performance, and lower disease incidence in multiple locations. However, site-specific variations suggest that T₂ and T₃ also exhibited superior performance in certain locations, indicating the potential for region-specific recommendations. The findings of this study contribute to the development of more effective disease management strategies for turmeric cultivation, ultimately improving productivity and sustainability in the crop.

Effect of rhizome priming on yield of turmeric



Effect of rhizome priming on storage rot

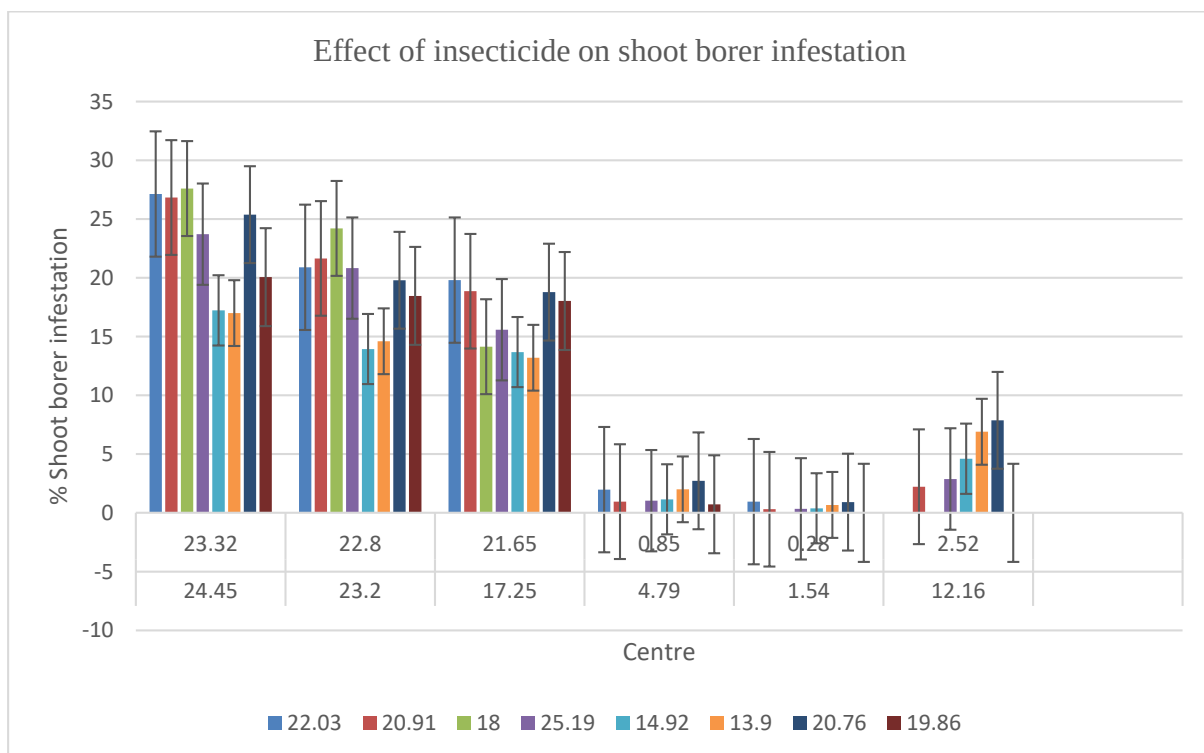




TUR/CP/7.9: Spray schedule optimization of effective insecticides for shoot borer (*Conogethes punctiferalis*) in turmeric

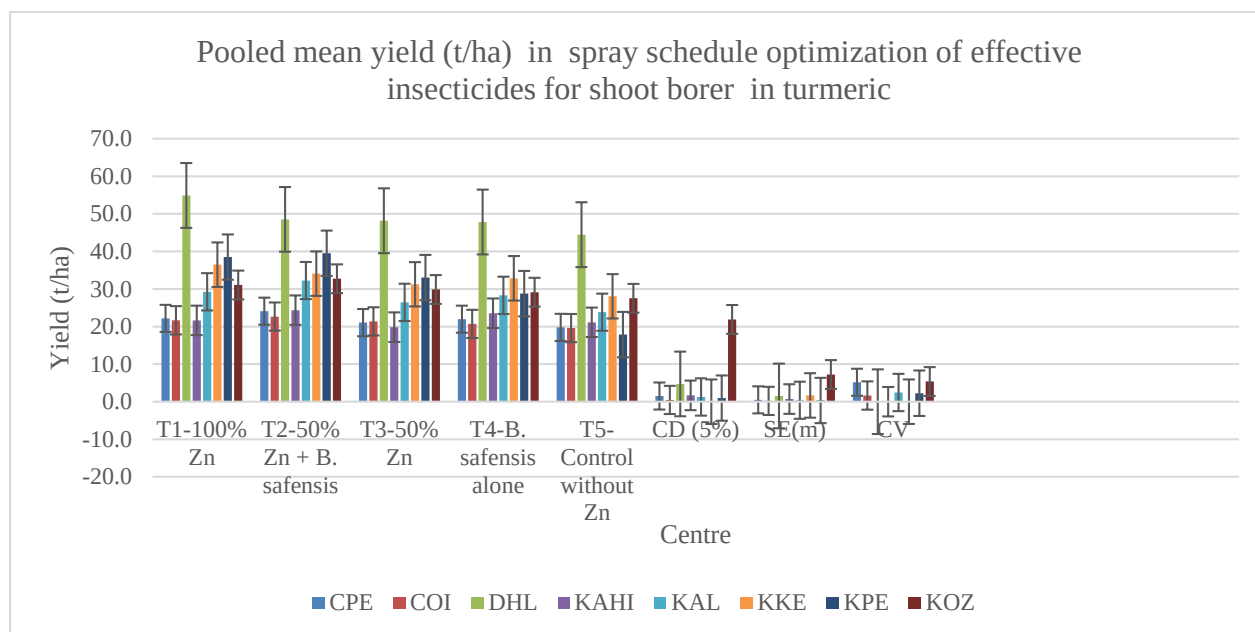
(Centres: Ambalavayal, Barapani, Guntur, Kammarapally, Kanke, Mizoram, Mudigere, Pasighat, Pottangi, Pundibari, Sirsi)

Analysis of pooled data from 2020 to 2023 revealed significant regional variations in pest infestation across different locations. Notably, no pest incidence was observed in Pundibari, Mizoram, Mudigere, and Barapani. Among the treatments evaluated, T₇ (Chlorantraniliprole + Spinosad @ 0.5 ml L⁻¹, applied alternately) proved most effective in minimizing pest incidence in Ambalavayal, Pasighat, Guntur, and Sirsi. In contrast, Kamarapally and Potangi recorded the lowest pest infestation with T₂ (Chlorantraniliprole @ 0.5 ml L⁻¹). The overall pest incidence across all locations ranged between 0.00% and 40.80%, with Potangi demonstrating the highest level of infestation control.



T1- Chlorantraniliprole @ 0.3 ml L⁻¹, T2- Chlorantraniliprole @ 0.5 ml L⁻¹, T3- Flubendiamide @ 0.3 ml L⁻¹, T4- Flubendiamide @ 0.5 ml L⁻¹, T5- Spinosad @ 0.3 ml L⁻¹, T6- Spinosad @ 0.5 ml L⁻¹, T7- Chlorantraniliprole + Spinosad @ 0.5 ml L⁻¹ (alternatively), T8- Control (water spray)

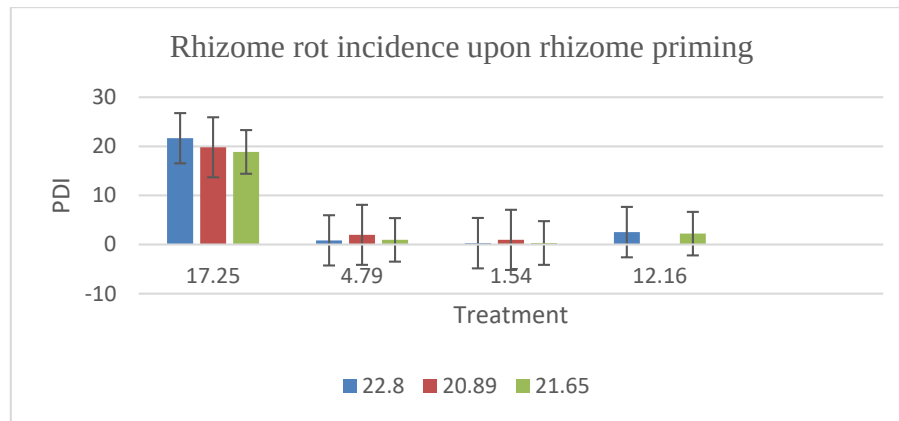
The pooled yield results indicated that in centres such as Kammarapally, Kanke, Mudigere, and Pottangi, treatment T₂ outperformed the other treatments. In Ambalavayal and Pundibari, treatment T₃ showed superior performance. The highest yield was recorded for treatment T₇ in Guntur, Mizoram, and Sirsi, while the highest yield in Barapani was observed with treatment T₁. The overall yield ranged from 6.12 t/ha to 41.26 t/ha.



TUR/CP/7.10: Observational trial on the efficacy of *Trichoderma asperellum* and *Pochonia chlamydosporia* for the management of rhizome rot and nematodes in turmeric (Centres: Barapani, Coimbatore, Guntur, Kozhikode)

Field trial was conducted during the year 2024–25 following a randomized block design (RBD) with five treatments viz., T₁ –Control; T₂ -*T. asperellum* talc formulation; T₃ -Drenching metalaxyl-mancozeb solution; T₄ -Drenching *Pochonia chlamydosporia* liquid formulation; and T₅ -Recommended nematicide) and four replications across four different centres. The results of the trial revealed significant variations in disease incidence among the different treatments and locations.

The data show that T₁ and T₅ exhibit the highest PDI values in Barapani, and Coimbatore with Kozhikode showing significantly lower incidence under the same treatments. Treatments T₂, T₃, and T₄ show minimal or negligible PDI across all locations, suggesting their effectiveness in reducing rhizome rot incidence. Error bars indicate variability within the data, and differences across locations highlight potential environmental or treatment-related factors influencing disease severity.



Guntur consistently shows the highest yield, ranging from 39.9 to 43 (t/ha), indicating suitability of location for turmeric. Kozhikode exhibits moderate yield values between 13.1 and 19.6. In contrast, Coimbatore records the lowest yield, ranging from 4.71 to 5.45 (t/ha), Barapani shows intermediate yield returns, with values fluctuating between 13.04 and 17.22. The observed variation in yield across locations highlights the influence of environmental factors, soil microbiota, and local pathogen pressure on rhizome rot incidence.



Control

*T. asperellum**P. chlamydosporia*

Tree Spices

Genetic Resources

TSP/CI/1.1: Germplasm collection, characterization, evaluation and conservation of clove, nutmeg and cinnamon

(Centres: Dapoli, Pechiparai)

Nutmeg

Among the 24 accessions conserved and evaluated at Pechiparai, MF- 1 recorded maximum tree height (13.04 m) and stem girth (65.04 cm) while MF 4 recorded maximum leaf length (17.35 cm), leaf breadth (6.25 cm), number of fruits (693.20), single fruit weight (56.58 g) and mace yield (296.95 g tree⁻¹). Local check recorded 505.68 fruits per tree, with single fruit weight (52.92 g) and mace yield (168.48 g tree⁻¹).

Among 90 different germplasm collections of nutmeg planted during the year 1996–97, eighteen promising genotypes have been identified. Data revealed that, the highest number of nuts per tree (1840) were registered by genotype DBSKKVMF 65. The maximum fresh nut weight (12.40 g), dry nut weight (8.40 g), fresh mace weight (8.56 g) and dry mace weight (1.90 g) was recorded in genotype DBSKKVMF 9772. The genotype DBSKKV 9772 recorded maximum dry nut yield per tree (12.62 kg) and dry mace yield (2.85 kg) followed by genotype DBSKKV 65 which recorded dry nut yield per tree (11.41 kg) and dry mace yield (1.93 kg). The minimum dry nut yield per tree (0.492 kg) and dry mace per tree (0.075 kg) was found in DBSKKVMF 27

Clove

Among the germplasm of clove planted at Dapoli three promising genotypes were selected. The plant height varied from 4.92 to 6.21 m; girth ranged from 69.82 to 90.42 cm and spread varied from 3.98 m to 4.32 m. No flowering was observed during the year 2023-24.

From the growth parameters, genotype DBSKKVSA-1 was found superior over other genotypes

Among the 24 accessions at Pechiparai, SA-1 recorded the highest tree height of 14.36 m, followed by SA-3 (12.67 m). The lowest tree height was observed in SA- 23 where the tree height was 5.18 m. The accession SA-3 was significantly superior to other accessions and recorded highest stem girth (52.85 cm) compared to local check (41.96 cm). The accession SA-3 recorded the highest leaf length (12.93 cm), leaf breadth (7.73 cm), number of branches (26.16 Nos.). Among the 24 accessions, SA3 had been identified as the best performer as the dry bud yield is 1.83 kg tree⁻¹ while the local check recorded 0.55 kg tree⁻¹.

Cinnamon

Among twelve accessions evaluated at Pechiparai, CV-5 recorded maximum tree height (6.20 m), number of shoots (42.02), dry leaf weight (17.54 kg), wet bark weight (10.64 kg) and dry bark yield (4.51 kg) against local check with plant height (5.22 m), rejuvenation shoots (26.50 Nos.), dry leaf weight (13.48 kg), wet bark weight (8.85 kg) and dry bark yield (3.75 kg).

The details of germplasm of tree spices being conserved at the AICRPS Centres are presented in Table 37.

Table 37. Tree spices germplasm collections at AICRPS Centres

Crop/Centre	Collections	Crop/Centre	Collections
Clove		Cinnamon	
Dapoli	03	Dapoli	11
Pechiparai	24	Pechiparai	12
Total	27	Total	23
Nutmeg		Cassia	
Dapoli	90	Dapoli	06
Pechiparai	24	Pechiparai	-
Total	114	Total	06

TSP/CI/1.2: Collection of unique germplasm in tree spices (Nutmeg)

(Centres: Dapoli, Pechiparai)

Based on the consolidated data from Dapoli and Pechiparai centres, significant variation was observed among the nutmeg genotypes for various morphological and yield traits. At Dapoli centre, plant height ranged from 2.1 m (Acc. 9, Acc. 13) to 6.14 m (Yellow mace type), which also recorded the highest number of branches (80) and the widest plant spread (3.42 m). The local check variety, Konkan Sugandha, stands at 4.23 m. In contrast, at Pechiparai, plant heights generally exceed those observed at Dapoli, ranging from 4.24 m (Acc. 17) to a notable 7.27 m for IISR Viswashree, which serves as a National Check variety. Konkan Swad records a height of 5.43 m. At Dapoli, no. of branches ranged from 32 (Acc. 11) to 80 (Yellow mace type). In contrast, at Pechiparai, no. of branches is considerably lower, ranging from 13.32 (Acc. 17) to 24.44 (IISR Viswashree). Plant spread at Dapoli ranged from 1.72m (Acc. 13) to 3.42m (Yellow mace type). However, the recorded plant spread for Pechiparai are exceptionally large, ranged from 24.10m (Konkan Shremathi) to 44.12m (IISR Viswashree). Among the fruit-yielding accessions at Dapoli, the *Yellow mace type* recorded the highest fruit yield (42 fruits/tree), followed by Acc. 1 (26 fruits/tree) and Acc. 5 (12 fruits/tree). For single fruit weight, IISR Viswashree was the best performer (48.46 g), followed by Acc. 13 (40.92 g) and Acc. 5 (40.14 g). Mace yield per tree was also highest in IISR Viswashree (74.58 g), followed by Acc. 3 (53.02 g), Acc. 5 (51.10 g), and Acc. 13 (46.23 g). In summary, IISR Viswashree emerged as the best performer for plant height, fruit yield, fruit weight, and mace yield at Pechiparai. Among local genotypes, Acc. 13, Acc. 5, and *Konkan Swad* showed consistent promise across multiple traits, and the *Yellow mace type* stood out at Dapoli for its superior plant architecture and yield. By comparing the common accessions across both centres and assessing the superior single-location performers, it is evident that Acc. 13, Acc. 5, *Yellow mace type*, and *IISR Viswashree* are promising lines with strong performance in key economic traits like mace yield, plant vigour, and fruit productivity.

Table 38. Growth and yield parameters of unique nutmeg planted at Dapoli & Pechiparai (2024-25)

Accession	Centre	Plant Height (m)	Branches (no./tree)	Plant Spread (m)	Fruit Yield (no./tree)	Single fruit weight (g)	Mace yield/tree (g)
Acc. 1	Dapoli	3.78	44.00	2.9	26.00		
Acc. 3	Dapoli	3.12	52.00	2.96	-		
	Pechiparai	5.05	18.44		30.32	36.28	53.02
Acc. 5	Dapoli	2.88	46.00	2.82	12.00		
	Pechiparai	4.96	15.10		29.20	40.14	51.10
Acc. 7	Dapoli	2.48	50.00	2.07	-		
	Pechiparai	4.88	21.20		24.50	38.46	42.87
Acc. 9	Dapoli	2.10	38.00	1.82	-		
Acc. 10	Dapoli	2.26	48.00	2.14	-		
Acc. 11	Dapoli	2.12	32.00	1.82	-		
Acc. 12	Dapoli	2.24	42.00	1.9	-		
Acc. 13	Dapoli	2.10	34.00	1.72	-		
	Pechiparai	6.34	19.24		24.42	40.92	46.23
Acc. 14	Dapoli	2.52	46.00	2.1	-		
Acc. 17	Pechiparai	4.24	13.32		26.80	36.22	46.90
Yellow mace type	Dapoli	6.14	80.00	3.42	42.00		
	Pechiparai	5.74	22.62		26.28	32.20	45.10
Konkan Sugandha (Local Check)	Dapoli	4.23	14.44		22.00	34.38	37.00
Konkan Swad	Pechiparai	5.43	20.44		30.24	40.24	45.36
IISR Viswashree (Nat. Check)	Pechiparai	7.27	24.44		44.12	48.46	74.58
Konkan Suganda	Pechiparai	4.98	22.18		25.62	30.42	48.43
Konkan Shremathi	Pechiparai	5.13	23.42		24.10	28.20	42.17

Crop Improvement

TSP/CI/2 Coordinated Varietal Trial (CVT)

TSP/CI/2.4: Coordinated Varietal Trial (CVT) on farmer's varieties of nutmeg

(Centres: Dapoli, Pechiparai, Thrissur)

The trial has been laid out in 2016 with four farmer's varieties (*Kochukudy*, *Punnathanam Jathy*, *Kadukkamakkan Jathy* and *Cheripuram*) provided by NIF/farmer), along with one local check and a national check at Dapoli, Pechiparai and Thrissur (Fig. 23). Budded plants of the varieties were planted in existing coconut plantation at a spacing of 8 m x 8 m and a few accessions have started flowering and fruiting at Thrissur.

Pooled analysis of morphological observations at all three locations indicated significant differences for the growth parameters. The significantly highest plant height was observed in genotype *Kochukudy* (4.6 m). The maximum number of branches was observed in *Punnathanam Jathy* (48.2), with the maximum plant spread (3.5 m) in all three except *Kadukkamakkan Jathy*. The highest yield (45.6 nuts per tree) was registered in *Kochukudy*.

Table 39: Comparative Performance of Farmer-Selected Nutmeg Varieties across Dapoli, Pechiparai, and Thrissur Centres (2024-25)

Entries	Plant height (m)				Number of Branches				Plant spread (m)			Yield (Nut/tree)			
	DAP	PECH	KAU	Mean	DAP	PECH	KAU	Mean	DAP	KAU	Mean	DAP	PECH	KAU	Mean
Punnathanam Jathy	5.1	3.3	4.4	4.3	68.4	17.3	59.0	48.2	3.5	3.5	3.5	66.0	26.7	23.0	38.6
Kochukudy	5.8	3.2	4.8	4.6	62.4	19.0	61.0	47.5	3.8	3.2	3.5	78.0	20.8	38.0	45.6
Kadukkamakkan Jathy	4.1	3.7	2.7	3.5	48.2	19.1	36.0	34.4	3.6	2.2	2.9	42.0	25.2	9.0	25.4
Cheripuram	3.8	5.0	3.7	4.2	46.1	21.3	43.0	36.8	3.7	3.3	3.5	52.0	32.6	8.8	31.1
Local Check	3.5	2.9	4.3	3.6	36.3	15.8	46.0	32.7	3.6	2.7	3.1	36.0	23.7	52.4	37.4
Mean	4.5	3.6	4.0	4.0	52.3	18.5	49.0	39.9	3.6	3.0	3.3	54.8	25.8	26.2	35.6
CD @ 5 %	0.3	1.3	0.57	0.7	14.5	2.17	8.99	8.6	0.1	0.6	0.3	11.1	5.93	4.07	7.0
SE	0.1	0.64		0.4	4.71	1.09		2.9	0		0.0	3.6	2.91		3.3
CV (%)	12	5.34	12.2	9.9	16.7	5.06	14.9	12.2	2.8	4.6	3.7	13.3		13.6	13.5

Where, **DAP:** Dapoli; **PECH:** Pechiparai; **KAU:** Thrissur. Local check included were Dapoli: konkan Sungandha, Pechiparai: IISR Vishwasree and KAU: KAU Pullan.

Table 40. Growth and yield parameters of nutmeg genotypes evaluated in KAU, Thrissur (2024-25)

Entries	Plant height (cm)	No. of branches (Nos)	Plant spread (cm)-EW	Plant spread (cm)-NS	No. of flowers	No. of fruits	Fruit wt (g)	Nut wt (g)	Mace wt(g)	Dry nut wt (g)	Dry Mace wt (g)
Acc.1	4.3	46	2.58	2.8	95.6	46.6	60.43	8.29	2.73	6.45	1.21
Acc.5	4.8	61	3.2	3.14	70.2	39.4	71.92	9.17	2.99	7.29	2.13
Acc.12	3.02	37	2.28	2.24	9.4	2.6	-	-	-	-	-
Acc.13	3.78	42	2.36	2.32	51.2	19	61.16	8.6	2.29	5.78	1.58
Acc.14	3.96	52	3.72	3.5	78	39.4	85.3	7.97	5.57	6.64	2.58
Acc.17	3.52	40	2.74	2.78	97.4	56.4	62.04	9.79	2.07	6.96	1.27
Acc.20	3.38	53	1.76	1.72	48.8	5.8	62.34	9.72	2.68	7.62	0.93
Acc.21	4.24	58.6	2.43	2.04	55.56	10.16	63.83	9.03	2.16	7.36	1.5
Acc.23	4.42	70	4.42	4.24	288.8	228.8	51.98	6.75	2.47	5.85	1.29
Acc.28	3.06	39	2.92	2.59	6	-	-	-	-	-	-
IISR Viswasree (Check)	2.24	29	2.2	2.08	19.8	3.8	51.97	6.61	1.16	3.08	0.41
CD @5%	0.47	9.09	0.6	0.47	8.98	-	-	-	-	-	-
CV(%)	9.88	14.98	17.08	13.48	19.8	-	-	-	-	-	-

TSP/CI/5.1: Evaluation of nutmeg genotypes

(Centres: Thrissur)

The trial was initiated at the AICRPS centre, Thrissur, in 2018 as a long-term evaluation programme. The objective of the trial is to assess the field performance, growth behaviour, and yield potential of selected nutmeg genotypes under the local agro-climatic conditions. A total of ten nutmeg entries—*Acc.1*, *Acc.5*, *Acc.12*, *Acc.13*, *Acc.14*, *Acc.17*, *Acc.20*, *Acc.21*, *Acc.23*, and *Acc.28*—are being evaluated for their suitability in terms of plant vigour, fruit yield, and quality traits along with national check, IISR Viswashree. The trial is designed to generate multi-year performance data for identifying promising lines suitable for farmer adoption or advancement to coordinated evaluation trials.

Budded plants of all the entries have established well in the field and were showing satisfactory growth. Accessions differed significantly for growth characters. *Acc. 5* was observed to be significantly superior in growth as well as mace (2.99g) and nut weight (7.29g). *Acc.23* exhibited remarkable productivity, recording the highest number of flowers (288.8) and fruits (228.8) per tree, although its individual fruit (51.98 g), nut (6.75 g), and mace weights (2.47 g) were lower than those of *Acc.5* and *Acc.14*. *Acc. 14* recorded the highest mace weight and dry mace weight among all the accessions (5.57 g and 2.58g respectively). Among the standard checks, *IISR Viswasree* had the lowest values for almost all traits, including plant height (2.24 cm), branches (29), number of fruits (3.8), and mace weight (1.16 g), establishing the superiority of the selected genotypes over the check under the given conditions.

Crop Management

GIN/CM/4.1: Site-Specific Nutrient Management in Nutmeg (*Myristica fragrans*)

(Centres: Coimbatore, Dapoli, Kozhikode, Vellanikkara)

The experiment aims to evaluate the efficiency of site-specific, soil test-based nutrient application strategies, including fertigation, for enhancing yield and income of nutmeg farmers. The trial involves five treatments: full-dose nutrient application based on soil test results (with and without fertigation), and reduced fertigation levels at 75% and 50%, along with a control. All the participating centres have finalised the site of experiment. Ready to start the experiment during 2025-26.

07 Coriander

Genetic Resources

COR/CI/1.1: Germplasm collection, description, characterization, evaluation, conservation and screening against diseases

(Centres: Coimbatore, Dholi, Guntur, Hisar, Jagudan, Jobner, Kumarganj, Raigarh)

This is a long-term project aims at collecting, conserving and evaluating the available coriander germplasm towards identifying promising accessions with high yielding potential/resistance to powdery mildew disease. A total of 1226 accessions being conserved and maintained by these AICRPS centres jointly (Table 38).

Table 41. Coriander germplasm collections maintained at various AICRPS centres

Centre	Indigenous	Exotic	Total
Coimbatore	278	-	278
Dholi	81	-	81
Guntur	35	-	35
Hisar	100	-	100
Jagudan	149	-	149
Jobner	351	-	351
Kumarganj	200	-	200
Raigarh	32	-	32
Total	1226	-	1226

Among the 278 genotypes of coriander maintained in the germplasm at Coimbatore, 48 genotypes were evaluated along with one check (CO (CR) 4 for growth and yield characters. Among the germplasm lines evaluated, eight genotypes recorded significantly higher seed yield compared to the best check CO(CR) 4 (7.10 g plant⁻¹). The best seven genotypes in terms of seed yield per plant are CS 95 & CS 99 (9.50 g), CS 162 (8.50 g), CS 124 (8.60 g), CS 131 (8.40 g) and CS 132 (8.15 g). Significantly higher seed yield was recorded in CS 95 and CS 99 (8.50 g plant⁻¹) compared to the best check CO(CR) 4 (7.10 g plant⁻¹). The other best performing genotypes were CS 162 (8.40 g plant⁻¹) and CS 131 (8.30 g plant⁻¹). Eighty one accessions of coriander along with two checks (Pant Haritma and Rajendra Dhanian-1) were evaluated for promising lines with respect to yield at Dholi. Out of these 81 accessions, only two accessions namely- RD-417 and RD-412, gave higher yield than both the check variety, Rajendra Dhanian-1 (16.85 g plant⁻¹) and Pant Haritma (16.33 g plant⁻¹). The yield of best ten accessions ranged from 11.37 to 16.94 g plant⁻¹. Among the promising accessions, RD-417 and RD-412 gave the highest yield of 16.94 g plant⁻¹.

Among thirty-five germplasm lines evaluated at Guntur, the genotypes viz., LCC-319, LCC-344, LCC-343, LCC-336 and LCC-316 were found superior in yield. Twelve new germplasm lines under leafy entries were collected and forty-nine entries were evaluated. LCC-387 was found promising and recorded highest fresh herb yield. One hundred accessions of coriander were evaluated at Hisar in two row plots of 3.0 meter length each with Hisar Sugandh, Hisar Bhoomit and Hisar Anand as checks. The plant height ranged from 97.4 cm to 153.6 cm, umbels

per plant 22.0 to 67.8 and seed per umbel 28.5 to 53.9. The seed yield of the germplasm material ranged from 12.8 g plant⁻¹ (DH-284) to 37.8 g plant⁻¹ (DH-280) and 22 lines produced higher seed yield over the best performing check Hisar Anand. The most promising lines for seed yield were DH-207, DH-212, DH-228, DH-234, DH-246, DH-279, DH-280, DH-294-1, DH-297-1, DH-301 and DH-307.

During 2023-24, total 149 entries were evaluated along with the checks at Jagudan. The genotypes viz., UD 217, JCr 2013-9, UD 184, Lam-44, JCr-378, JCr 2013-11 were the highest yielding genotypes. Three hundred fifty one germplasm accessions of coriander were evaluated along with nine check varieties viz., RCr 20, RCr 41, RCr-435, RCr-436, RCr-446, RCr 475, RCr-480, RCr-684 & RCr-728 in augmented design having six blocks at Jobner. A wide range of variability was recorded for all the characters studied. Seed yield per five plants ranged from 2.0 g (UD-576) to 64.0 g (UD 451). Based on seed yield per five plants, out of 351 accessions evaluated, only 29 accessions were found superior than best check variety RCr-475 (33.25 g). Promising top ten accessions identified based on seed yield per five plants are UD-451 (64.0 g), UD-473 (62.0 g), UD-228 (55.0 g), UD-744 (55.0 g), UD 449 (53.0 g), UD-208 (51.0 g), UD-500 (50.0 g), UD-568 (50.0 g), UD-595 (50.0 g), and UD-568 (48.0 g). Thirty two germplasm of coriander were maintained at CARS, Raigarh during Rabi 2023. Evaluation of PGR revealed that maximum seed yield in ICS 20 (48.20 g plant⁻¹) followed by ICS 2 (47.2 g plant⁻¹) and ICS 26 (46.9 g plant⁻¹) over the check Hisar Anand (37.15 g plant⁻¹), CG Shri Chandrahasini Dhaniya-2 (34.9 g plant⁻¹) and Rajendra Swati (24.85 g plant⁻¹).

COR/CI/1.3: Identification of drought tolerant genotypes in coriander

(Centres: Jobner)

The trial was initiated in 2015 under the AICRPS with the primary objective of identifying genotypes resilient under limited moisture conditions. The programme was conducted at the Jobner centre, focusing on screening promising coriander genotypes under differential irrigation regimes. Although the project commenced in 2015, three complete trials were conducted in successive *Rabi* seasons, with the latest trial initiated during the 2020–21 season and continued up to 2023–24. Eighteen genotypes were randomly selected from the conserved germplasm and were evaluated under two distinct environmental conditions: normal irrigation (NI, E1) and restricted irrigation (RI, E2), where staggered irrigation was applied at half the level of the normal regime.

The data recorded over the three consecutive *Rabi* seasons from 2021–22 to 2023–24 reveal significant differences in genotype performance under both irrigation conditions. The mean performance data for seed yield under NI and RI, along with associated drought tolerance indices including Tolerance Index (TOL), Stress Susceptibility Index (SSI), and Stress Tolerance Index (STI), were meticulously calculated to identify the most resilient genotypes. Among the tested entries, UD-808 stood out as the best-performing genotype across both moisture regimes, recording the highest mean seed yield under NI (30.33 g/plant) and RI (21.52 g/plant), with a relatively moderate TOL of 8.81, an SSI of 1.09, and the highest STI of 0.94, thus securing rank 1 in both conditions. This was closely followed by UD-607 and UD-630, which also exhibited consistent performance under stress, with mean RI seed yields of 21.52 g and 20.13 g respectively, and STI values of 0.89 and 0.83.

Genotypes such as UD-599 and UD-542 demonstrated high levels of drought tolerance as reflected by their low SSI values of 0.67 and 0.75, and low TOL values of 4.50 and 4.91, respectively, indicating their inherent resilience to moisture stress despite their moderate yield



Figure 17. Field view of coriander genotypes under restricted irrigation (RI) condition during drought tolerance trial at AICRPS, Jobner (Rabi 2023–24).

levels. Similarly, UD-686 recorded a balanced response with mean yields of 26.66 g under NI and 19.90 g under RI, coupled with an SSI of 0.95 and STI of 0.76. On the contrary, genotypes like UD-627 and UD-625 displayed poor adaptability to water-limited conditions, reflected in their low mean yields under RI (15.22 g and 17.11 g respectively), high TOL (8.84 and 6.59), and lower STI (0.53 and 0.58), ranking among the least drought-tolerant lines.

Overall, the analysis suggests that genotypes such as UD-808, UD-607, RCr-684, and UD-599 are among the most promising entries for cultivation under water-scarce conditions, combining high yield potential with superior drought adaptability indices.

Table 42. Pooled mean performance of coriander genotypes under NI (E₁) and RI (E₂) conditions during *Rabi*, 2020-21 to 2023-24 at Jobner

Entry	Seed yield in NI condition (E ₁)					Seed yield in RI condition (E ₂)					TOL	R	SSI	R	STI	R
	Y1	Y2	Y2	Mean	R	Y1	Y2	Y2	Mean	R						
UD-119	33.93	11.65	31.33	22.79	17	26.50	8.68	29.33	17.59	15	5.20	4	0.86	5	0.58	16
UD-540	40.37	11.73	36.33	26.05	10	31.80	6.36	28.00	19.08	12	6.97	9	1.01	12	0.71	12
UD-542	34.57	14.58	32.00	24.58	14	31.27	8.06	26.33	19.67	11	4.91	3	0.75	2	0.69	13
UD-599	36.73	13.52	31.33	25.13	13	32.50	8.76	29.00	20.63	5	4.50	1	0.67	1	0.74	10
UD-605	37.87	13.44	37.33	25.66	11	34.43	5.64	27.33	20.04	9	5.62	5	0.83	4	0.74	11
UD-607	42.53	15.21	39.00	28.87	2	34.00	9.03	33.67	21.52	1	7.36	11	0.96	8	0.89	2
UD-608	43.90	13.50	35.33	28.70	4	29.07	7.34	30.33	18.21	14	10.50	18	1.38	17	0.75	9
UD-616	32.23	11.41	32.67	21.82	18	27.93	6.54	30.33	17.24	16	4.59	2	0.79	3	0.54	17
UD-625	34.70	12.69	36.00	23.70	16	24.90	9.32	32.67	17.11	17	6.59	7	1.05	13	0.58	15
UD-626	40.03	10.27	32.33	25.15	12	31.10	6.45	30.67	18.78	13	6.38	6	0.95	7	0.68	14
UD-627	36.53	11.57	33.67	24.05	15	23.70	6.73	32.33	15.22	18	8.84	17	1.38	18	0.53	18
UD-629	43.40	13.90	23.67	28.65	6	34.27	6.94	23.33	20.61	6	8.05	14	1.06	14	0.85	4
UD-630	44.17	13.30	29.33	28.74	3	33.80	6.46	28.33	20.13	7	8.61	15	1.13	16	0.83	6
UD-686	35.77	17.54	33.67	26.66	9	32.63	7.17	28.67	19.90	10	6.76	8	0.95	6	0.76	8
UD-808	47.03	13.62	35.33	30.33	1	35.97	7.06	30.33	21.52	1	8.81	16	1.09	15	0.94	1
RCr-436	44.20	12.14	39.00	28.17	7	35.13	6.23	28.33	20.68	4	7.49	12	1.00	9	0.84	5
RCr-475	44.00	10.89	33.67	27.45	8	32.60	7.61	30.00	20.11	8	7.34	10	1.01	11	0.79	7
RCr-684	43.57	13.82	50.00	28.70	5	34.10	7.99	42.00	21.05	3	7.65	13	1.00	10	0.87	3
Mean	39.75	13.04	34.56	26.40		31.43	7.35	30.05	19.39							

Seed yield values (g/plant) were recorded across three *Rabi* seasons (Y1:2021–22, Y2:2022–23, and Y3:2023–24) under two irrigation regimes: normal irrigation (NI or E₁) and restricted irrigation (RI or E₂). TOL (Tolerance Index) = Yield under NI – Yield under RI; SSI (Stress Susceptibility Index) = $[(1 - \text{RI yield} / \text{NI yield}) / \text{stress intensity}]$;

STI (Stress Tolerance Index) = $(\text{Yield under RI} \times \text{Yield under NI}) / (\text{Mean NI yield})^2$.

"R" denotes the rank of each genotype for the respective parameter.

Crop Improvement

COR/CI/2 Coordinated Varietal Trial (CVT)

COR/CI/2.8: Coordinated Varietal Trial on coriander 2021-Series XI

(Centres: Ajmer, Coimbatore, Dholi, Guntur, Hisar, Jabalpur, Jagudan, Jobner, Kalyani, Kota, Kumarganj, Navsari, Pantnagar, Raigarh, Sanand)

Coordinated Varietal Trial (CVT) on coriander 2021 series trial laid out at 15 AICRPS centres in RBD with nine test genotypes (NCOR 102, LCS-19-1, SCr 24, DH 316, JCr 16-02, UD 565, PD 7, NDCor 22, CS 46, ICS 15 and ACr 6) with two national check (Hisar Anand and RCr 728). The CVT trial initiated during *rabi*, 2021-22 and concluded during *rabi*, 2023-24.

Table 43. Summary of Seed Yield per Hectare (Q/ha) data of Coordinated Varietal Trials on Coriander-2021 Series

Entries	AJM	CBE	DHL	GTR	HSR	JBR	JAG	JOB	KOT	KUM	KAL	NAV	PNR	RAI	SAD	Mean	Rank
NCOR-102	13.8	8.1	18.7	8.6	14.7	15.4	9.2	12.5	8.9	14.6	8.9	17.8	18.4	11.2	24.2	13.7	7
LCS-19-1	10.3	8.2	18.5	11.1	12.2	13.2	8.6	14.9	10.4	13.8	10	18	8.6	16.4	22.1	13.1	13
SCr-24	14.2	8.8	14.4	6.9	17.2	14.8	11.6	12.5	12.3	14.5	7	15.3	8.4	11.8	29.1	13.3	12
DH 316	15.7	6.3	16.3	9	17.4	14.1	10	15.3	10.5	16.9	8.1	14.1	15.6	18	25	14.1	4
JCr 16-02	17.5	7.3	16.4	6.8	15.1	12.9	12.6	14.7	13.8	14.7	9.5	17.5	13.7	15.2	26.5	14.3	2
UD 565	13.4	8.8	20.1	8.9	14.8	15.9	12.3	17.1	14.2	13.1	9.6	13.5	15.4	17.9	27.4	14.8	1
PD 7	17.6	6.3	17.6	6.7	17.2	16.1	9.8	12.5	10.8	15.5	7.1	17.8	23.3	12.3	23.4	14.3	3
NDCor 22	16.4	8.8	16.7	7.5	17.2	12.4	7.8	11.8	10.5	14.8	11	16	18.5	15.3	23.3	13.9	6
CS 46	15.3	8.3	17.5	9.4	12.2	13.8	11.4	13	10.4	14	9.4	16.9	15.7	10.9	25.5	13.6	8
ICS 15	16.7	7.4	16.1	7.8	17.6	15.2	11.5	12.2	11.7	15.4	9.6	17.6	10	13.7	19.7	13.4	10
ACr 7	16.8	8.1	16.2	6.7	17.1	13.2	10.1	14.2	11.3	13.6	8.5	14.7	11.9	14.2	24.4	13.4	11
Hisar Anand (Check)	14.6	5.4	16	5.7	15.7	13.5	9.3	11.3	13.1	13.2	8.5	15.8	20.5	14.5	25.4	13.5	9
RCr 728 (Check)	17	7.9	19.1	7.2	18.8	12.9	11.1	14.1	9.5	15.1	8.9	14	18.3	13	21.3	13.9	5
Loc MEAN	15.3	7.7	17.2	7.9	15.9	14.1	10.4	13.6	11.3	14.5	8.9	16.1	15.3	14.2	24.4	13.8	

Where, AJM: Ajmer; COI: Coimbatore; DHI: Dholi; GTR: Guntur; HSR: Hisar; JBR: Jabalpur; JAG: Jagudan; JOB: Jobner; KYI: Kalyani; KOT: Kota; KGJ: Kumarganj; NAV: Navsari; PNR: Pantnagar; RAI: Raigarh; and SAD: Sanand.

Over three years, all test genotypes exhibited significant variation for seed yield across locations. The mean seed yield across locations and years ranged from 1306 to 1482 kg/ha, indicating substantial diversity and adaptive potential among the entries. Among the test entries, UD 565 (1482 kg/ha) recorded the highest mean seed yield, followed by JCr 16-02 (1428 kg/ha) and PD 7 (1426 kg/ha).

These entries surpassed both checks and established themselves as promising lines for further evaluation and potential release.

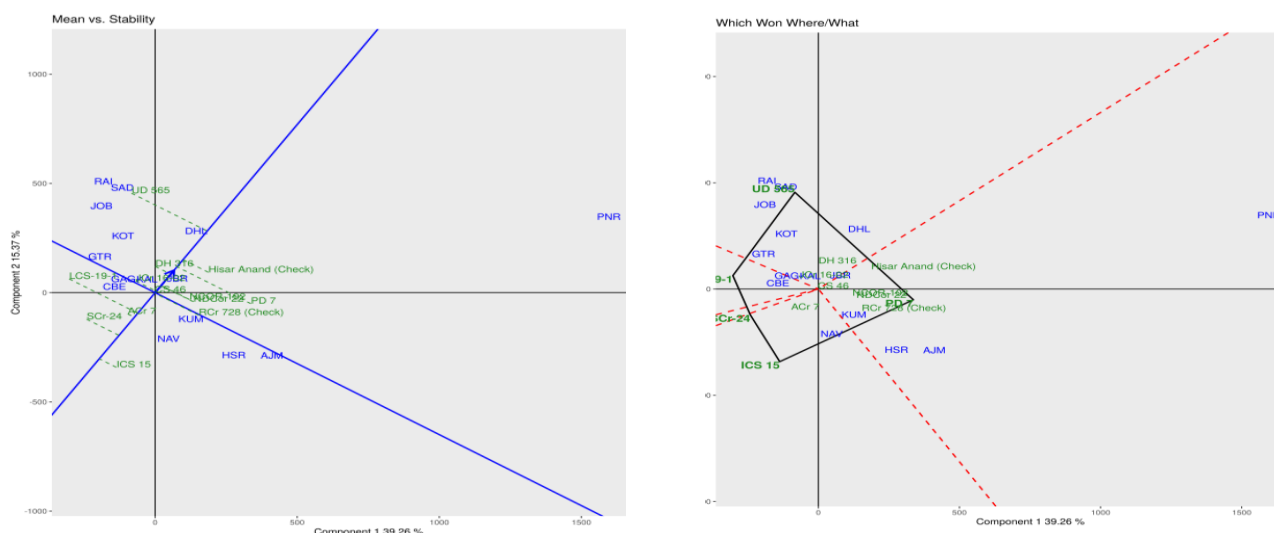


Figure 12: GGE Biplot Analysis of CVT on coriander entries (2021–2023): (a) Mean vs Stability, (b) Which-Won-Where

The genotype UD 565 showed a 7.0% increase in yield over best check, RCr 728 and a 10.1% increase over Hisar Anand the frequency of appearance in the top three performers across all trials by UD 565 (15 times) and JCr 16-02 (10 times). GGE biplot analysis was performed using multilocation seed yield data across all trial centres. The biplot indicated that UD 565, JCr 16-02, and DH 316 clustered close to the average environment coordinate, demonstrating both high mean performance and stability across test environments.

The coordinated varietal trial entries in coriander were screened for their response to powdery mildew disease across two distinct AICRPS centres—Jobner (Rajasthan) and Jagudan (Gujarat)—over three consecutive Rabi seasons.

Table 44. Screening of CVT coriander entries for Powdery Mildew Resistance (PDI%) at Jobner and Jagudan (2021–2024)

Entries	Powdery Mildew (PDI)				Disease reaction
	2021-22	2022-23	2023-24	Mean	
Location: Jobner					
UD 565	38.30	40.00	39.50	39.27	Moderately Resistant
JCr 16-02	37.60	40.10	39.75	39.15	Moderately Resistant
PD -7	39.00	45.50	45.60	43.36	Susceptible
RCr 728 (NC)	48.30	61.00	43.17	50.82	Susceptible
Hisar Anand (NC)	35.00	39.00	45.83	39.94	Moderately Resistant
Location: Jagudan					
UD 565	22.00	21.50	19.63	21.04	Moderately Resistant
JCr 16-02	21.20	23.20	20.50	21.63	Moderately Resistant
PD -7	20.00	24.20	25.30	23.16	Moderately Resistant
RCr 728 (NC)	36.25	24.75	38.50	35.17	Moderately Resistant
Hisar Anand (NC)	32.75	23.25	35.00	30.33	Moderately Resistant

At Jobner, the mean PDI values for test entries ranged from 39.15 to 50.82, indicating a moderate to high level of disease pressure under natural field conditions. The test entries UD 565 (39.27) and JCr 16-02 (39.15) were rated as moderately resistant, showing consistent and relatively lower PDI compared to the susceptible check RCr 728 (50.82), which was rated susceptible. The genotype PD-7, another high-yielding entry, exhibited a higher mean PDI of 43.36, also falling in the susceptible category. The check Hisar Anand showed a mean PDI of 39.94, categorizing it as moderately resistant, similar to UD 565 and JCr 16-02.

At Jagudan, the disease pressure was comparatively lower, with all entries showing improved resistance. The genotype UD 565 recorded the lowest PDI of 21.04, closely followed by JCr 16-02 (21.63) and PD-7 (23.16). Notably, all three were categorized as moderately resistant, confirming their better adaptation and resistance response in this environment. The check RCr 728, which was susceptible at Jobner, displayed improved resistance at Jagudan with a mean PDI of 35.17, while Hisar Anand showed a moderate reaction with a mean PDI of 30.33.

COR/CI/4.8: Quality evaluation in coriander

(Centres: Jobner)

The pooled mean volatile oil content across genotypes ranged from 0.42% (ICS 15) to 0.63% (ACr 7), with an overall trial mean of 0.54%. Genotypes ACr 7 (0.63%), NDCor 22 (0.61%), and PD 7 (0.62%) consistently exhibited higher essential oil content across the three years, indicating their superior aromatic potential. These genotypes outperformed the checks, with Hisar Anand recording a lower oil content of 0.47% and RCr 728 yielding 0.52%.

Considering along with yield performance, UD 565, besides being the highest yielder, also recorded a relatively high oil content of 0.56%, making it a promising dual-purpose genotype for both grain and oil traits. Similarly, ACr 7 combined superior oil content (0.63%) with a high yield of 1419 kg/ha, offering a balanced trait package. In summary, genotypes ACr 7, PD 7, and NDCor 22 demonstrated superior aromatic quality, while UD 565 and DH 316 offered excellent yield potential. Among these, ACr 7 and UD 565 stood out as the best-performing entries for integrated yield and oil traits.

Table 45. Mean seed yield and volatile oil content of coriander entries evaluated in coordinated varietal trials (2021–2024)

Entries	Seed yield (Kg/ha)			Mean	Volatile oil (%)			Mean
	2021-22	2022-23	2023-24		2021-22	2022-23	2023-24	
NCOR-102	860	989	1891	1247	0.44	0.54	0.51	0.50
LCS-19-1	1280	1307	1874	1487	0.58	0.60	0.51	0.56
SCr-24	1061	1135	1550	1248	0.41	0.60	0.53	0.51
DH 316	1354	1478	1770	1534	0.47	0.60	0.53	0.53
JCr 16-02	1599	1329	1479	1469	0.52	0.61	0.50	0.55
UD 565	1607	1978	1546	1710	0.55	0.60	0.53	0.56
PD 7	1105	1156	1501	1254	0.64	0.80	0.43	0.62
NDCor 22	752	838	1955	1181	0.65	0.60	0.59	0.61
CS 46	1124	1215	1574	1304	0.52	0.60	0.61	0.58
ICS 15	831	911	1914	1219	0.41	0.42	0.43	0.42
ACr 7	1000	1108	2150	1419	0.58	0.70	0.60	0.63
Hisar Anand (Check)	995	1090	1315	1134	0.41	0.60	0.41	0.47
RCr 728 (Check)	1198	1355	1667	1407	0.53	0.60	0.44	0.52
Mean	1136	1222	1707	1355	0.52	0.61	0.51	0.54
CD (p=5%)	128.75	205.40	340.58		0.035	0.052	0.103	
CV (%)	6.73	9.97	11.84		3.986	5.092	12.032	
SE (m)	44.11	70.37	116.69		0.012	2.364	0.035	

Crop Management

COR/CM/5.1: Growth and yield of Coriander as influenced by AMF (Arbuscular Mycorrhizal Fungi)

(Centres: Ajmer, Coimbatore, Dholi, Guntur, Jabalpur, Kota)

A multi-location trial conducted to study the effect of Arbuscular Mycorrhizal Fungi (AMF) application and phosphorus levels on the growth and yield of coriander across six AICRPS centres. The experiment was laid out in a FRBD involving two factors: phosphorus application level and mode of AMF application. A total of 12 treatment combinations were tested, combining four phosphorus levels—100%, 75%, 50%, and 0% Recommended Dose of Phosphorus (RDP)—with three AMF application strategies: seed treatment (@100 g/kg seed), soil application (@5 kg/acre at 20 days after sowing), and a combination of both seed and soil application. The treatments ranged from T₁ (100% RDP + Seed treatment) to T₁₂ (0% RDP + Seed treatment + Soil application).

Coimbatore centre reported, among different P levels (1st factor) 100% RDP of P recorded highest seed yield of 12.40 q/ha. In case of mode of application (factor 2), maximum plant height (60.50 cm) and seed yield (11.56 q/ha) was recorded in treatment T₃ (100% RDP + Seed treatment + soil application of VAM). Among the interaction 100% RDP + Seed treatment + soil application of VAM recorded maximum plant height of 69.40 cm and maximum seed yield was recorded in 100% RDP + seed treatment (12.53 q/ha) followed by 75% RDP + Soil application + seed treatment of VAM (12.33 q/ha). In Ajmer centre, the trial results showed application of 50, 75 and 100 % recommended P gave 9.61, 11.89 and 14.00 q/ha seed yield whereas among AMF application methods, seed treatment along with soil application gave 11.55 q/ha seed yield. Maximum seed yield of 14.53 q/ha of coriander was recorded with the application of 100% RDP and seed treatment of coriander with AMF@100g/kg of seed at the time of sowing and soil application AMF @5 kg/acre 20 days after sowing. The highest BC ratio was reported in 100 % RDP application.

In Dholi centre, among the different treatments, the highest seed yield was observed in 100 % RDP level (19.28 q/ha) followed by 75 % RDP (18.78 q/ha) and Seed treatment + soil application level (18.34 q/ha). The level 100 % RDP also exhibited the highest HI %, net return and BC ratio.

In Guntur, effect of various levels of Phosphorus in combination with various application mode of AMF (Arbuscular mycorrhizal fungi) revealed that 75%RDP + ST + SOT (1293.00 kg ha⁻¹), 100% RDP (Recommended dosage of Phosphorus) in combination with seed treatment (ST) and soil treatment (SOT) of AMF recorded higher yields of 1268.00 kg ha⁻¹ followed by 100% RDP + ST (1256.00 kg ha⁻¹) and were on par with one another and significantly superior to the absolute control (804 kg ha⁻¹) (Table 14). In Jabalpur centre, 75% RDP level performed better in terms of plant height, branching, and earlier maturity compared to other phosphorus levels. The highest yield (15.27 q/ha) was obtained in this treatment only. The combined application of VAM through seed treatment and soil application showed the most beneficial effects on plant height and branching and yield (14.43 q/ha). These results suggest that optimized phosphorus levels and an integrated approach to VAM application can enhance growth and productivity. The highest BC ratio was recorded in 75% RDP application (3.53) and seed treatment and soil application (3.26). In Kota centre, application of 100% RDP was recorded significantly higher growth, yield attributes and yield (19.97 q/ha) of coriander over control. Among the different mode of application, seed treatment + soil application gave significantly higher seed yield (19.81 q/ha) of coriander and net returns and BC ratio (4.07) as compared to seed treatment.

Table 46: Performance of Coriander under AMF treatment and different doses of phosphorus application

Treatment	Ajmer		Kota		Coimbatore		Guntur		Dholi		Jabalpur	
	Yield	BCR	Yield	BCR	Yield	BCR	Yield	BCR	Yield	BCR	Yield	BCR
Phosphorus level												
100% RDP	14.00	1.62	19.97	4.03	12.40	1.76	12.2	1.44	19.28	1.49	14.60	3.25
75% RDP	11.89	1.24	19.25	3.92	11.86	1.70	12.0	1.46	18.78	1.47	15.27	3.53
50% RDP	9.61	0.82	18.42	3.77	10.76	1.71	10.7	1.22	17.27	1.40	12.93	2.91
0% RDP	6.72	0.30	16.97	3.52	8.60	1.70	8.2	0.79	16.36	1.24	12.12	2.82
SEm±	19.6	0.04	0.67	0.17	0.41	-	0.32	-	33.30	0.05	0.43	-
CD (P=0.05)	57.9	0.11	1.97	NS	1.30		0.95	-	98.32	0.16	1.26	-
Mode of application of VAM												
Seed Treatment	10.54	1.32	17.32	3.54	10.41	1.69	10.34	0.85	17.47	1.42	12.90	2.98
Soil Application	9.58	0.77	18.83	3.82	10.76	1.71	10.74	0.73	17.96	1.37	13.87	3.14
Seed treatment + Soil Application	11.55	0.90	19.81	4.07	11.56	1.73	11.25	0.79	18.34	1.42	14.43	3.26
SEm±	17.0	0.03	0.58	0.15	0.36	-	0.28	-	28.84	0.04	0.74	-
CD (P=0.05)	50.2	0.10	1.71	NS	1.13	-	0.82	-	NS	NS	2.17	-

COR/CM/6.1: Effect of growth regulators on yield and quality of Coriander
(Centres: Coimbatore, Guntur, Hisar, Jabalpur, Jobner, Kota, Raigarh)

The experiment on effect of growth regulators on yield and quality of Coriander which was initiated in the year 2022-23 with seven centres with the following nine treatments: T1-Salicylic acid @ 50 ppm; T2 - Salicylic acid @ 100 ppm; T3-Jasmonic acid @ 50 ppm; T4-Jasmonic acid @ 100 ppm; T5-Benzyl adenine @ 10 ppm; T6-Benzyl adenine @ 20 ppm; T7-Brassinosteroid @ 0.50 ppm; T8-Brassinosteroid @ 1.00 ppm; T9-Control (Water spray). In Hisar centre, significant differences were obtained for all the treatments. Maximum Umbels per plant (53.2) and seed yield (19.93 q/ha) was recorded in treatment T6 (application of Benzyl adenine @ 20 ppm) which is being at par with T5 (spray of benzyl adenine @ 10 ppm) (19.66 q/ha). In Guntur, during 2023-24, among the different growth regulators evaluated, the highest yield was obtained in T1 (salicylic acid @ 50 ppm) (12.58.q/ha) followed by T5 (benzyl Adenine @ 10 ppm) (12.07 q/ha). The seed yield of T2 (12.04 q/ha), T3 (11.66 q/ha) were on par with one another and significantly superior to the control (10.00 q/ha). The highest B:C ratio was observed in T5 (1.46), followed by T1 (1.32) and T6 (1.30). In Coimbatore, the highest coriander seed yield was observed in T1- salicylic acid @ 50 ppm (12.33 q/ha) followed by T5- benzyl adenine @ 10 ppm (12.13 q/ha) and T2 - salicylic acid @ 100 ppm (12.06). On the other hand, the highest B:C ratio was obtained in T5 (1.94). In Jabalpur, the findings revealed foliar-applied PGRs has significant result in treatments. BR@ 0.5ppm and JA@ 50ppm showed

highest value in growth parameters whereas JA@ 50ppm and BA@ 20ppm has maximum value in yield parameters. The highest B:C ratio was recorded in plant treated with BA@ 20ppm.

In Jobner centre, brassinosteroid treatments recorded maximum plant height, number of branches/plant, umbels/plant, umbellets/umbel, seeds/umbel, test weight and seed yield of coriander. T8 (brassinosteroid @ 1.00 ppm) showed the highest seed yield of 15.31 q/ha followed by T7 (brassinosteroid @ 0.50 ppm) (15.20 q/ha). In Kota, among the different growth regulators, the foliar application of Salicylic acid @ 100 ppm (2 spray at 30 & 60 DAS) gave the highest growth parameters, yield attributes and seed yield of coriander (225.52 q/ha) followed by application of Jasmonic acid @ 100 ppm (21.03 q/ha). Raigarh centre reported the highest seed yield of 17.059 q/ha in T6 – benzyl adenine @ 20 ppm followed by T8-brassinosteroid @ 1.0 ppm (17.59 q/ha). The B: C ratio of the trial yielded different result in different centre. Jobner, Coimbatore and Guntur centre reported higher B:C ratio in T5 (Benzyl adenine @ 10 ppm). Whereas in Jabalpur, T6 (benzyl adenine @ 20 ppm) has given higher B:C ratio. In Kota, the water spray treatment (T9) has given higher B:C ratio.

Table 47. Effect of growth regulators on yield and quality of Coriander

Treatment	Jobner		Kota		Coimbatore		Hisar		Jabalpur		Raigarh		Guntur		Mean	
	Y	BCR	Y	BCR	Y	BCR	Y	Y	BCR	Y	Y	BCR	Y	BCR	Y	BCR
T1 : Salicylic acid @ 50 ppm	14.9	3.21	20.2	3.39	12.3	1.88	19.3	10.9	2	13.45	12.6	1.32	14.8	2.4		
T2 : Salicylic acid @ 100 ppm	15.1	2.81	22.5	3.14	12.1	1.76	19	10.9	1.8	14.75	12	0.97	15.2	2.1		
T3 : Jasmonic acid @ 50 ppm	14.7	3.12	19.9	3.27	11.4	1.73	19.2	12	2.2	11.85	11.7	0.97	14.4	2.3		
T4 : Jasmonic acid @ 100 ppm	14.7	2.67	21	2.77	11.5	1.66	18.9	10.5	1.8	12.65	11.3	0.59	14.4	1.9		
T5 : Benzyl adenine @ 10 ppm	14.6	3.63	15.7	3.06	12.1	1.94	19.7	12.3	2.4	10.04	12.1	1.46	13.8	2.5		
T6 : Benzyl adenine @ 20 ppm	14.7	3.57	17.7	3.41	11.6	1.85	19.9	13.7	2.8	21.35	11.7	1.3	15.8	2.6		
T7 : Brassinosteroid @ 0.5 ppm	15.2	3.41	18.6	3.24	11.2	1.74	19.2	12	2.3	14.87	11.2	1.02	14.6	2.3		
T8 : Brassinosteroid @ 1.0 ppm	15.3	3.06	18.2	2.64	11.2	1.59	19.2	10.3	1.7	17.59	10.1	0.59	14.6	1.9		
T9: Water spray	12.5	3.18	17.9	3.76	9.56	1.58	18.6	9.22	2	10.85	10	1.11	12.7	2.3		
CD (P=0.05)	1.8		2.61		0.3		0.54	1.74		1.37	1.47					
SEm±	0.6		0.87		0.14		-	0.58		0.23	0.49					
CV %	-				11.4		3.6				7.5					

where table present Y: seed yield (q/ha) and BCR: benefit-cost ratio

Statistical parameters include Standard Error of Mean (SEm), Critical Difference (CD) at 5% probability, and Coefficient of Variation (CV%).

Crop Protection and Food Safety

SS/CP/7.1: Survey and monitoring of diseases and insect pests of seed spices for development of prediction models

(Centres: Dholi, Jagudan, Jobner, Kalyani, Kumarganj, Raigarh)

As part of this project, it is envisaged to conduct surveys in institute plots as well as farmer's fields of cumin, coriander, fenugreek, fennel, ajwain and nigella for the prevalence of various diseases and insect pests during the cropping season. Also, the local popular/ susceptible variety of cumin, coriander, fenugreek and fennel crops were planted in experimental plots. Plots (5m x 5m) were maintained under natural conditions without any plant protection measures for any of the pests/disease on seed spice crop. Observations for diseases and pests along with meteorological factors were recorded during crop germination to maturity at weekly intervals. Standard package of practices was followed in these plots except plant protection measures.

Field survey of diseases and insect pests of seed spices at Institute farm

The monitoring trial of coriander across different locations revealed variations in the incidence and severity of stem gall (*Protomyces macrosporus*), Alternaria blight (*Alternaria alternata*), and powdery mildew (*Erysiphe polygoni*) over different weeks. Stem gall was highest in Dholi, peaking at 55.00 PDI in the 7th week before disappearing in subsequent weeks, whereas Kumarganj showed a steady presence of Alternaria blight, ranging from 43.30 to 45.35 PDI across weeks. Powdery mildew was most severe in Coimbatore (45.20 PDI in the 8th week) and Jagudan (11.80 PDI in the 8th week), while Jobner had a significant rise in Alternaria blight (31.20 PDI in the 11th week). The data indicates that disease severity fluctuates across locations and weeks, emphasizing the need for location-specific management strategies to control these fungal diseases effectively. The monitoring trial for aphids (*Hydaphis coriandri*) and seed wasps (*Systole albipennis*) across different locations showed significant variations in infestation levels over time. Aphid populations were highest in Kumarganj (36.45 per plant) during the 22/01–28/01 period, while Dholi experienced an early peak (21.20 per plant in the first week of January) before declining to zero in March. In Jobner, aphid numbers surged from 0.50 in early January to 31.20 in mid-March, while Jagudan also saw a rise, peaking at 14.46 in March. Seed wasps were detected only in Jobner, with the highest incidence (4.00 per plant) recorded between 05/03 and 11/03 before disappearing in the following week. The data suggests that aphid infestations were more severe in Kumarganj and Jobner, while seed wasps were sporadic but notable in Jobner, emphasizing the need for timely pest management interventions.

The monitoring trial for cumin diseases at Jobner and Jagudan revealed variations in the incidence and severity of Alternaria blight, powdery mildew, aphids, and thrips over different time periods. Alternaria blight was more prevalent in Jagudan, with its severity rising from 34.50 in the 7th week to 52.46 in the 10th week. Powdery mildew was observed in both locations, with a higher PDI in Jobner (41.50) compared to Jagudan (26.73) in the 8th week. Aphid infestations were initially higher in Jagudan (36.00 in the 7th week) but declined to 0.00 by the 9th week, while Jobner maintained a moderate but steady presence. Thrips populations remained low across both locations, with minor fluctuations. The peak occurrences of diseases and pests were mostly between the 7th and 10th weeks, indicating a crucial period for implementing effective pest and disease management strategies.

The monitoring trial of fenugreek for powdery mildew (*Erysiphe polygoni*) and downy mildew (*Peronospora trigonellae*) across multiple locations showed dynamic disease progression over time. Powdery mildew incidence was initially low across all locations but steadily increased, peaking at 41.50% in Jobner and 28.65% in Jagudan during the 11th and 9th SMW, respectively. Kumarganj and Raigarh also experienced substantial disease severity, reaching 21.80% and 23.50%, respectively. Downy mildew was more prominent in Jobner, where its severity increased to 26.8% by the 9th SMW before declining to zero, while in Kumarganj, it peaked at 12.40% during the 8th SMW. The data highlights the progressive nature of powdery mildew, especially in Jobner and Jagudan, while downy mildew was more severe in Jobner before disappearing, emphasizing the need for targeted disease management during peak infection periods.

The monitoring data for aphids (*Aphis craccivora*, *Acyrtosiphon* sp.) and jassids (*Empoasca kerri*) across Jobner, Jagudan, Dholi, and Kumarganj indicate varying levels of infestation over different periods. Aphid populations were highest in Jobner (95.20) and Kumarganj (40.60) during the 9th SMW, while Jagudan saw a moderate rise (18.40), and Dholi recorded no aphid infestation at this stage. Earlier, Dholi had the highest aphid infestation (31.00) in the 4th SMW, but its population later declined. Jassid infestations were generally low, with Jagudan recording a peak of 0.70 in the 49th SMW, and Kumarganj reaching a high of 7.26 in the 6th SMW before dropping significantly. Jobner showed a gradual increase in jassid numbers, peaking at 4.70 in the 9th SMW. The trends indicate aphids as the dominant pest, with Jobner and Kumarganj experiencing severe outbreaks, while jassid populations remained low across all locations, suggesting that pest control measures should prioritize aphid management.

The incidence of Ramularia blight (*Ramularia foeniculi*), powdery mildew (*Erysiphe polygoni*), aphids (*Myzus persicae*, *Aphis gossypii*), and seed wasps (*Systole albipennis*) in fennel varied across Jobner, Jagudan, Raigarh, and Kumarganj over different periods. Ramularia blight remained low initially but peaked in Jagudan (26.50) and Jobner (8.60) by the 11th and 12th SMW. Powdery mildew was only recorded in Kumarganj, with a peak of 28.10 in the 5th SMW before disappearing. Aphid infestations increased significantly, with Raigarh reaching a peak of 300.00 in the 13th SMW and Jobner following closely at 104.2 in the same period. Earlier, aphid populations surged in Raigarh (58.00) during the 4th SMW and Jobner (96.1) by the 12th SMW. Kumarganj showed moderate aphid presence (27.22) in the 1st SMW but dropped to zero afterward. Jagudan recorded minimal aphid presence (10.50) only in the 4th SMW. Seed wasps were detected exclusively in Jobner, peaking at 3.40 in the 13th SMW, with a gradual increase from the 4th SMW onward. The data indicate a severe aphid outbreak in Raigarh and Jobner, with minimal impact in other locations, while fungal diseases were more prominent in Kumarganj and Jagudan.

The incidence of root rot (*Rhizoctonia solani*), aphids (*Myzus* sp.), and Lygus bug (*Nysius* sp.) in Ajwain varied across Jobner and Kumarganj over different periods. Root rot was absent in Jobner after a slight presence (0.50%) in the 51st SMW, while it increased in Kumarganj, peaking at 9.88% in the 11th SMW before declining to 7.48% in the 12th SMW. Aphid populations rose significantly in Jobner, reaching a peak of 120.3 per plant in the 11th SMW, while in Kumarganj, the highest count was 33.80 in the same period. Aphid numbers were moderate in earlier weeks, with Jobner recording 45.00 and Kumarganj 12.45 in the 5th SMW. Lygus bug presence remained low overall, with a slight increase in Jobner (2.50) in the 12th SMW, whereas Kumarganj recorded a peak (6.30) in the 5th SMW before disappearing in later weeks. The data suggest a severe aphid outbreak in Jobner, significant root rot in Kumarganj, and sporadic Lygus bug presence.

Field survey of diseases and insect pests of seed spices at farmer's plot

The survey conducted in coriander across different centres recorded varying levels of disease incidence and insect pest infestation. Jagudan, with 11 villages surveyed, showed a Powdery Mildew PDI of 7.24 and an aphid infestation of 15.49 aphids per plant. Kumarganj, covering 15 villages, exhibited a high Stem Gall PDI of 34.93 and the highest aphid infestation at 24.41 aphids per plant. Raigarh, with 8 villages surveyed, had a Powdery Mildew PDI of 19.35 and a Leaf Spot (A. Blight) PDI of 14.57, but no aphid data was recorded. Dholi, which surveyed 6 villages, had a high Stem Gall PDI of 31.10 and an aphid infestation of 22.87 aphids per plant. Jobner, covering 9 villages, showed relatively lower disease incidences with a Stem Gall PDI of 1.50 and a Powdery Mildew PDI of 11.80, while aphid infestation was recorded at 24.60 aphids per plant. These findings highlight the variations in disease and pest prevalence across different locations.

The survey conducted for pest and disease in cumin, in Jagudan and Jobner assessed the incidence of various diseases and insect pest infestations across different villages. In Jobner, 21 villages were surveyed, revealing that Alternaria Blight had a mean disease incidence of 28.40% (PDI), Wilt affected 20.80% of the plants, and Powdery Mildew had a lower incidence of 5.40% (PDI). The mean aphid infestation was recorded at 27.70 aphids per plant. The findings highlight the prevalence of multiple diseases and pests affecting crops, with Alternaria Blight being the most severe disease and aphids posing a major insect threat in Jobner.

The survey conducted for pest and diseases in Fennel in Jobner covered 11 villages and recorded a mean disease incidence of 3.80% (PDI) for Ramularia Blight. Additionally, the mean aphid infestation was found to be 20.60 aphids per plant. Jagudan centre reported lower pest and disease incidence. These findings highlight the relatively low incidence of Ramularia Blight in Jobner, while aphid infestation remains a concern.

The survey in crop Fenugreek was conducted across different centers, including Kumarganj, Raigarh, Dholi, and Jobner, covered multiple districts and villages to assess disease incidence and insect pest infestation. Kumarganj, with one district and five villages surveyed, showed the highest aphid infestation at 28.60 aphids per plant, but no disease incidence was recorded. Raigarh, covering four districts and eight villages, reported a powdery mildew incidence of 11.13% and a root rot disease index of 5.70%, without any aphid infestation. Dholi, with one district and six villages surveyed, recorded an aphid infestation of 22.00 aphids per plant but no disease occurrence. Jobner, covering three districts and 13 villages, had the highest powdery mildew incidence at 19.80% and was the only location where downy mildew (7.50%) was observed, with a moderate aphid infestation of 15.90 aphids per plant. These findings highlight varying levels of disease and pest pressure across the surveyed regions, with Jobner showing the highest combined disease incidence, while Kumarganj experienced the most severe aphid infestation.

The survey conducted at Kalyani for Nigella covered 2 districts and 9 villages, revealing a high incidence of wilt disease with an average PDI of 58.27%. This indicates a significant prevalence of the disease in the surveyed areas, highlighting the need for effective disease management strategies.

08 Cumin

Genetic Resources

COR/CI/1.1: Germplasm collection, characterization, evaluation, conservation and screening against diseases

(Centres: Jagudan, Jobner, Mandor, Sanand)

AICRPS centres collectively maintained 975 cumin germplasm accessions, including 13 exotic collection at Jagudan and Jobner. During 2023–24, 505 genotypes evaluated for trait expression across four key locations.

Table 48 Germplasm Holding and Evaluation of Cumin at AICRPS Centres (2023–24)

Centre	Indigenous	Exotic	Total Accessions	Germplasm evaluated in 2023–24
Jagudan	360	7	367	163
Jobner	370	6	376	170
Mandor	208	–	208	150
Sanand	24	–	24	24
Total	962	7	975	505

During 2023-24, 163 germplasms were evaluated with GC4. Cumin crop was heavily affected due to adverse environmental conditions and blight infestation. Though JC 2002-37, JC 2002-34, JC 2002-27, JC 2002-18, Dehgam 5-2017 were the highest yielding genotypes.

One hundred seventy (170) germplasm accessions were evaluated along with five check varieties viz., RZ-19, RZ-209, RZ-223, RZ-341 and RZ-345 in augmented design at Jobner. A wide range of variability was observed for all the characters studied. Based on seed yield per five plants, out of one hundred seventy accessions, fifteen accessions were recorded superior over the best check variety RZ-19 (18.0 g). Promising accessions identified based on seed yield per five plants are NC 2022-48, (28.0 g), NC 2022-85 (27.0 g) NC 2022-15 (27.0 g) NC 2022-4 (26.0 g) UC 257 (26.0 g) NC 2022-46 (25.0 g) NC 2022-86 (25.0 g) NC 2022-6 (25.0 g) NC 2022-45 (23.0 g) and NC 2022-35 (22.0 g)

At Sanand, a total of twenty-four germplasms were sown for evaluation, along with two checks, GC 2 and GC 4. All germplasms were affected by cumin root rot at the early stage, and later, they were severely impacted by cumin blight disease. As a result, the trial was considered vitiated. Total 58 germplasm lines available at the centre along with checks GC 4, MCU-105 and MCU-9 were evaluated in augmented design. 11 entries sowed significant gain in seed yield over best check MCU-105 (300 g/plot). 20 entries found to be wilt resistant and 8 entries were blight tolerant. 10 entries had more than 4.00 g 1000 seed weight.

Crop Improvement

CUM/CI/2 Coordinated Varietal Trial (CVT)

CUM/CI/2.8: Coordinated Varietal Trial on Cumin 2021-Series XI

(Centres: Ajmer, Jagudan, Jobner, Mandore, Sanand)

Coordinated Varietal Trial (CVT) on cumin 2021 series trial laid out at 5 AICRPS centres in RBD with eleven test genotypes (CZC-94, CZC-135, MCU 73, MCU 105, JC 18-10, JC 18-09, UC 350, UC 257, UC 250, SPS/166/2-3, and BC 13) with one national check (GC 4). The CVT trial initiated during *rabi*, 2021-22 and concluded during *rabi*, 2023-24.

Table 49. Summary of Seed Yield per Hectare (Kg/ha) data of Coordinated Varietal Trials on cumin-2021 Series pooled average from 2021-23

Entries	Ajmer	Jagudan	Jobner	Mandore	Sanand	Grand Mean	Rank
CZC-94	126	142	399	208	266	300	9
CZC-135	220	230	567	586	553	522	2
MCU 73	109	276	400	685	386	470	3
MCU 105	136	263	539	789	503	566	1
JC 18-10	162	255	332	330	291	322	7
JC 18-09	87	275	247	294	191	286	11
UC 350	77	213	607	363	271	384	5
UC 257	86	113	362	246	141	256	12
UC 250	72	133	443	335	179	309	8
SPS/166/2-3	111	150	272	410	734	291	10
BC 13	80	224	340	415	450	343	6
GC 4	113	264	524	522	647	469	4
Loc MEAN	120	212	634	432	384	436	

Locations and years viz., AJM-23, JAG-22, JAG-23, SAD-22, SAD-23 with high experimental variability (CV% > 30%), were excluded from the final grand mean computation to ensure reliability and consistency of the yield estimates.

Over three years, all test genotypes exhibited significant variation for seed yield across locations. The mean seed yield across locations and years ranged from 256 to 566 kg/ha, indicating substantial diversity and adaptive potential among the entries. Among the test entries, MCU 105 (566 kg/ha) recorded the highest mean seed yield, followed by CZC-135 (522 kg/ha) and MCU 73 (470 kg/ha). These entries surpassed both checks and established themselves as promising lines for further evaluation and potential release. The genotype MCU 105 showed a 43.7% increase in yield over check, GC-4 and the frequency of appearance in the top three performers across all trials by MCU 105 (8 times in 10 instance).

The coordinated varietal trial entries in coriander were screened for their response to blight and wilt disease across three distinct AICRPS centres—Mandore and Jobner (Rajasthan) and Jagudan (Gujarat)—over three consecutive Rabi seasons.

Table 50. Screening of CVT coriander entries for Blight and wilt tolerance (PDI%) at Jagudan, Jobner and Mandore (2021–2024)

Entries	Blight incidence					Wilt incidence			
	JAG	JOB	MDR	Mean	Rank	JOB	MDR	Mean	Rank
CZC-94	65.45	48.07	46.33	48.66	11	56.97	31.67	44.32	11
CZC-135	45.94	47.55	26.33	36.02	5	30.82	10.67	20.74	1
MCU 73	36.72	55.29	16.67	32.84	2	43.94	7.33	25.64	4
MCU 105	35.45	44.13	12.67	27.88	1	36.08	7.67	21.88	3
JC 18-10	44.84	60.42	40.33	44.04	8	56.17	20.00	38.08	9
JC 18-09	55.66	60.07	46.00	48.89	12	49.78	22.00	35.89	8
UC 350	43.63	42.38	24.67	33.40	3	42.13	23.33	32.73	5
UC 257	46.26	48.29	57.00	45.83	9	52.02	38.00	45.01	12
UC 250	47.98	56.22	56.00	48.56	10	46.89	41.00	43.95	10
SPS/166/2-3	45.55	58.75	25.33	38.92	7	51.95	14.67	33.31	7
BC 13	46.86	44.44	34.00	37.73	6	45.84	20.33	33.09	6
GC 4	43.18	39.35	32.00	34.43	4	27.11	15.00	21.06	2

Among the tested cumin genotypes, MCU 105 and CZC-135 recorded the lowest mean blight and wilt incidences, respectively, indicating their superior resistance, while JC 18-09 and UC 257 showed higher susceptibility across locations.

Crop Protection and Food Safety

CUM/CP/7.1: Eco-friendly management of cumin blight (Centres: Jagudan, Jobner, Mandore)

A multilocation trial for ecosafe production of cumin is progressing from *rabi*, 2022-2025, the second year of trial with eleven treatments, three replications in RBD. The results for the year 2023-2024, that showed lowest blight (PDI) recorded in T₁₀ three foliar spray Kresoxim-methyl 44.3 SC @ 0.044 % (10 ml/10 L water) (First spray at 35 days after germination and subsequent two spays at 10 days interval after first spray) followed by T₉ i.e. St & 4 FS of *B. subtilis* 1.15 WP (1x10⁸ cfu/g) @ 40 g / 10 L water + *P. fluorescens* 1.15 WP (1x10⁸ cfu/g) @ 50 g / 10 L water in all the centre viz., Jagudan, Jobner & Mandore, correspondingly all the centres reported highest seed yield in T₁₀ followed by T₉.

These results indicate that a well-planned fungicide application strategy (T₁₀) and an integrated biocontrol approach (T₉) significantly reduce blight incidence and enhance cumin productivity under field conditions. Pooled Mean disease incidence ranged from 10.68 % to 45.78 % with highest in control.

Table 51. Effect of Fungicides and Bioagents on Seed yield and Cumin Blight Incidence Recorded Across Locations During 2023–24 and Pooled Over Two Years

Treatment	Jagudan		Jobner		Mandor		Pooled	
	SY	PDI	SY	PDI	SY	PDI	SY	PDI
T1: <i>P. fluorescens</i>	4.22	21.50 (37.74)	3.78	20.00 (31.34)	6.02	20.50 (27.04)	4.67	20.67 (32.04)
T2: <i>P. fluorescens</i> + <i>T. harzianum</i>	4.20	15.50 (40.78)	3.92	18.50 (30.26)	7.38	15.50 (22.91)	5.17	16.50 (31.32)
T3: <i>P. fluorescens</i> + <i>T. viride</i>	4.31	15.50 (36.81)	4.36	16.00 (28.60)	6.93	16.25 (24.03)	5.20	16.58 (29.81)
T4: <i>T. harzianum</i>	2.82	18.00 (42.59)	3.68	21.00 (33.60)	6.16	22.00 (26.78)	4.22	20.33 (34.32)
T5: <i>T. viride</i>	2.89	22.75 (42.06)	3.95	21.00 (29.61)	6.35	22.33 (27.99)	4.39	22.03 (33.22)
T6: <i>B. subtilis</i>	4.34	14.50 (36.60)	4.16	15.50 (28.10)	7.24	16.50 (23.18)	5.25	15.50 (29.59)
T7: <i>B. subtilis</i> + <i>T. harzianum</i>	4.37	19.00 (36.94)	3.59	18.50 (33.67)	6.60	19.75 (25.90)	4.85	19.08 (32.17)
T8: <i>B. Subtilis</i> + <i>T. viride</i>	4.29	15.00 (41.03)	3.71	14.50 (31.62)	7.55	16.33 (23.00)	5.18	15.28 (31.88)
T9: <i>B. subtilis</i> + <i>P. fluorescens</i>	6.19	12.50 (30.47)	4.72	16.00 (25.89)	8.05	15.50 (22.49)	6.32	14.67 (26.28)
T10:Kresoxim-methyl 44.3 SC @ 0.044	7.10	8.50 (21.73)	5.53	8.00 (17.93)	8.99	9.50 (17.11)	7.21	8.67 (18.92)
T11:Control	2.09	35.00 (48.63)	2.85	40.00 (42.46)	3.67	47.00 (39.59)	2.87	40.67 (43.56)
S.Em.±	0.34	2.28	0.25	0.79	0.31	0.71	0.33	1.34
CD (P=0.05)	1.00	6.73	0.72	2.33	0.90	2.09	0.97	3.95
CV (%)	13.72	10.47	10.57	4.50	7.78	4.81	8.29	7.74

*Figures in parenthesis are angular transformed values.



Figure 13. Field view of cumin blight management trial conducted at Jagudan, Jobner, and Mandor during 2023–24

09 Fennel

Genetic Resources

FNL/CI/1.1: Germplasm collection, description, characterization, evaluation, conservation and screening against diseases

(Centres: Dholi, Hisar, Jagudan, Jobner, Kumarganj)

This is a long-term project aims at collecting, conserving and evaluating the available coriander germplasm towards identifying promising accessions with high yielding potential/resistance to powdery mildew disease. A total of 731 accessions of fennel being conserved and maintained by these AICRPS centres jointly (Table 19).

Table 52. Fennel germplasm collections maintained at various AICRPS centres

Centre	Indigenous	Exotic	Total	Germplasm evaluated during 2023-24
Dholi	44	-	44	44
Hisar	106	-	106	106
Jagudan	160	2	162	80
Jobner	289	20	309	57
Kumarganj	110	-	110	110
Total	709	22	731	397

A total of 44 genotypes of fennel, along with two checks (Rajendra Saurabh and GF-11), were evaluated for their yield potential at Dholi. Among the 44 genotypes, only two—RF-61 and RF-73—outperformed the check variety, Rajendra Saurabh. The highest yield was recorded in RF-61 (85.83 g plant⁻¹), followed by RF-73 (84.60 g plant⁻¹), while the check variety, Rajendra Saurabh, yielded 82.48 g plant⁻¹. The top ten highest-yielding germplasms had yields ranging from 42.80 to 85.83 g plant⁻¹. Out of 160, 80 accessions of fennel were evaluated in two row plots of 3.0 m length each using Hisar Sawrup, Raj. Saurabh, GF-2 and PF-35 as checks during 2023-24 at Hisar. The seed yield of the germplasm material ranged from 15.7 g plant⁻¹ (HF-112) to 41.2 g plant⁻¹ (HF-134). The most promising lines were HF-103, HF-105, HF-107, HF-109, HF-125, HF-129, HF-134 HF-136 HF-167, HF-169, HF-180, HF-182, HF-197 HF-198 HF-199, HF-200, HF-201 and HF-202.

During the 2023-24, 80 accessions of fennel were evaluated at Jagudan with the check variety GF 12. At Jagudan, the seed yield ranged from 100 to 1350 g plot⁻¹ and among the 80 entries, twenty two genotypes recorded higher seed yield than the check, GF-12. JF 351-5, JF 391, JF 531-1, JF 472-2, JF 303 were found as promising for high yielding ability. Fifty-seven (57) inbred lines of fennel were evaluated along with ten checks in augmented design at Jobner. A wide range of variability was found for all the characters studied. Out of 57 inbred lines, 4 inbred were better than best check variety RF-289 (77.75 g) on the basis of seed yield per 5 plants. Promising inbred identified on the basis of seed yield per 5 plants were ILF-117 (81.0g) ILF-87 (80.0g) ILF-11 (79.50g) and ILF-112 (78.0g). Among the 110 germplasm collections of fennels evaluated at Kumarganj, maximum yield was recorded in NDF-46 (67.30 g plant⁻¹), followed by NDF-48 (65.70 g plant⁻¹) and NDF -59 (63.90 g plant⁻¹).

Crop Improvement

FNL/CI/2 Coordinated Varietal Trial (CVT)

FNL/CI/2.8: Coordinated Varietal Trial on fennel 2021-Series XI

(Centres: Ajmer, Dholi, Hisar, Jabalpur, Jagudan, Jobner, Kumarganj, Navsari, Pantnagar)

Coordinated Varietal Trial (CVT) on coriander 2021 series trial laid out at 9 AICRPS centres in RBD with nine test genotypes (HF 192, HF 256, JF 18-13, JF 18-03, UF 231, UF 230, AF 87, AF 17, RF 67, NDF 59, and NDF 46, along with two national check RF-101 and RF 205. The CVT trial initiated during *rabi*, 2021-22 and concluded during *rabi*, 2023-24.

Table 53. Summary of Seed Yield per Hectare (kg/ha) data of Coordinated Varietal Trials on fennel-2021 Series

Entries	AJM	DHL	HSR	JBR	JAG	JOB	KUM	NAV	PNR	Mean	Rank
HF 256	2381	1682	2046	1209	1031	1079	1521	1395	1426	1530	12
HF 192	2186	1582	2111	1422	1051	1293	1274	1390	1471	1531	11
JF 18-13	2127	1589	1706	1077	1937	1767	1363	2566	1561	1744	2
JF 18-03	2222	1663	1910	1150	1915	1865	1608	2402	1590	1814	1
UF 231	2148	1530	1906	1409	1484	1996	1604	2007	1596	1742	3
UF 230	2145	1709	1690	1479	1530	1814	1211	2154	1716	1716	4
AF 87	2248	1650	1822	1136	1598	1822	1245	2280	1420	1691	6
AF 17	2411	1681	1990	1210	1449	1606	1471	2235	1337	1710	5
RF 67	2072	1602	1650	1215	893	1089	1351	1261	1285	1380	13
RF-101 (Check)	2336	1567	1594	1158	1483	1771	1215	2355	1556	1670	7
RF-205 (Check)	2213	1519	1663	1041	1579	1647	1230	1955	1357	1578	10
NDF 59	2316	1696	1809	1005	1333	1264	1291	2073	1527	1590	8
NDF 46	1954	1687	1724	1125	1423	1155	1247	2508	1417	1582	9
Loc MEAN	2212	1627	1817	1203	1439	1551	1356	2045	1482	1637	

Where, AJM: Ajmer; DHL: Dholi; HSR: Hisar; JBR: Jabalpur; JAG: Jagudan; JOB: Jobner; KUM: Kumarganj; NAV: Navsari; PNR: Pantnagar.

Over three years, all test genotypes exhibited significant variation for seed yield across locations. The mean seed yield across locations and years ranged from 1380 to 1814 kg/ha, indicating substantial diversity and adaptive potential among the entries. Among the test entries, six entries surpassed the seed yield of best check, RF-101 (1670 kg/ha) numerically, among which JF 18-03 (1814 kg/ha) recorded the highest mean seed yield, followed by JF 18-13 (1744 kg/ha) and UF 231 (1742 kg/ha). These entries surpassed both checks and established themselves as promising lines (~5% IOC over average check yield) for further evaluation and potential release. The genotype JF 18-03 showed a 8.5% increase in yield over best check, RF-101 and a 17.4% increase over RF-205 the frequency of appearance in the top three performers across all trials by 12 times out of 27 locations by year tested.

Fenugreek

Genetic Resources

FGK/CI/1.1: Germplasm collection, characterization, evaluation, conservation and screening against diseases

(Centres: Dholi, Guntur, Hisar, Jagudan, Jobner, Kumarganj, Raigarh)

This is a long-term project aims at collecting, conserving and evaluating the available coriander germplasm towards identifying promising accessions with high yielding potential/resistance to powdery mildew disease. A total of 1331 accessions being conserved and maintained by these AICRPS centres jointly (Table 19).

Table 54. Coriander germplasm collections maintained at various AICRPS centres

Centres	Indigenous	Exotic	New Additions	Total	Evaluated 2023-24
Dholi	170	-	-	170	62
Guntur	124	-	-	124	124
Hisar	406	-	5	411	120
Jagudan	82	-	-	82	82
Jobner	373	12	-	385	125
Kumarganj	148	-	-	148	148
Raigarh	11	-	-	11	11
Total	1314	12	5	1331	672

Sixty accessions of fenugreek along with two checks (Rajendra Kanti and Hisar Sonali) were evaluated with respect to yield at Dholi. Among 60 genotypes evaluated, only five genotypes namely, RM-213, RM-187, RM-212, RM-203, RM-219, RM-112, RM-198, RM-119, RM-205 and RM-217 gave higher yield than both the check varieties. The performance of top ten promising accessions ranged from 15.73 to 18.65 g plant⁻¹. Among the 124 entries evaluated at Guntur, ten entries recorded significantly higher yield than the best check LM-2 (3.02 g plant⁻¹) and the better performing entries were LFC-41 (4.92 g plant⁻¹), LFC-32 (4.72 g plant⁻¹), LFC-38 (4.67 g plant⁻¹), LFC-51 (4.57 g plant⁻¹) and LFC-122 (4.51 g plant⁻¹). Further, all the 124 accessions were evaluated for herb yield. Among the entries, LFC-122 performed superior over all the entries.

During the 2023-24, total 82 germplasms were evaluated at Jagudan along with check variety GM 2. JFg-267, JFg-255, JFg-245, JFg-239 were the highest yielding genotypes. One hundred twenty accessions of fenugreek were evaluated at Hisar along with Hisar Sonali, Hisar Suvarna and Hisar Mukta as checks from the total germplasm of 411. The seed yield of the germplasm material ranged from 14.2 g plant⁻¹ (HM-246-1) to 36.2 g plant⁻¹ (HM-440). The most promising lines for seed yield were HM-240, HM-259-1, HM-273, HM-277-1, HM-278, HM-326, HM-331, HM-335, HM-338, HM-341, HM-342-1, HM-344, HM-426, HM-429, HM-440 and HM-441.

One hundred ten germplasm accessions of fenugreek were evaluated along with seven check varieties viz., RMt-1, RMt-143, RMt-303, RMt-305, RMt-351 and RMt-354 in augmented

design at Jobner. A wide range of variability was recorded for all the characters studied. Based on seed yield per five plants, out of 110 accessions evaluated, only 14 accessions were found superior than best check variety RMt-354 (39.40 g). Promising top five accessions identified based on seed yield per five plants are LFC 75 (60.0 g) LFC 117 (60.0 g) LFC 70 (55.0 g), LFC 113 (52.0 g) and LFC 100 (50.0 g). Among the 148 germplasm lines being maintained and evaluated at Kumarganj, the highest yield was obtained from NDM-49 (12.70 g plant⁻¹) followed by NDM-37 (11.30 g plant⁻¹), and NDM-45 (10.80 g plant⁻¹).

In Raigarh, the highest seed yield was recorded by genotype IFGS-6 (27.96 q ha⁻¹), followed by IFGS-11 (24.58 q ha⁻¹) and IFGS-09 (23.95 q ha⁻¹). These genotypes outperformed both national checks, Hisar Sonali (14.89 q ha⁻¹) and RMT 305 (13.09 q ha⁻¹), as well as the grand mean of the trial (18.28 q ha⁻¹).

FGK/CI/1.3: Identification of drought tolerant source in fenugreek (Centres: Jobner)

An experiment was conducted during *Rabi*, 2021-22, 2022-23 and 2023-24 to identify drought tolerant genotypes/varieties of fenugreek. Eighteen (18) genotypes/varieties of fenugreek were randomly selected from the germplasm being maintained at Jobner. These genotypes were sown in two environments namely irrigated (normal irrigation) and drought (staggered irrigations i.e., half of that given in normal irrigation).

Mean performance of three-year data of fenugreek indicated that the genotypes UM-216, RMt-354, RMt- 305, UM-162 , UM-163 and UM-373 in normal while UM-300, RMt- 354, RMt-361, UM-329, RMt- 305 and UM-134 in stress condition were top yielders. Based on stress susceptibility index UM-329, UM-300, UM-199, UM-178, UM-365, UM-134 and RMt- 361 were found to be the desirable genotypes for drought conditions. **(Table 9)**

Table 55. Pooled mean performance of fenugreek genotypes under NI (E₁) and RI (E₂) conditions during *Rabi*, 2020-21 to 2023-24 at Jobner

Entry	Seed yield in normal irrigation condition (E ₁)					Seed yield in staggered irrigation condition (E ₂)					TOL	R	SSI	R	STI	R
	Y1	Y2	Y3	Mean	R	Y1	Y2	Y3	Mean	R						
UM-44	16.5	22.0	27.3	19.3	16	15.7	16.3	21.3	16.0	17	3.2	8	0.9	9	0.5	16
UM-134	23.9	24.0	22.7	23.9	10	20.7	21.7	19.7	21.2	6	2.8	7	0.6	6	0.8	7
UM-162	30.6	23.7	23.0	27.1	4	17.4	15.3	18.0	16.4	16	10.8	17	2.0	18	0.7	13
UM-163	26.0	27.0	22.3	26.5	5	22.2	18.8	19.7	20.5	10	6.0	13	1.2	12	0.9	6
UM-178	21.0	15.7	27.3	18.3	18	19.2	14.0	26.3	16.6	15	1.7	3	0.5	4	0.5	17
UM-199	19.8	25.0	25.0	22.4	12	17.2	24.0	23.7	20.6	9	1.8	4	0.4	3	0.8	12
UM-216	35.7	30.7	24.3	33.2	1	17.1	24.7	22.7	20.9	7	12.3	18	1.9	17	1.2	2
UM-249	21.1	15.7	23.3	18.4	17	16.3	15.3	16.3	15.8	18	2.6	6	0.7	8	0.5	18
IM-300	23.6	25.0	25.3	24.3	9	24.2	24.0	23.0	24.1	1	0.2	2	0.0	2	1.0	4
UM-329	26.2	18.5	20.7	22.4	13	26.7	17.7	17.7	22.2	4	0.2	1	0.0	1	0.8	9
UM-343	26.6	23.7	21.3	25.1	8	18.8	21.3	19.0	20.1	11	5.1	11	1.0	11	0.8	8
UM-365	23.8	22.9	24.0	23.3	11	21.2	20.3	23.7	20.8	8	2.6	5	0.6	5	0.8	11
UM-368	23.3	21.0	22.7	22.2	14	14.1	20.0	18.0	17.1	14	5.1	12	1.2	13	0.6	14
UM-373	27.6	25.0	26.3	26.3	6	15.4	22.0	26.0	18.7	12	7.6	14	1.5	16	0.8	10
RMt- 305	35.0	26.3	27.7	30.7	3	24.8	19.0	23.7	21.9	5	8.7	16	1.5	15	1.1	3

Entry	Seed yield in normal irrigation condition (E ₁)					Seed yield in staggered irrigation condition (E ₂)					TOL	R	SSI	R	STI	R
	Y1	Y2	Y3	Mean	R	Y1	Y2	Y3	Mean	R						
RMt- 351	23.4	19.3	30.0	21.3	15	20.4	14.3	26.0	17.4	13	4.0	10	1.0	10	0.6	15
RMt- 354	36.4	26.3	25.3	31.4	2	26.0	21.0	23.0	23.5	2	7.9	15	1.3	14	1.2	1
RMt- 361	25.2	26.7	28.7	25.9	7	24.0	20.7	25.7	22.3	3	3.6	9	0.7	7	1.0	5
Mean	25.9	23.2	24.9	24.6		20.1	19.5	21.9	19.8							

Seed yield values (g/plant) were recorded across three Rabi seasons (Y1:2021–22, Y2:2022–23, and Y3:2023–24) under two irrigation regimes: normal irrigation (NI or E₁) and restricted irrigation (RI or E₂).

TOL (Tolerance Index) = Yield under NI – Yield under RI; SSI (Stress Susceptibility Index) = $[(1 - \text{RI yield} / \text{NI yield}) / \text{stress intensity}]$; STI (Stress Tolerance Index) = $(\text{Yield under RI} \times \text{Yield under NI}) / (\text{Mean NI yield})^2$.

"R" denotes the rank of each genotype for the respective parameter.

Crop Improvement

FGK/CI/2 Coordinated Varietal Trial (CVT)

FGK/CI/2.5: Coordinated Varietal Trial on fenugreek 2021-Series XI

(Centres: Ajmer, Dholi, Hisar, Jabalpur, Jagudan, Jobner, Kalyani, Kota, Kumarganj, Navsari, Pantnagar, Raigarh)

Coordinated Varietal Trial (CVT) on fenugreek 2021 series trial laid out at 12 AICRPS centres in RBD with nine test genotypes (AFg 9, AFg 10, NDM 119, HM 242, HM 560, JFg-17-04, JFg-17-06, UM 259, UM 233, NFG 201, NFG 202, PM 4, KFG 12, KFG 17, and IFGS6 along with checks Hisar Sonali and RMt 361. The CVT trial initiated during *rabi*, 2021-22 and concluded during *rabi*, 2023-24.

Table 56. Summary of Seed Yield per Hectare (Q/ha) data of Coordinated Varietal Trials on fenugreek-2021 Series

Entries	AJM	DHL	HSR	JBR	JAG	JOB	KOT	KUM	KAL	NAV	PNR	RAI	Mean	Rank
AFg 9	1378	2040	1990	2063	1265	1824	1538	1989	781	1147	1662	1228	1583	12
AFg 10	1695	1794	2050	1606	1691	1835	1879	1632	808	1122	1638	1441	1576	14
NDM 119	1450	1933	1957	2003	1537	1641	1317	1924	827	1279	1700	1320	1580	13
HM 242	1314	1679	2273	2224	1355	1677	1687	1895	749	1324	1738	1556	1607	8
HM 560	1588	1574	2371	2096	1528	1737	1731	1825	809	1299	1789	1308	1649	3
JFg-17-04	1446	1796	2076	1869	1781	1938	1505	1870	788	1291	1852	1067	1631	4
JFg-17-06	1181	1922	1682	1348	1246	1687	1476	1679	936	1420	1598	1196	1457	16
UM 259	1707	1799	2245	2100	1463	2126	1624	2294	827	1344	2011	1218	1742	1
UM 233	1393	1989	1769	1813	1732	1959	1565	1984	879	1246	1739	1231	1611	7
NFG 201	1325	1673	2148	1924	1462	1933	1658	1991	869	1240	1821	1222	1620	5
NFG 202	1391	1691	2207	2145	1693	1567	1592	1852	790	1236	1728	1253	1614	6
PM 4	1304	1767	2146	1733	1165	1690	988	1900	867	1284	1915	1194	1500	15
KFG 12	1299	1640	2003	1729	1576	1752	1864	1804	903	1290	1833	1346	1589	9
KFG 17	1243	1659	1574	1645	1283	1193	1645	1655	777	1029	1507	1566	1396	17
IFGS6	1502	1736	2119	2302	1701	1822	1592	1820	848	1291	1956	1620	1693	2
Hisar Sonali (Check)	1441	1759	2126	1754	1383	1871	1768	1711	946	1287	1564	1472	1586	11
RMt 361 (Check)	1275	1940	2036	1899	1421	1846	1700	1825	781	1078	1692	1424	1587	10
Loc MEAN	1398	1788	2046	1902	1478	1773	1583	1874	834	1255	1750	1322	1590	

Where, AJM: Ajmer; DHL: Dholi; HSR: Hisar; JBR: Jabalpur; JAG: Jagudan; JOB: Jobner; KOT: Kota; KUM: Kumarganj; KAL: Kalayani; NAV: Navsari; PNR: Pantnagar; and RAI: Raigarh.

Over three years, all test genotypes exhibited significant variation for seed yield across locations. The mean seed yield across locations and years ranged from 1457 to 1742 kg/ha, indicating substantial diversity and adaptive potential among the entries. Among the test entries, UM 259 (1742 kg/ha) recorded the highest mean seed yield, followed by IFGS6 (1693 kg/ha) and HM 560 (1649 kg/ha). The genotype UM 259 showed a 9.8% increase in yield over check, RMt 361 and a 9.9% increase over Hisar Sonali the frequency of appearance in the top three performers across all trials by UD 565 (16 times out of 35) and IFGS6 (6 times). GGE biplot analysis was performed using multilocation seed yield data across all trial centres. The biplot indicated that UM 259 clustered close to the average environment coordinate, demonstrating both high mean performance and stability across test environments.

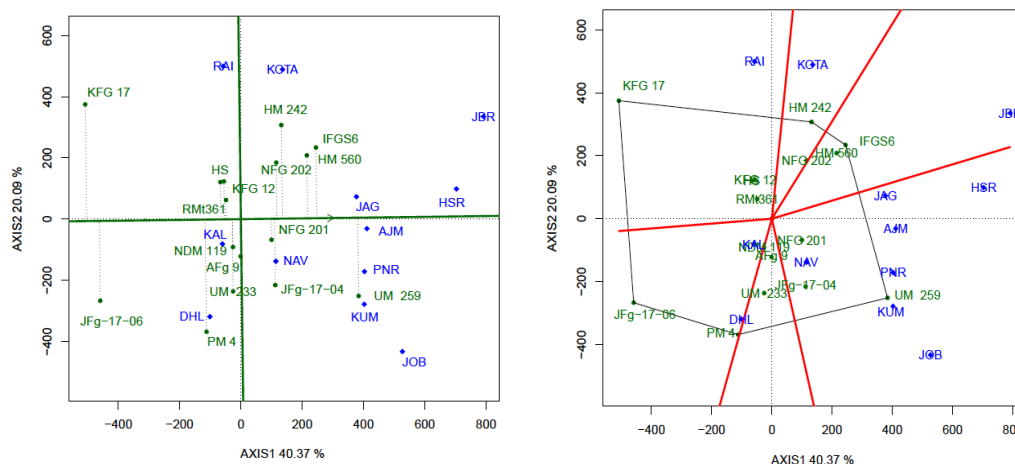


Figure 14: GGE Biplot Analysis of CVT on fenugreek entries (2021–2023): (a) Mean vs Stability, (b) Which-Won-Where

Crop Management

FGK/CM/5.1: Growth and yield of fenugreek as influenced by AMF (Arbuscular Mycorrhizal Fungi)

(Centres: Dholi, Guntur, Kota, Mandor, Jabalpur)

A multi-location trial conducted to study the effect of Arbuscular Mycorrhizal Fungi (AMF) application and phosphorus levels on the growth and yield of fenugreek across five AICRPS centres. The experiment was laid out in a FRBD involving two factors: phosphorus application level and mode of AMF application. A total of 12 treatment combinations were tested, combining four phosphorus levels—100%, 75%, 50%, and 0% Recommended Dose of Phosphorus (RDP)—with three AMF application strategies: seed treatment (@100 g/kg seed), soil application (@5 kg/acre at 20 days after sowing), and a combination of both seed and soil application. The treatments ranged from T₁ (100% RDP + Seed treatment) to T₁₂ (0% RDP + Seed treatment + Soil application).

At Dholi centre, among all the treatments irrespective of the application method 100 % RDP exhibited the highest seed yield (1817.37 Kg/ha), while among the application methods, irrespective of the application RDP % level, Seed + Soil application method exhibited the highest yield (1731.12 Kg/ha). However, in terms of B:C ratio, irrespective of the treatment level AMF seed application method exhibited the highest ratio (1.20), while among the treatments, 100 % RDP level exhibited the highest B:C ratio (1.14), which shows its economic feasibility compared to other RDP % levels. The Kota centre reported maximum and

significantly higher plant height, pods/plant, seeds/pod and seed yield of fenugreek in 100% RDP over 75% RDP and 50% RDP. While in case mode of applications, the seed treatment + soil application recorded higher plant height and seed yield of fenugreek. In terms of B:C ratio, no significant differences was observed among all treatments, though 75 % RDP level and soil application has given B:C ratio of 0.76. Mandor centre reported maximum and significantly higher seed yield (1619 Kg/ha) of fenugreek under 100% RDP along with AMF and in the second factor, seed treatment and soil application has given higher seed yield (1481 Kg/ha) among all treatments. On the other hand, B:C ratio was higher under 70% RDP (2.65) and seed and soil treatment (2.44). In Jabalpur, the study concludes that the variation in phosphorus levels (Factor A), methods of AMF application (Factor B), and their interaction (A×B) shows significant result on morphological characteristics that are plant height, primary branches and secondary branches at harvest. However, it do not exhibit statistically significant effect on phenological characteristics such as days to flower initiation and days to 50 % flowering. Factor A (phosphorus level), Factor B (AMF application method), and their interaction (A×B) exerted significant influence on yield parameters such as pods/plant (26.59), pod length (13.82), seeds /pod (22.88), test weight (15.97), seed yield (16.97) and harvest index (34.83). The maximum seed yield (1607 Kg/ha) was observed at 75% RDP for Factor A, seed treatment combined with soil application for factor B yielded the best results (1530 Kg/ha). From an economic perspective, T₆, which involves 75% RDP with seed treatment and soil application, yielded a higher income per hectare and achieved the highest B:C ratio (3:63). This treatment is economically advantageous due to its lower expenditures compared to T₃ (3:41), which uses 100% RDP with seed treatment and soil application.

Table 57. Performance of fenugreek under AMF treatment and different doses of phosphorus application

Treatment	Dholi		Jabalpur		Kota		Mandor		Mean	
	Yield	BCR	Yield	BCR	Yield	BCR	Yield	BCR	Yield	BCR
Phosphorus level (P)										
P ₁₀₀	18.2	1.14	15.9	3.27	13.4	0.75	16.2	2.62	15.9	1.95
P ₇₅	17.7	1.12	16.1	3.38	14.5	0.76	16.1	2.65	16.1	1.98
P ₅₀	14.5	0.97	14.2	2.96	15.5	0.77	13.8	2.31	14.5	1.75
P ₀	12.2	0.93	13.4	2.85	11.9	0.74	12.2	2.1	12.4	1.66
SEM (±)	0.93	0.05	0.66	0.13	0.34	0.01	0.26	0.13	0.55	0.08
CD (p=0.05)	0.28		0.01		0.98		0.57		0.46	
Mode of application (S)										
S ₁	15.3	1.2	14.3	3.05	12.9	0.75	14.4	2.39	14.2	1.85
S ₂	16.9	0.94	15.1	3.15	14.2	0.76	14.6	2.42	15.2	1.82
S ₃	17.3	0.97	15.3	3.14	14.4	0.75	14.8	2.44	15.5	1.83
SEM (±)	0.38	0.07	0.3	0.03	0.29	0	0.21	0.01	0.3	0.03
CD (p=0.05)	NS		0.86		0.85		NS		0.86	#####

Footnote:

Factor A -P: Phosphorus levels where as P₁₀₀: 100% Recommended Dose of Phosphorus (RDP), P₇₅: 75% RDP, P₅₀: 50% RDP, P₀: Control (0 RDP).

Factor B -S: Mode of AMF application whereas S₁: Seed treatment (@100g/kg of seed at sowing), S₂: Soil application (20 DAS @5 kg/acre), S₃: Seed treatment + Soil application (20 DAS @5 kg/acre).

Treatment combinations (T₁-T₁₂) represent all possible permutations of phosphorus level and mode of application.

BCR: Benefit-Cost Ratio; SEM: Standard Error of Mean; CD: Critical Difference at p = 0.05; NS: Not Significant; DAS: Days After Sowing.



Figure 15. Field view of trial undertaken at (a) Mandor, Rajasthan (b) Jabalpur, MP

FGK/CM/6.1: Effect of growth regulators on yield and quality of fenugreek

(Centres: Ajmer, Dholi, Hisar, Jobner, Kota)

The experiment on effect of growth regulators on yield and quality of fenugreek which was initiated in the year 2022-23 with seven centres with the following nine treatments: T1-Salicylic acid @ 50 ppm; T2 - Salicylic acid @ 100 ppm; T3-Jasmonic acid @ 50 ppm; T4-Jasmonic acid @ 100 ppm; T5-Benzyl adenine @ 10 ppm; T6-Benzyl adenine @ 20 ppm; T7-Brassinosteroid @ 0.50 ppm; T8-Brassinosteroid @ 1.00 ppm; T9-Control (Water spray).

Table 58. Effect of growth regulators on yield and quality of fenugreek

Treatment	Ajmer		Dholi		Hisar	Jobner		Kota		mean	
	Yield	BCR	Yield	BCR	Yield)	Yield	BCR	Yield	BCR	Yield	BCR
T1	10.51	0.89	17.46	1.28	20.7	14.37	2.77	11.36	2.37	14.88	1.83
T2	12.06	1.03	17.91	1.34	23.84	14.44	2.41	11.83	2.49	16.02	1.82
T3	12.88	1.31	16.54	1.22	22.98	14.19	2.7	10.82	2.23	15.48	1.87
T4	15.05	1.51	17.16	1.2	20.73	14.29	2.34	12.2	2.63	15.89	1.92
T5	10.07	0.92	17	1.18	21.07	14.18	3.15	11.65	2.42	14.79	1.92
T6	13	1.46	17.76	1.27	21.12	14.23	3.08	11.9	2.42	15.6	2.06
T7	12.12	1.22	18.38	1.36	20.67	14.84	2.98	11.3	1.83	15.46	1.85
T8	16.48	1.87	18.67	1.39	20.89	14.96	2.68	12.15	1.61	16.63	1.89
T9	8.92	0.72	15.18	1.15	18.73	11.95	2.77	9.31	1.78	12.82	1.61
C.D.	2.247		1.505		1.489	0.0171		1.617			
SE(m)	0.743		0.498		0.485	0.0057		0.539			
C.V.	10.4		5		4	6.39		8.2			

where table present Y: seed yield (q/ha) and BCR: benefit-cost ratio

Statistical parameters include Standard Error of Mean (SEm), Critical Difference (CD) at 5% probability, and Coefficient of Variation (CV%).

The experiment on effect of growth regulators on yield and quality of fenugreek which was initiated in the year 2022-23 with seven centres with the following nine treatments: T₁-Salicylic acid @ 50 ppm; T₂ - Salicylic acid @ 100 ppm; T₃-Jasmonic acid @ 50 ppm; T₄-Jasmonic acid @ 100 ppm; T₅-Benzyl adenine @ 10 ppm; T₆-Benzyl adenine @ 20 ppm; T₇-Brassinosteroid @ 0.50 ppm; T₈-Brassinosteroid @ 1.00 ppm; T₉-Control (Water spray).

Ajmer centre reported higher seed yield in T₈ - Brassinosteroid @ 1.00 ppm (1648 Kg/ha), followed by T₄-Jasmonic acid @ 100 ppm (1505 Kg/ha). The economic return and B:C ratio was found highest in T₈ (1.87) and T₅ (1.51). In Dholi centre, results revealed that application of Brassinosteroid @ 1.00 ppm (T₈) exhibited the highest yield (1867.20 Kg/ha) followed by Brassinosteroid @ 0.5 ppm (at par) with yield of 1837.59 Kg/ha. All the treatments were significantly high yielding than that of the control (water spray) which exhibited a yield of 1518.20 Kg/ha. The highest BC ratio (1.39) was by Brassinosteroid @ 1.00 ppm which was significantly higher than all other attempted treatments, showing its cost effectiveness compared to all other treatments. In Hisar, significant differences were obtained for all the treatments. Maximum number of pods per plant (64.4) and seed yield (2384.4 kg/ha) was recorded with the application of Salicylic Acid @ 100 ppm which is being at par with spray of Jasmonic Acid @ 50 ppm (2298 kg/ha). Jobner centre reported maximum plant height, number of branches/plant, pods/plant, seeds/pod, pod length, test weight and seed yield of fenugreek in brassinosteroid treatment @1.0 ppm (1496 Kg/ha). But the BC ratio was found higher (3.15) in T₅-benzyl adenine @ 10 ppm among all treatments. Kota centre reported maximum plant height, pods/plant and seed yield (1220 Kg/ha) of fenugreek in foliar application of Jasmonic acid @ 100 ppm (T₄) over control.

Crop Protection and Food Safety

FGK/CP/7.1: Bio-efficacy of fungicides against powdery mildew of fenugreek (Centres: Coimbatore, Hisar, Jagudan, Jabalpur, Jobner, Kota, Raigarh)

A field trial was initiated in 2022 to assess the efficacy fungicides in managing disease incidence across seven centres. The experiment was conducted in a RBD with three replications per treatment. The mean PDI across locations ranged from 16.68% to 46.91%, with the highest incidence observed in the untreated control plots. Significant variability in PDI was observed across different centres for each treatment. Notably, Jabalpur and Jobner consistently exhibited higher PDIs across most treatments, suggesting that these locations might have more favourable environmental conditions for disease development, such as higher humidity, temperature, or pathogen presence.

At Coimbatore centre treatment T₄ (Propiconazole 25% EC at 0.1%) demonstrated the lowest disease incidence, with PDI values ranging from 6.43% to 29.63%. At Jabalpur and Kota centres, treatment T₂ (Tebuconazole 25.9% EC at 0.1%) outperformed all other treatments, significantly reducing disease incidence compared to the control. At Jagudan and Jobner centres, the most effective treatment was T₃ (Hexaconazole 5% SC at 0.1%), which resulted in the lowest PDI values at these locations. At Kota centre, treatment T₂ was again found to be the most effective in reducing disease incidence. At Raigarh Centre, the recommended package of practices emerged as the superior treatment in minimizing disease incidence. Hisar centre, reported treatment T₅ (Myclobutanil 10% WP at 0.05%) recorded the lowest disease incidence, demonstrating its effectiveness in this region.

Treatment	Powdery mildew (PDI)*							
	Coimbatore	Jabalpur	Jagudan	Jobner	Kota	Raigarh	Hisar	Mean (PDI)
T ₁	15.74 (23.38)	41.33 (6.46)	23.67 (29.11)	21.75 (27.78)	11.30 (19.6)	17.49 (24.71)	22.8	22.01
T ₂	12.43 (20.65)	22.67 (4.81)	21.62 (27.71)	14.53 (22.40)	5.70 (13.7)	8.83 (17.29)	31.0	16.68
T ₃	13.80 (21.81)	36.00 (6.04)	12.55 (20.75)	7.90 (16.32)	8.30 (16.7)	19.23 (26.01)	26.2	17.71
T ₄	6.43 (14.68)	33.33 (5.81)	18.18 (25.24)	13.00 (21.12)	7.70 (16.0)	21.91 (27.91)	24.0	17.79
T ₅	21.37 (27.53)	36.67 (6.09)	33.63 (35.44)	19.67 (26.32)	12.30 (20.5)	15.95 (23.54)	21.8	23.06
T ₆ (SAU)	8.52 (16.96)	27.33 (5.25)	19.13 (25.93)	11.64 (19.92)	16.70 (24.1)	6.94 (15.27)	35.1	17.91
T ₇ (Control)	29.63 (31.97)	59.33 (7.73)	55.79 (48.32)	45.23 (42.26)	43.70 (41.4)	24.48 (29.65)	70.2	46.91
SEm	0.47	0.19	1.33	0.60	0.72	0.25	-	-
CD (5%)	3.12	0.59	4.10	1.79	2.16	0.78	2.13	2.10
CV (%)	1.25	5.51	7.60	6.54	-	1.88	3.92	-

The results highlight the importance of site-specific treatment selection, as the efficacy of fungicides varied across different environmental conditions. The superior performance of certain treatments at specific locations suggests that factors such as climatic conditions, pathogen load, and soil properties may influence the effectiveness of disease management strategies.

The control (T₇) consistently recorded the lowest yield across all locations, proving that disease management significantly impacts crop productivity. T₂ (Tebuconazole 25.9% EC) was the best-performing treatment in Jabalpur and Kota, indicating its suitability for these regions. T₃ (Hexaconazole 5% SC) performed best in Jagudan and Jobner, suggesting its effectiveness under conditions in these locations. T₆ (SAU recommendation) provided the highest yield at Raigarh, showing that localized recommendations can be highly beneficial. T₅ (Myclobutanil 10% WP) recorded the highest yield in Hisar, suggesting its effectiveness in that region. Coimbatore and Hisar showed the least variation across treatments, implying that environmental factors may have a lesser impact on disease incidence in these locations.

Treatment	Yield (q/ha)							
	Coimbatore	Jabalpur	Jagudan	Jobner	Kota	Raigarh	Hisar	Mean seed Yield (q/ha)
T ₁	4.41	19.64	13.14	14.12	12.73	9.33	20.96	13.48
T ₂	4.79	24.86	13.57	16.40	12.96	13.64	19.74	15.14
T ₃	4.87	20.63	14.78	21.30	11.02	9.80	19.99	14.63
T ₄	5.45	21.14	13.90	17.96	10.51	12.00	20.85	14.54
T ₅	4.30	20.85	12.05	15.72	11.81	12.45	21.13	14.04
T ₆ (SAU)	5.16	22.12	14.01	19.85	10.65	14.31	19.79	15.13
T ₇ (Control)	4.16	17.91	7.12	11.91	8.33	6.40	19.41	10.75
SEm	0.23	1.15	1.02	0.89	0.77	0.13	0.18	0.62
CD (5%)	0.70	3.55	3.20	2.73	2.36	0.38	0.52	1.92



Figure 16. Field view at Jobner and Jagudan centres

11

Ajwain

Genetic Resources

Germplasm Collection, Characterization, Evaluation and Conservation

(Centres: Ajmer, Guntur, Hisar, Jagudan, Jobner, Kumarganj, Raigarh)

A total of 500 germplasm accessions of ajwain accessions are currently being maintained across six AICRPS centres. Out of these, 91 accessions have been characterized and assigned IC numbers. AICRPS Centre-wise distribution of ajwain germplasm is presented in Table 1.

Table 61. Ajwain germplasm collections maintained at various AICRPS centres

Centre	No. of accessions	Germplasm with IC number
Ajmer	150	50
Guntur	101	35
Hisar	56	-
Jagudan	98	-
Jobner	45	-
Kumarganj	46	5
Raigarh	4	1
Total	500	91

Table 62 Summary of centre-wise evaluation of ajwain germplasm carried out in rabi, 2023–24

AICRPS Centre	No. of Accessions Evaluated	Range (Seed Yield)	Promising Accessions (Yield in g/plant or kg/ha)
Hisar	48+2C	12.2-26.4 g/plant	HAJ-4 (25.6), HAJ-7 (24.8), HAJ-10 (25.4), HAJ-36 (24.0), HAJ-40 (26.4), HAJ-42 (23.8)
Jagudan	98+1C	4-17 g/plant	JA 07-11, JA 07-12, JA 2013-4, JA 187, MLT-58
Jobner	45+3C	1-13.0 g/plant	JAJ-22 (13.0), JAJ-35 (10.8), JAJ-25 (9.8), JAJ-11 (8.8), JAJ-08 (8.6)
Kumarganj	46+2C	5.84-9.5 g/plant	NDAJ-21 (9.5), NDAJ-34 (8.8), NDAJ-30 (8.5)
Raigarh	7+1C	2.15-3.71 g/plant	IA-6 (3.71), IA-7 (3.69), IA-5 (3.05), IA-3 (2.76), IA-1 (2.40)

Crop Improvement

AJN/CI/2 Coordinated Varietal Trial (CVT)

AJN/CI/2.8: Coordinated Varietal Trial on Ajwain 2022-Series

(Centres: Ajmer, Guntur, Hisar, Jagudan, Jobner, Kumarganj, Raigarh)

Coordinated Varietal Trial (CVT) on Ajwain – 2022 Series was laid out at multiple AICRPS centres in randomized block design (RBD) involving nine test genotypes, namely MAS-19-1, LAS-19-2, HAJ-38, HAJ-7, JA-19-05, JA-19-01, AA-16, AA-45, and AA-24, along with one national check, Ajmer Ajwain-2. The trial was conducted during *Rabi 2023-24* with coded entries to evaluate the genotypes for yield performance and adaptability across diverse agro-climatic zones.

Table 63. Summary of seed yield per hectare (kg/ha) data of coordinated varietal trials on ajwain-2023 series

Entries	Ajmer	Guntur	Hisar	Kumarganj	Jagudan	Jobner	Raigarh	Mean	Rank
AJN-20	1724	821	1140	1056	1773	1043	871	1204	VIII
AJN-21	1755	1176	1258	854	1837	1156	684	1246	VI
AJN-22	2270	1373	1104	889	1998	931	663	1318	IV
AJN-23	1420	1028	887	910	2279	1122	663	1187	IX
AJN-24	1955	1386	1027	819	1480	1230	913	1259	V
AJN-25	2201	1389	872	785	2047	1284	1034	1373	I
AJN-26	1861	933	1108	938	1798	1242	1031	1273	IV
AJN-27	1997	1429	1015	833	1598	1013	1019	1272	VI
AJN-28	1745	1470	1086	667	2031	1356	1093	1350	II
AJN-29	2163	1207	1080	875	1711	1446	774	1322	III
Mean	1919.1	1221.2	1067.7	853.6	1855.2	1183.3	878.5	—	—

Location-wise performance for seed yield is presented in the above table. The mean seed yield of genotypes ranged from **1187 kg/ha (AJN-23)** to **1373 kg/ha (AJN-25)**. Three genotypes, **AJN-25 (1373 kg/ha)**, **AJN-28 (1350 kg/ha)**, and **AJN-29 (1322 kg/ha)** recorded numerically higher seed yield compared to the trial mean. Analysis across locations indicated significant variation in yield potential among the entries.

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Nigella

Genetic Resources

Germplasm collection, characterization, evaluation and conservation of Nigella

(Centres: Dholi, Guntur, Hisar, Jagudan, Jobner, Kumarganj, Raigarh)

Even though AICRPS doesn't have a trial project to evaluate the germplasm of Nigella. Various AICRPS centre voluntary conserve nigella accessions based on their SAU mandate. A total of 109 accessions of nigella is being maintained by various AICRPS centres (Table 60).

Table 64. Germplasm collection of nigella maintained in various AICRPS centres

Centre	No. of accessions	Unique collections registered	IC number obtained
Ajmer	38	10	10
Kumarganj	37	Nil	5
Raigarh	7	1	1
Pantnagar	19	Nil	Nil
Hisar	8	Nil	Nil
Total	109	11	16

Crop Protection and Food Safety

NGL/CP/7.1: Management of root rot of nigella.

(Centres: Dholi, Kumarganj, Raigarh)

The experimental trial initiated to study the effect of different soil treatment methods and chemicals on root rot disease incidence (%) and yield (q/ha) of nigella across three locations. The trial is designed in RBD with three replication and seven treatments viz., T₁: Soil application with Talc-based *Trichoderma viride* @2.5kg multiplied in minimum 250kg FYM per ha; T₂: Soil application with Mustard oil cake @1 ton per ha; T₃: Soil application with Neem cake @1 ton per ha; T₃: Soil application with Castor oil cake @1 ton per ha; T₃: Soil drenching with Boscalid (25.2%) + Pyraclostrobin (12.8%) WG @0.2%; T₃: Soil drenching with Azoxystrobin (20%) + Difenconazole (12.5%) SC @0.2%; T₇: Control.

The treatment (T₇) control recorded the highest disease incidence and the lowest yield across all locations. Among the treatments, T₆ (Azoxystrobin + Difenconazole) recorded the highest yield at Dholi (10.67 q/ha) and Kumarganj (7.72 q/ha). This suggests that T₆ is one of the most effective treatments in terms of yield improvement. T₅ (Boscalid + Pyraclostrobin) showed a moderate effect, with disease incidence at 8.11% and a yield of 9.67 q/ha at Dholi. T₁ (*Trichoderma*-based soil application) and T₄ (Castor oil cake application) showed some reduction in disease incidence but did not outperform T₆ in terms of yield. Oil cake-based treatments (T₂ - Mustard, T₃ - Neem, and T₄ - Castor) reduced disease incidence moderately

but showed variable effects on yield, indicating that organic treatments may need additional support for optimal disease control.

Treatments	Dholi		Kumarganj		Raigarh		Mean	
	PDI	Yield	PDI	Yield	PDI	Yield	PDI	Yield
T1	8.39	9.22	6.8	7.78	10.9	6.3	8.7	7.8
T2	10.4	8.22	8.27	7.44	16.6	5.59	11.8	7.1
T3	9.53	8.67	8.06	7.33	15.2	5.33	10.9	7.1
T4	12.4	8.11	9.4	6.56	18.3	4.7	13.4	6.5
T5	7.4	9.67	6.87	8.11	9.32	6.6	7.9	8.1
T6	7.72	10.67	6.36	8.89	8.33	6.8	7.5	8.8
T7	18.2	7.33	12.18	6.22	23.9	4.4	18.1	6.0
CD (p=0.05)	3.19	1.46	1.78	0.89	1.43	0.43	0.9	0.9

13

Saffron

Genetic Resources

Conservation, evaluation and utilization of exotic and indigenous saffron germplasm accessions (Centre: Pampore)

During the cropping season of 2024-25, a total of nine new germplasm lines / clones were collected making the overall collection to 247 lines. However, to maintain the uniqueness of the dataset, germplasm lines/clones exhibiting repetitive data expressions were culled out and only 213 clones were considered for generating data to ensure precise evaluation of the genotypes.

The extent of variability observed in these traits is presented in Table 1 highlighting the genetic diversity within the studied germplasm.

Table 66. Evaluation of saffron germplasm for morphological traits

Sl. No	Traits	Trait expression range
1.	Foliage colour	Light green, Green, Dark green
2.	No. of leaves in main sprout	5–10
3.	Days to 50% flowering [d]	105 – 117 (1 st week of July sowing)
4.	Number of flowers per corm	1 – 3
5.	Tepal shape	Oblanceolate, Obovate
6.	Outer tepals length [cm]	2.8-4.8
7.	Outer tepals width [cm]	1.0-2.7
8.	Style length (cm)	0.91 – 4.0
9.	Pistil length (cm)	3.43 – 7.26
10.	Fresh Weight of pistil (mg)	17.40 – 45.38
11.	Dry weight of pistil(mg)	3.90 – 9.13
12.	Style length (cm)	0.91 – 4.0
13.	Stigma length (cm)	2.23 – 5.13
14.	Plant height (cm)	10.2 – 26.5
15.	Number of leaf sprouts	2-7

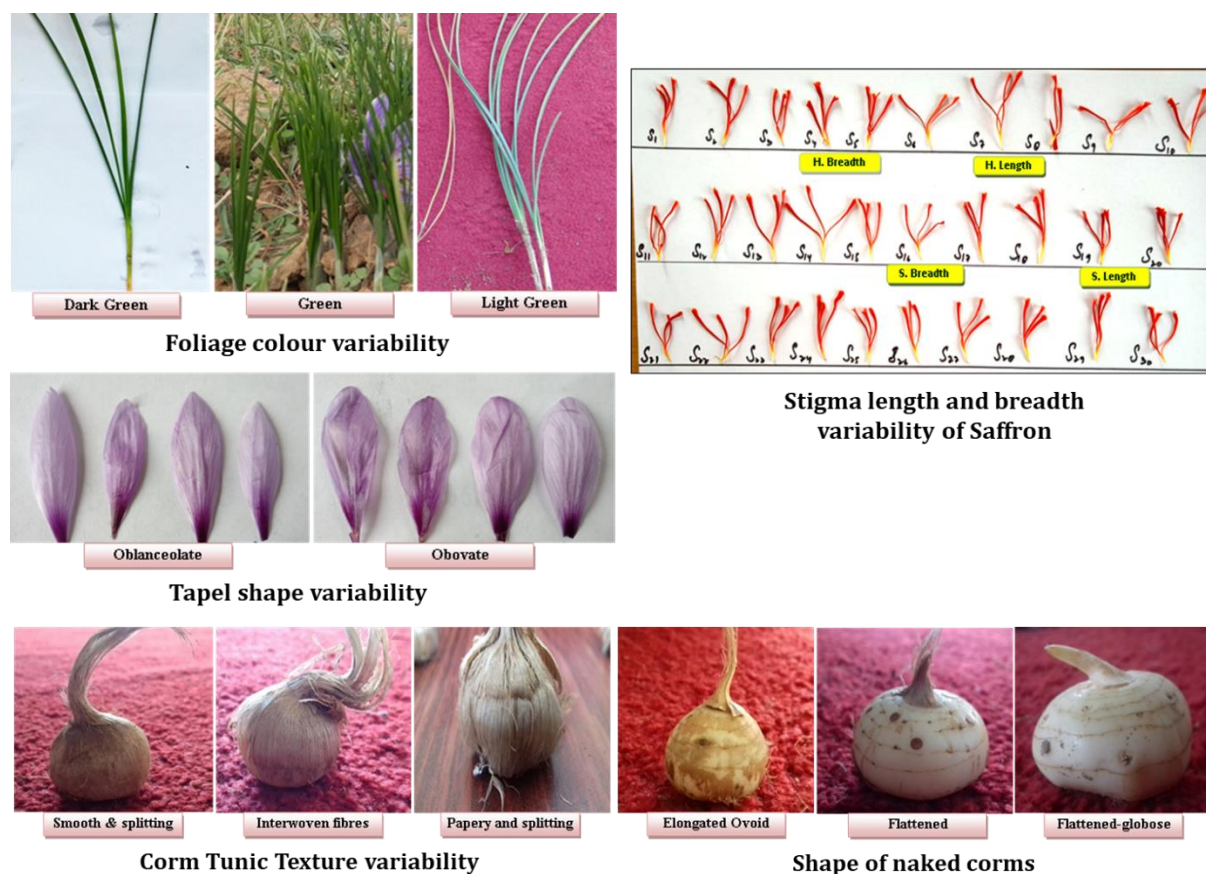


Figure 17. Morphological Variability observed in Leaf Colour, Petal Shape, and Stigma Traits of Saffron accession evaluated at Pampore.

A comprehensive evaluation of these saffron germplasm lines revealed significant variation in corm characters, growth parameters and quality traits. Morphological assessment identified distinct diversity in corm tunic (coat) texture and aspect, including types such as smooth and splitting, interwoven fibres, and papery and splitting tunics (Figure X). All genotypes exhibited persistent tunics, and the shape of naked corms varied from elongated, flattened, to flattened-globose forms. Quantitative variation was also recorded for corm dimensions, with corm length ranging from 13 to 34 mm and corm width from 15 to 44 mm.

Crop Improvement

Advanced Varietal Trial-I (AVT-I)

(Centres: Pampore)

Under the AVT-I, eleven elite accessions, including check (Shalimar Saffron-1) are planted with three replications. The accessions showed significant variation among them with regard to yield and yield-attributing traits. Amongst these accessions, SRS-Saf-178 emerged as a promising performer with the longest pistil length, averaging 6.28 cm, which was significantly higher than most other genotypes under evaluation. Although SRS-Saf-199, SRS-Saf-195, SRS-Saf-124, Shalimar Saffron-1, and SRS-Saf-128 were statistically at par, SRS-Saf-178 consistently demonstrated superiority in floral trait development. This trend extended to both fresh and dry pistil weight, where SRS-Saf-178 again recorded the highest values, indicating its robust floral biomass potential. On the contrary, the lowest fresh and dry pistil weight was noted in SRS-Saf-253, reflecting its relatively poor expression of floral quality traits. In addition to population parameters, flower production per unit area also highlighted the potential of SRS-Saf-178. This genotype produced the highest number of flowers per square meter (89

flowers/m²), followed closely by SRS-Saf-199 (85 flowers/m²), SRS-Saf-253 (82 flowers/m²), and SRS-Saf-251 (79 flowers/m²). With respect to yield performance, SRS-Saf-178, along with SRS-Saf-199, exhibited significantly higher saffron yield in comparison to all other evaluated genotypes as well as the control (Table 3).

Table 67. Yield and yield attributes of Saffron accessions evaluated under AVT-I

Accession name	Pistil length (cm)	Fresh weight of pistil (mg)	Dry weight of pistil (mg)	Stigma length (cm)	Flowers (m ⁻²)	Yield (kg ha ⁻¹)
SRS-Saf-124	6.05	32.61	6.52	3.21	72	4.80
SRS-Saf-128	5.41	27.33	5.47	3.65	74	4.93
SRS-Saf-157	5.82	32.14	6.43	4.25	76	5.07
SRS-Saf-178	6.28	35.92	7.18	3.10	89	5.93
SRS-Saf-183	5.11	29.77	5.95	3.96	74	4.93
SRS-Saf-194	5.33	31.14	6.23	4.33	78	5.20
SRS-Saf-195	6.12	33.57	6.71	4.67	73	4.87
SRS-Saf-199	6.21	34.13	6.83	4.78	85	5.67
SRS-Saf-251	5.42	28.21	5.64	4.02	79	5.27
SRS-Saf-253	5.17	27.06	5.41	3.35	82	5.47
Shalimar Saffron-1 (check)	5.91	35.63	7.13	4.05	77	5.13
CD ($p=0.05$)	0.667	3.732	0.647	0.405	3.984	0.416



Figure 18. Pictures depicting blooming and foliage of saffron germplasm at Pampore

14

Kalazeera

Genetic Resources

Exploration, collection and conservation of Kalazeera from high altitudes of northern Himalayas (Centre: Pampore)

During 2024-25, a total of 22 seed germplasm lines were collected from the higher altitudes of Himachal Pradesh. These collections were part of an extensive germplasm exploration effort aimed at identifying superior genetic resources for Kalazeera. In total, 52 seed accessions of Kalazeera were obtained, providing a valuable repository for future breeding and improvement programs.

The extent of variability observed in these traits is presented in Table 1 highlighting the genetic diversity within the studied germplasm.

Table 68. Evaluation of Kalazeera germplasm for morphological traits

Sl.No	Traits	Trait expression range
1.	Leaf colour	Green, Dark green, Pink
2.	Leaf shape	Pedate, Pinnatipartite, Multifid, Linear, Ovate, Acicular
3.	Flower colour	White, Pink, Yellowish green
4.	Plant growth habit	Spreading, Non-spreading
5.	Seed colour	Blackish, Greyish black, Pale green
6.	Plant height (cm)	22.86 – 96.52
7.	Primary branches plant ⁻¹	1 - 6
8.	Umbel diameter (cm)	1.6 - 11.3
9.	Number of umbels plant ⁻¹	1 – 40
10.	Number of seeds umbel ⁻¹	2.0 - 26.0
11.	Seed shape	Curved, Straight
12.	Days to maturity (days)	170 - 180
13.	1000-seed weight (g)	0.90 - 2.88
14.	Biological yield (g/m ²)	27.36 - 229.45
15.	Harvest index (%)	0.23 - 0.44
16.	Seed yield per plant	0.35 - 13.10

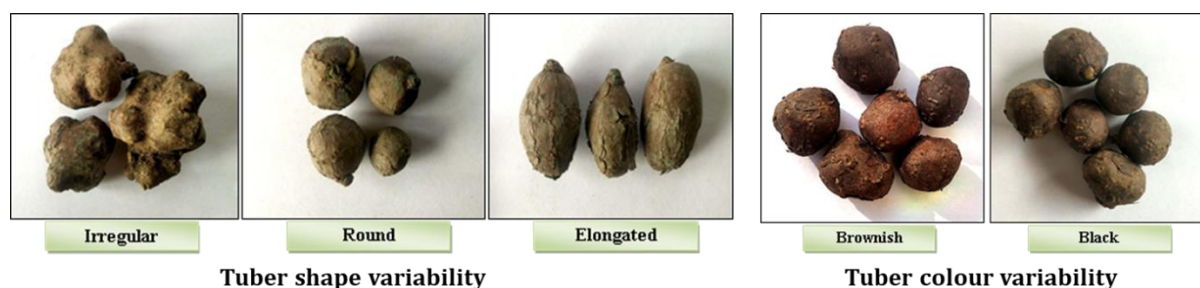


Figure 19. Morphological Variability observed in tuber traits of kalazeera accession evaluated at Pampore.

A comprehensive evaluation of these kalazeera germplasm lines revealed significant variation in tuber characters, growth parameters and quality traits. Morphological assessment identified distinct diversity in tuber tunic (coat) colour which varied between Blackish in 48 accessions and Brownish in 50 accessions. The tuber shape exhibited three distinct forms: Irregular in 79 accessions, Round in 16, and Elongated in 3. The tuber length, measured in the third year, ranged from 0.9 to 2.1 cm, while the tuber width, also recorded in the third year, ranged from 1.2 to 2.5 cm. The weight of tubers, again assessed in the third year, ranged between 2.82 and 4.78 g.

Crop Improvement

Advanced Varietal Trial-I (AVT-I)

(Centres: Pampore)

Under the AVT-I, significant differences in plant height were observed among the genotypes. The genotype SRS-KZ-170 was recorded as the tallest, reaching a height of 93.15 cm. This was followed by Shalimar Kalazeera-1 (88.8 cm) and SRSKZ-167 (83.95 cm). In contrast, the lowest plant height was recorded for genotype SRS-KZ-172, which measured only 60.25 cm. The highest number of umbels per plant was recorded for genotype SRS-KZ-177, with an average of 37 umbels per plant. In contrast, Shalimar Kalazeera-1 exhibited the lowest number of umbels per plant, with only 23.

The highest seed yield was recorded for genotype SRS-KZ-177 which produced 435.0 kg/ha which was followed by SRS-KZ-167 (422.45 kg/ha) and SRS-KZ-170 (402.0 kg/ha). In contrast, the lowest seed yield was recorded for genotype SRS-KZ-192, which produced only 319.9 kg/ha. The highest essential oil content was recorded for genotype SRS-KZ-170 with a value of 9.35%. Genotypes SRS-KZ-177 and Shalimar Kalazeera-1 (SK-1) exhibited slightly lower essential oil content both recording 9.25%. On the other hand, the lowest essential oil content (8.7%) was observed for genotype SRS-KZ-149

Based on the performance evaluation conducted during the AVT, the variety designated as SRS/KZ/177 exhibited promising results (Table X). Consequently, it has been recommended for Minikit Testing during the 55th Research and Extension Advisory Committee Meeting, held on July 18, 2024 to assess its adaptability and performance under diverse field conditions. Furthermore, the proposed name for this variety has been recommended as Shalimar Kalazeera-2, signifying its potential for commercial release and widespread cultivation.

Table 69. Pooled analysis of yield and yield attributes of kalazeera lines evaluated under AVT (2022-24)

Entries	Plant height (cm)	Umbles per plant	Days to maturity (days)	Seed Yield / ha (kgs)	Essential oil content (%)
SRS-KZ-149	74.25	27.5	211.0	386.05	8.70
SRS-KZ-158	75.55	32.0	208.0	381.15	9.15
SRS-KZ-167	83.95	34.5	204.5	422.45	9.20
SRS-KZ-170	93.15	30.5	206.0	402.00	9.35
SRS-KZ-172	60.25	32.5	219.5	347.95	9.20
SRS-KZ-177	59.10	37.0	217.5	435.00	9.25
SRS-KZ-192	68.70	27.5	210.5	319.90	9.05
Shalimar Kalazeera-1	88.80	23.0	215.5	338.20	9.25
CD (p=0.05)	6.878	1.835	NS	13.661	0.237



Fig. 20. Field Performance and Morphological Features of SRS/KZ/177 (Proposed as Shalimar Kalazeera-2) under Minikit Testing

15 Monitoring

The Project Coordinator and the PC unit scientists have proactively monitored the progress of research trials under the AICRPS through in-person visits, virtual engagements, and periodic reporting mechanisms. AICRPS centre visits enabled hands-on evaluation of experimental trials and facilitated direct interaction with scientists for addressing centre-specific issues. During 2024–25, Dr. D. Prasath, PC, AICRPS, undertook monitoring visits covering NEH region centres at Medziphema, Barapani, Kaikuchi, Mizoram, Sikkim, Pasighat, Pundibari, and Kalyani in May 2024; ICAR-NRCSS, Ajmer in September; ICAR-IISR RS, Appangala; Sanand centre; and PRS, Panniyur. Additional visits were made to Navsari, Jagudan, and HC&RI, TNAU, Coimbatore during January and February 2025. Dr. Vinay Bharadwaj led the seed spices trial monitoring team at ARS Mandore, SKNAU Jobner, and SSRS SDAU, Jagudan. Mr. Nafid C., YP-I, PC Cell also visited NEH centres in Sikkim and Nagaland to assess AICRPS and training activities. In parallel, online review meetings were held throughout the year to finalize trial plans, assess financial progress, and deliberate on crop-specific issues. XXXV AGM of AICRPS was held at CCSHAU, Hisar in October 2024 to comprehensively review the scientific progress across all centres. This integrated monitoring framework has ensured improved compliance with technical protocols, enhanced communication among stakeholders, and timely corrective measures, thereby strengthening the overall impact and efficiency of the AICRPS research programmes.



16

Annual Group Meeting

The XXXV Annual Group Meeting (AGM) of ICAR- AICRPS was held during 15–17 October 2024 at CCS Haryana Agricultural University (CCS HAU), Hisar. The meeting brought together researchers, and experts from across the country to review the progress of trials conducted at various AICRPS centres during 2023–24.

Dr. Rajbir Garg, Director of Research, CCS HAU, welcomed the delegates and emphasized the importance of collaborative research in addressing emerging challenges in spice cultivation. Dr. D. Prasath, Project Coordinator, AICRP on Spices, presented a comprehensive overview of the project network and its key achievements. In the inaugural session, Dr. S.K. Singh, Deputy Director General (Horticulture), ICAR, underscored the need for realigning R&D efforts to meet market demands, with a particular focus on essential oil extraction and microbiome research to strengthen the value chain. Dr. V.R. Kamboj, Vice Chancellor, CCS HAU, Dr. Sudhakar Pandey, ADG (FVSMP), ICAR, Dr. N. Krishna Kumar, Dr. Vinay Bhardwaj and Dr. V.A. Parthasarathy and Dr. R. Dinesh addressed group during the meeting. The meeting witnessed participation from several distinguished personalities including Dr. Nirmal Babu, Dr. Homey Cherian, Dr. Prakash Patil, Dr. Augustine Jerard, Dr. E.V.D. Sastry, Dr. K.P. Singh, and Dr. Vikramaditya Pandey, along with heads of various participating institutions.

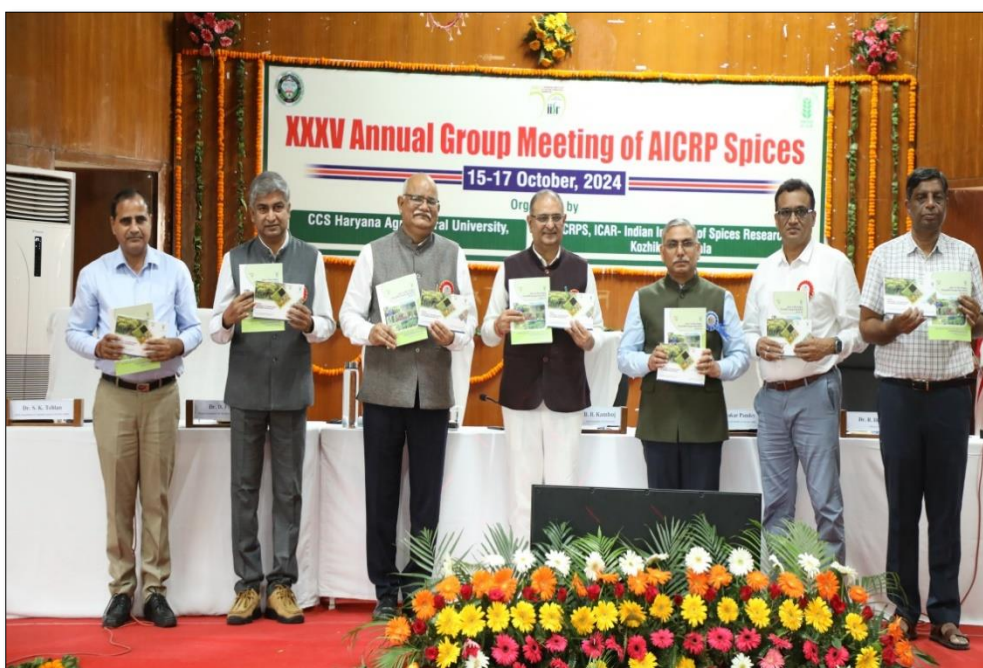
The “Best AICRPS Centre Award” for the year was conferred on NM College of Agriculture, Navsari, in recognition of their exemplary contributions. Eleven new publications were released during the meeting, further enriching the knowledge resources available for spice researchers and stakeholders.

The workshop was organized in six Technical Sessions viz., Genetic Resources and Crop Improvement, Crop Management, Crop Protection, Variety Release, Technology Transfer and Plenary Session. Several new spice varieties were identified during the meeting. These included Karan Dhaya-1 (RCr 565/ UD-565), a coriander variety with a seed yield of 1482 kg/ha, volatile oil content of 5.73 l/ha, and resistance to stem gall, recommended for Rajasthan, Gujarat, and other coriander-growing regions; Jodhpur Jeera-1 (MCU-105), a cumin variety yielding 566 kg/ha and moderately resistant to wilt and blight; CAZRI Cumin-1 (CZC 135), another cumin variety with 522 kg/ha yield and tolerance to Fusarium wilt, both suited for Rajasthan; Gujarat Fennel-13 (JF 2018-03), a fennel variety with a yield of 1814 kg/ha and moderate resistance to Ramularia, suitable for Gujarat, Rajasthan, Haryana, Bihar, and Uttar Pradesh; Karan Methi-1 (RMt-259/ UM 259), a fenugreek variety maturing in 121 days, yielding 1742 kg/ha and resistant to powdery and downy mildew, recommended for all fenugreek-growing regions; SAS-KEVÜ, a ginger variety for NE states and hilly Andhra Pradesh, yielding 17.21 t/ha with soft bold rhizomes; and IISR Surya (Acc 849), a turmeric variety rich in zingiberene (21.07%) with a fresh yield of 29 t/ha and dry yield of 5.8 t/ha, identified for Kerala, Telangana, Odisha, Jharkhand, and Arunachal Pradesh.

In addition to varietal developments, several new technologies were also recommended for adoption. These included leaf mould mulching in large cardamom, which resulted in a 41.5% increase in yield and improved moisture conservation and benefit-cost ratio, suggested for

NE Himalayan states; use of azole fungicides for managing cardamom leaf blight, leading to up to 35% disease reduction and 18% increase in yield, effective in Karnataka and Kerala; integrated application of azole and mancozeb fungicides for rhizome rot management in cardamom, which showed yield increases of up to 51% in Karnataka and 45.1% in Kerala with a B:C ratio of up to 3.34; Trichoprime priming in ginger rhizomes, which resulted in a 7.52% increase in yield and enhanced plant vigour, recommended for ginger-growing regions in Kerala, NE, Jharkhand, and Odisha; and Trichoprime priming in turmeric rhizomes, which led to a 5.51% increase in yield and improved sprouting and storage performance across turmeric-growing regions including Kerala, Tamil Nadu, and Uttar Pradesh.

The XXXV AGM of AICRPS thus provided a vital platform for reviewing research progress, releasing new varieties and technologies, and strategizing future directions for enhancing the productivity, resilience, and sustainability of spice crops in India.



Glimpses of 35th AGM (a) release of publication (b) Dr. Prasath explaining the new ginger variety SAS-KEVU kept in exhibition hall. (c) presentation of best centre award

QUINQUENNIAL REVIEW TEAM

As per ICAR's order F. No. 1(6)/2018-IA.V dated 6th November 2023, the Quinquennial Review Team (QRT) was constituted to review the functioning and achievements of AICRP on Spices for the period 2018–2023. The committee, chaired by Dr. Parvinder Kaushal and comprising Dr. S.K. Pandey, Prof. V. Palanimuthu, Dr. Yaduraju N.T., Dr. S.K. Sharma as members, and Dr. D. Prasath as Member Secretary, undertook a detailed assessment through presentations, field inspections, and stakeholder interactions. The QRT visited AICRPS centres at Kozhikode, Appangala, Jobner, Ajmer, Guntur, and Medziphema, spanning January to May 2024, and reviewed centre-specific activities, constraints, and achievements in varietal development, crop protection, climate resilience, and value chain interventions. The team interacted extensively with scientists and stakeholders including Spices Board, farmers, and exporters, and visited research farms, KVKs, processing units, and pesticide residue laboratories. Key sites included the ITC spice unit in Guntur, SK Cardamom Estate in Madikeri, and Guntur chilli market. The final review meeting was held at NIFTEM, Thanjavur on 22–23 June 2024. The final QRT report, encapsulating insights and recommendations, was formally presented before the Director General, ICAR, on 12th August 2024 at ICAR headquarters.



NEH/TSP/SCSP ACTIVITIES

Promotion of spice cultivation in NEH

During 2024–25, various AICRP on Spices centres under the NEH programme actively promoted spice-based development in North Eastern and Himalayan regions through targeted training, demonstrations, input supply, quality planting material distribution, and value addition programmes. In Meghalaya, 26 tribal farmers from Marngar, Lawmei, and West Jaintia Hills participated in a three-day training at ICAR RC NEH, Umiam, focusing on scientific cultivation of turmeric, ginger, vegetables, and fruits, including hands-on sessions on pro-tray nursery, hydroponics, grafting, and turmeric slicer and washer; they were also supplied with vegetable seeds, irrigation cans, and turmeric seed rhizomes. A total of 750 kg of Megha Turmeric-1 and 300 kg of Nadia ginger were distributed in Meghalaya and Sikkim, which yielded 6–7 t/acre and 39.8% more productivity respectively compared to local varieties. In Sikkim, a model large cardamom nursery village was developed at Radhu Khandu GPU, Gyalshing District, with 30 nurseries expected to produce 3 lakh suckers benefiting 100 farmers, including 13 women. In Kamrup, Assam, 12,048 black pepper plants of Panniyur-1 and Karimunda were distributed through two nurseries benefitting 120 farmers, while trainings on intercropping, pest and nutrient management, and women-oriented value addition activities such as sun drying and packaging of black pepper products were held. In Mizoram, entrepreneurship and capacity building trainings on ginger and turmeric for nutritional security empowered Mizo tribal farmers, especially women, to adopt precision farming and climate-resilient practices, leading to improved income and sustainability.

Developmental activities in the tribal villages

During 2024–25, AICRP on Spices centres under the TSP programme actively empowered tribal farmers through training, demonstrations, input support, and quality planting material distribution across Odisha, Andhra Pradesh, Tamil Nadu, and other regions. At Chintapalli (Andhra Pradesh), 122 tribal farmers from Burisingi, Pinapadu, and Kothapalem villages received 1140 black pepper cuttings, 2000 cinnamon seedlings, and 1000 kg ginger (Suprabha), alongside inputs like 50 kg *Trichoderma harzianum* and 24 battery sprayers, improving pest and disease control. In Odisha's Koraput district, 100 tribal farmers were trained on organic spices cultivation, with 400 kg ginger, 500 kg turmeric, and over 2000 seedlings (black pepper, clove, vanilla, cardamom, allspice) distributed; 20 nurseries in Lamataput produced 1 lakh black pepper rooted cuttings. In Tamil Nadu's Yercaud, 300 tribal farmers received 3000 pepper cuttings and 2000 coffee seedlings and attended 11 training sessions on ICM, postharvest handling, and value addition. Women were empowered through dedicated training on vermicomposting, kitchen gardening, and flower value addition, enhancing both skills and livelihoods.

Developmental activities for SC communities

During 2024–25, AICRP on Spices centres actively supported Scheduled Caste farmers through the SCSP programme via training, input distribution, and demonstration across several states. In West Bengal, 120 SC farmers from Nadia and North 24 Parganas were trained and supplied with 600 kg of turmeric (var. Pragati), along with *Trichoderma viridae* (400 g), *Azotobacter* and PSB (1 kg each), and spades to promote organic turmeric cultivation, indirectly benefiting over 300 farmers. In Rajasthan, 165 farmers were trained

and 30 frontline demonstrations conducted on cumin (var. GC-4) across 12 hectares in Nagaur and Jodhpur, yielding an 18.5% increase over local varieties. In Chhattisgarh, 216 kg of coriander seed (Chhattisgarh Shri Chandrahasini Dhaniya-2) was distributed to SC farmers, benefiting over 100 through two trainings. In Tamil Nadu, HRS Yercaud distributed 6000 plants (pepper, fig, coffee, jasmine) to 30 farmers and held training on organic farming. In Odisha, 100 farmers received 3,200 seedlings including ginger, turmeric, and clove and participated in training on organic spice cultivation in Sonepur. At Pampadumpara (Kerala), focused training and distribution initiatives, each attended by around 40 SC farmers (total ~80 participants), covering improved cardamom nursery management, pepper foot-rot control, integrated pest management, and sustainable farming practices. Demonstrations were conducted on four demonstration plots (~0.5 ha each) showcasing high-yielding PV-1 cardamom clones and disease-resistant black pepper vines. As part of quality planting material distribution, 4,000 cardamom suckers (PV-1) and 2,500 black pepper cuttings were provided to the participants, directly benefiting these 80 farmers. Additionally, women farmers (25 of the trainees) received hands-on training in value addition such as cleaning, grading, and basic packaging of cardamom to enhance marketability and income. These integrated efforts aimed to build capacity, boost productivity, and promote income generation among SC farming communities in the region

Popularization of Technologies

Scientists from AICRPS centres are actively involved in popularization of the latest technologies to make aware the farming community about scientific cultivation practices and sustainable spice production. Some of the technologies demonstrated during the year as follows

High yielding varieties- boon to farmers

- ❖ Demonstration of newly released, high yielding turmeric variety YSRHU-Lam Swarna (Guntur)
- ❖ Demonstration of stable curcumin variety IISR Pragati at Talakanti, Suliamari, Kotia, Pottangi and Koraput, Andra Pradesh (Pottangi)
- ❖ Demonstration of high yielding fenugreek variety RMT-354 (Jobner) and RMT-1 (Jabalpur)
- ❖ Demonstration of high yielding fennel variety RF-290 (Jobner)
- ❖ Demonstration of high yielding cumin variety GC-4 (Mandor)
- ❖ Demonstration of high yielding leafy coriander culture CS 38 (Coimbatore) and Cimpoo S- 33 (Jabalpur)
- ❖ Demonstration of high yielding Panniyur black pepper varieties viz., Panniyur-8, Panniyur-9 & Panniyur-10 (Panniyur)
- ❖ Adoption of five high yielding IISR varieties of black pepper in farmers' field viz., IISR-Shakthi, IISR-Girimunda, Pournami, Panchami, Sreekara. (Pottangi)
- ❖ Adoption of Appangala-1 in Lamataput region, Andra Pradesh (Pottangi)
- ❖ Front line demonstration of turmeric cv. RCT 1 (ICAR-Mizoram)
- ❖ Front line demonstration of ginger cv. Bold Nadia (ICAR-Mizoram)

Rapid multiplication of planting materials- for minimal expenditure

- ❖ Protray cultivation technique for quality seed production of ginger & turmeric (Kammarpally)
- ❖ Rapid propagation method of black pepper and column method was demonstrated for farmers and students of TNAU (HRS Pechiparai)
- ❖ Performance demonstration of the two budded turmeric seed material on raised bed with 3 to 4 rows with fertigation. (Kammarpally)

Micronutrients & biocapsules for soil health

- ❖ Distribution and demonstration on beneficial effects of biocapsules and micronutrient packages specific to ginger, turmeric and black pepper were taken up on a pilot scale in all the spice growing tracts through AICRPS centres
- ❖ Demonstration of micronutrients IISR Power Mix T and IISR Power mix G and biocapsules namely *Trichoderma* sp, PGPR and *Bacillus amyloliquefaciens* from IISR Kozhikode, Kerala in farmers field for ginger and turmeric in Sikkim (ICRI Gangtok)
- ❖ Use of biocapsules of *Trichoderma* and PGPR (GRB-35) for the management of foliar diseases in turmeric. (Coimbatore, Guntur, Kammarpally).
- ❖ Front line demonstration of micro-nutrient in large cardamom for growth & yield (Nagaland).

Protection technologies- for plant health

- ❖ Technology demonstration on the effect of seed treatment with Trichoprime powder.
- ❖ Management of management of Phyllosticta leaf spot of ginger (Pundibari)
- ❖ Management of shoot fly in cardamom with fish meal traps (ICRI-Sakleshpur)
- ❖ Demonstration of bio control agents against pepper wilt (Yercard), distribution of biocapsules (PGPR, *Bacilich* and *Trichoderma*) at Pasighat.
- ❖ Priming of ginger seed rhizomes for safe storage of ginger seed rhizomes (Nagaland)

Processing machineries- for increase in efficiency

- ❖ Demonstration of value-added products preparation from *Garcinia* (Pechiparai)
- ❖ Demonstration of turmeric boilers, polishers (IISR, Kozhikode)

Apart from the above field level demonstrations, the scientists popularised technologies by conducting virtual trainings and attending as resource persons in virtual trainings and seminars and also through various media (newspaper, radio talks and TV programmes).

Success Story

Green Gold in the Drylands: Guntur Farmers Reap Rich Returns with Improved Coriander Varieties

AICRP on Spices at Lam, Guntur, has transformed coriander cultivation in Andhra Pradesh into a profitable, climate-resilient enterprise. Cultivated on 5,000 to 10,000 hectares annually, primarily in rainfed black vertisols, the crop's mean productivity has increased from 276 kg/ha in the 1990s to 1895 kg/ha in the Terminal Estimate (TE) 2018–23, surpassing the national average of 1333 kg/ha. Initial challenges included terminal moisture stress, poor germination, pests, diseases, and the absence of high-yielding varieties. Through sustained varietal development, the AICRP centre released eight improved varieties including Sindhu, Sadhana, Swathi, Sudha, AD-1, Suguna, Susthira, and Suruchi. Sudha increased yields to 1000 kg/ha during the 10th Plan, while Susthira, released in TE 2018–23, reached 1895 kg/ha, outperforming Sudha by over 50% under drought with a BCR of 1:1.3. Susthira now covers 9492 ha in AP, followed by Suguna (7444 ha), AD-1 (4860 ha), and Sudha (1587 ha). Varietal preference varies across districts—AD-1 leads in Ananthapur, Suguna in Kadapa, and Guntur shows balanced adoption. These varieties are also widely adopted in Gujarat, Rajasthan, Karnataka, and Tamil Nadu. Economic returns have soared, with income per 1000 ha rising from ₹1 crore during the 8th Plan to ₹6.6 crore in TE 2018–23. AICRP's off-season coriander herb model, yielding up to 4500 kg/ha with a BCR of 5.23, has seen widespread urban adoption. The holistic approach—combining genetics, agronomy, and outreach—has turned coriander into a reliable income generator and a model for seed spice success under rainfed conditions.

Spice Revival through Science: AICRP on Spices' Transformative Impact in Black Pepper Farming

AICRPS has played a pivotal role in revitalizing black pepper cultivation across India through farmer-centric, science-based interventions. In Sirsi, Karnataka, long-term partnerships between AICRPS Sirsi centre scientists and progressive growers have significantly enhanced conservation, nursery production, and disease management in black pepper. Shri Subray Hegde of Balekoppa, Siddapur, has conserved over 25 unique local pepper genotypes distinguished by their leaf morphology, yield, and resistance traits. He continues to maintain traditional cultivars like Kudure Bala, Nuchchu Menasu, and Huchchu Meanasu, with scientific support from AICRPS for agro-techniques and quality analysis.

From the tribal belts of Kumta, Shri Rajugowda has emerged as a model entrepreneur, producing 10,000 grafted pepper plants annually following training under AICRPS. His nursery has empowered nearby rural families through education and access to quality planting material. Similarly, Shri Gopal Krishna Hegde of Kodanmane demonstrated the effectiveness of Integrated Disease Management (IDM) for slow wilt, validated through a farm trial by AICRPS Sirsi during 2022–23. With improved plant recovery, he adopted

IDM practices across his farm and now advocates these methods among neighboring growers.

In Tamil Nadu, Th. Madhu, an M.Sc. Botany graduate from Yercaud, adopted scientific cultivation practices promoted by AICRPS-Yercaud through training in IPDM and INM. On his 3-acre pepper and coffee farm, his yields increased by 25% and 17% respectively, resulting in a rise in net annual income from ₹1.71 lakh to ₹2.5 lakh—a 46% gain. Timely spraying with his own equipment improved chemical efficiency and reduced costs. He is now exploring mixed cropping with banana, fig, and cinnamon to further boost farm income.

At Dapoli, Maharashtra, AICRPS inputs enabled Mr. Dhananjay Joshi to control *Phytophthora* foot rot in black pepper (Panniyur-1) using *Trichoderma harzianum* and *Pochonia chlamydosporia*. He achieved a yield of 800 gm/plant on 2 gunthas by combining biological control with organic foliar sprays and scientific soil management. Likewise, Mr. Mohan Mahadik cultivated black pepper on 1 guntha using non-traditional dead standards such as cement poles and GI mesh, applying bioagents and cow urine sprays to achieve the same yield.

In Pechiparai, Tamil Nadu, retired farmer Mr. Gnanadhas transitioned into a spice nursery entrepreneur after being trained in propagation techniques for black pepper, cinnamon, and nutmeg. He now manages 2 acres of shade-net cultivation with overhead irrigation, producing high-yielding pepper grafts with advised agot from experts of AICRPS, Yercaud.

Together, these stories from Sirsi, Dapoli, Yercaud, and Pechiparai underscore how AICRP on Spices has rejuvenated India's black pepper farming through region-specific, participatory, and science-backed interventions that enhance productivity, entrepreneurship, and livelihood resilience.

Smart Spacing, Smart Earnings: Mr. Pawar's Intercropping Success with Pepper and Tubers

With the intervention of AICRPS centre Dapoli Mr. Janu Pawar initiated intercropping black pepper with tuber crops, which resulted change as maximized land, water, and resource use. Following recommended practices and using biofertilizers, he improved yield and pepper quality, while earning additional income from tubers. This sustainable model highlights diversification and resource efficiency on a 2-guntha plot in Ratnagiri.

From Decline to Resurgence: SCSP Brings Back Productivity in Small Cardamom Plantations

In Pampadumpara, Kerala, small cardamom farming had declined due to poor inputs and unscientific practices, affecting the livelihoods of smallholders. The AICRP on Spices, under the SCSP programme, intervened with scientific training, quality inputs, and integrated management practices. Beneficiaries like Mr. Mohan Das and others adopted these methods, leading to significant improvements in productivity and sustainability. Post-intervention, the number of harvests increased from 3 to 5 annually. Average yield per harvest rose from 283 kg to 517 kg, raising annual production from 1067 kg to 2800

kg. Income increased from ₹3.73 lakh to ₹9.8 lakh, and the benefit-cost ratio improved from 1.32 to 2.12. Chemical sprays reduced by 35%, shade regulation improved from 20% to 50%, and input costs declined. Similar gains were observed across 50 farmers in the region, showcasing how SCSP support has rejuvenated spice farming. The initiative stands as a replicable model of inclusive, sustainable development for marginalized communities.

Turmeric Trailblazers of Telangana: From High-Yield Varieties to Farmer-Led Processing

Sri Chinnareddy excelled in turmeric farming by cultivating high-curcumin varieties like IISR Pragathi and selling his produce to Smart Agro Food Park. His success in quality turmeric production earned him recognition from the District Collector, boosting the profile of scientific spice cultivation in Nizamabad. Mr. Reddy from Zakranpally formed a turmeric farmer-producer group and secured ₹2 crore subsidy from MSME. He established a turmeric processing unit, empowering local farmers, generating employment, and strengthening value addition in turmeric. His initiative showcased how farmer-led entrepreneurship can transform rural spice-based economies.

Golden Roots of Change: Transforming Tribal Lives through Turmeric Cultivar 'Roma' in Chintapalli, Andhra Pradesh

Tribal farmers of Chintapalli improved livelihoods by adopting high-yielding turmeric cultivar 'Roma' and black pepper, with support from AICRP on Spices and NGOs. Technical support, planting material, and equipment like sprayers and tarpaulins were provided, benefiting 3,000 farmers through training and demonstrations on good practices, post-harvest management, and value addition.

Sealed for Success: Pit-Based Ginger Seed Storage Transforms Himachal's Spice Sector

In Himachal Pradesh, a scientific pit-based ginger seed storage method drastically reduced rhizome rot and post-harvest losses. In Solan, Himachal Pradesh, AICRPS solved the critical problem of ginger seed storage through a scientific pit-based method involving fungicide treatment, temperature control (12–13°C), and sealed cow dung layers. Earlier, traditional methods led to 87% seed loss due to rot, discouraging farmers. With over 90% recovery now achieved, ginger cultivation has spread to non-traditional districts like Kangra, Una, and Chamba. This technique is now officially part of Himachal Pradesh's Package of Practices.

Krishi Melas & Farmers Training

KRISHI MELAS & EXHIBITIONS

- College of Agriculture, Shivamogga organized “Krishi Mattu Totagarike Mela – 2024” from 18–21 October 2024, with active farmer participation and demonstrations of spice technologies.
- ZAHRS, Mudigere also hosted “Krishi Mattu Totagarike Mela – 2024” on 27–28 December 2024, focusing on spice crop technologies.
- TNAU, Coimbatore conducted an Exhibition and Field Demonstration on 26 September 2024 showcasing spices technologies and varieties to over 25,000 farmers.
- SSRS, SDAU, Jagudan organized a District-level Seminar on Seed Spices on 13 February 2024, with participation from multiple stakeholders.
- SDAU, Jagudan and KVK, Bhuj hosted a State-Level Seminar on Seed Spices on 11 March 2024 under the MIDH project.

FARMERS TRAININGS ORGANIZED BY AICRPS CENTRES

Sl. No.	Date	Details of Training Program	Centre/Organizer	No. of Participants
1	08-01-2024	Advanced management practices in Horticulture crops for Alluri Sitaramaraju Women Agri. FPO	AICRPS, Chinthapalle	75
2	02-03-2024	Post Harvest Management in Spices (TSP)	TSP, AICRPS Chinthapalle	30
3	07-03-2024	Good Agricultural Practices in Spices (TSP)	TSP, AICRPS Chinthapalle	30
4	18-03-2024	Post Harvest Management in Spices (TSP)	TSP, AICRPS Chinthapalle	30
5	22-03-2024	Good Agricultural Practices in Spices (TSP)	TSP, AICRPS Chinthapalle	30
6	06-07-2024	GAP practices in turmeric for Horticulture Dept. & Digital Green	AICRPS Chinthapalle	30
7	13-08-2024	Biological Control in Tribal Farming for farmer groups Dr. YSRHU – HRS, Ambajipeta	AICRPS Chinthapalle	30
8	17-08-2024	Pest and Disease Management in Spices	Dr. YSRHU – HRS, Chintapalli	30
9	19-09-2024	Pest and Disease Management in Spices for farmer group s VCF – Tata Trusts	AICRPS Chinthapalle	30
10	06-11-2024	Regional Seminar on Spices, Spices Board	AICRPS Chinthapalle	60

Sl. No.	Date	Details of Training Program	Centre/Organizer	No. of Participants
11	08-11-2024	Quality Improvement Training on Spices, Spices Board	Spices Board	100
12	23-01-2024	Chilli production technology by Scientists of HRS, Lam, Guntur	Mutyalampadu village of Dachepalli mandal, Palnadu district	150
13	19-12-2024	Navigating the path to geographical indicators procedure and processes for horticultural crops by HRS, Lam, Guntur in collaboration with DR, Dr. YSRHU and CRS, Tirupati	Online	96
14	19-12-2023	Production technology of turmeric by Dr. B. Tanuja Priya, Principal Scientist (Hort)	KVK, Vonipenta organized by BRS, Pulivendula	150
15	23-01-2024	Chilli production technology by Scientists of HRS, Lam, Guntur	Mutyalampadu village of Dachepalli mandal, Palnadu district	150
16	19-12-2024	Navigating the path to geographical indicators procedure and processes for horticultural crops by HRS, Lam, Guntur in collaboration with DR, Dr. YSRHU and CRS, Tirupati	Online	96
17	19-12-2023	Production technology of turmeric by Dr. B. Tanuja Priya, Principal Scientist (Hort)	KVK, Vonipenta organized by BRS, Pulivendula	150
18	23-01-2024	Chilli production technology by Scientists of HRS, Lam, Guntur	Mutyalampadu village of Dachepalli mandal, Palnadu district	150
19	19-12-2024	Navigating the path to geographical indicators procedure and processes for horticultural crops by HRS, Lam, Guntur in collaboration with DR, Dr. YSRHU and CRS, Tirupati	Online	96
20	08-07-2023	Production technology of horticulture crops (Farmers scientists' interaction)	RARS, Lam	53
21	18-03-2024	Scope and importance of fruits, vegetables and spices value addition	KVK, Lam, Guntur	52
22	22-03-2024	Production Technology in chillies (Formation and promotion of FPOs)	District Resource Center, ATMA, Ongole, Prakasam district (Online)	35
23	02-08-2024	Package of practices in chillies (Chilli training programme)	KVK, Vonipenta	30
24	12-09-2024	Production and protection in turmeric (Polam pilusthondi programme)	Kollipara village	50
25	24-09-2024	Turmeric production technology (Polam pilusthondi programme)	Mangalagiri mandal	30
26	08-07-2024	Production technology of horticulture	RARS, Lam	30

Sl. No.	Date	Details of Training Program	Centre/Organizer	No. of Participants
		crops (Farmers scientists' interaction)		
27	10.10.2024	Expert lectures in two Input Dealers Training Programmes	SDAU Jagudan	30
28	15–30 March 2024	Lead lecture on “Cumin Blight: A threat to cumin production and its management” (CSP in ASD-2024)	Astha Foundation, Meerut	30
29	13-02-2024	District level seminar on seed spices and six farmers trainings under MIDH project	SSRS, SDAU, Jagudan	50
30	2024	Lectures in farmers trainings / khedut din / field days / shibir under SSRS, COH(PHT), ATMA, Spices Board, GOG etc.	Various venues, organised by SDAU	30-50
31	11-03-2024	Lecture in State level seminar on seed spices at KVK, Bhuj	MIDH	50
32	21-02-2024	Lecture on seed spices protection in Gramsevak Training Programme	Kadi, OFR, SDAU, SKNagar	30
33	06.03.2024	Organized training program on Recent advances in turmeric cultivation, Post harvest and value addition	Vill: Renjarla, Mdl: Mupkal, Dist: Nizamabad	50
34	20.11.2024	Organized training program on Advances in turmeric cultivation post harvest and value addition	Vill: Venchiryal, Mdl: Mupkal, Dist: Nizamabad	62
35	22.11.2024	Organized training program on Advances in turmeric cultivation post harvest and value addition	Vill: Vadiyat, Mdl: Kammarpally, Dist: Nizamabad	75
36	28.11.2024	Organized training program on Advances in turmeric cultivation post harvest and value addition	Vill: Bopparam, Mdl& Dist: Nirmal	50
37	30.11.2024	Organized training program on Advances in turmeric cultivation post harvest and value addition	Vill: Paidimadugu Mdl: Korutla Dist: Jagtial	36
38	27-12-2024 to 28-12-2024	Integrated pest management in spice crops	ZAHRS Mudigere	35
39	06.01.2024	Plant protection	RARS Pilicode	121
40	10.01.2024	Production technology of spices for farmers	RATTC Thaliparamba	35
41	23.01.2024	Scientific cultivation of black pepper	Karimbam	35
42	23.01.2024	Integrated pest and disease management of black pepper	Karimbam	26
43	10.06.2024 – 14.06.2024	Collaborative Online Training on Innovations in Production, Value Addition & Marketing of Spices in India	ICAR-IISR & MANAGE, Hyderabad	45

Sl. No.	Date	Details of Training Program	Centre/Organizer	No. of Participants
44	10.06.2024 – 14.06.2024	Collaborative Online Training on Innovations in Production, Value Addition & Marketing of Spices in India (<i>duplicate</i>)	ICAR-IISR & MANAGE, Hyderabad	23
45	21.08.2024	Online talk on “Importance and uses of individual spices”	CRS, KAU Pampadumpara & ICAR-MANAGE, Hyderabad	115
46	27.10.2024	Delivered talks at Krishi Mela	Brahmvar, Udupi, Karnataka (Govt. of Karnataka)	500
47	24.11.2024	Class on Pepper production technology for 35 private fertilizer dealers (DAESI programme)	CoA, Padannakkad (Dept of Agriculture)	35
48	29.02.2024	Farmers training on Organic Spices Cultivation and seedling distribution at Ballel, Lamataput, Koraput under TSP project	AICRP (Spices), Koraput	50
49	19.02.2024	Farmers’ training on Organic Spices Cultivation at Singhari, Sonapur under SCSP project	AICRP (Spices), Koraput	75
50	02.03.2024	Training cum input distribution on Spice Cultivation and Processing at Telipara, Kumargram, Alipurduar District	AICRP (Spices), Pundibari	22
51	03.03.2024	Training cum input distribution on Spice Cultivation and Processing at Topsikhata, Alipurduar District	AICRP (Spices), Pundibari	20
52	02.03.2024	Training cum input distribution on Spice Cultivation and Processing at Telipara, Kumargram, Alipurduar District	AICRP (Spices), Pundibari	22
53	30.04.2024	Diagnosis and management of white rot of garlic (YouTube video content)	AICRP (Spices), Solan	(Digital)
54	19.06.2024	"Adrakh V Lahasun Ke Pramukh Rog Avam Roktham" – Talk for Krishi Darshan	AICRP (Spices), Solan	Broadcast (DD Shimla)
55	19.03.2024	Distribution of Agricultural Inputs & Training on “Improved Cultivation Practices in Turmeric” under SCSP	RSETI, Mundagod, Karnataka	100
56	22.04.2023	Lecture on “Different varieties of Ginger, Turmeric and Groundnut for Chhattisgarh” under Akti Tihar	CARS, Raigarh	100
57	15.06.2024	Exposure visit to Nursery (SVVK FPO)	AICRP (Spices), Yercaud	40
58	30.07.2024	Integrated Disease Management in pepper and coffee	AICRP (Spices), Yercaud	25
59	08.08.2024	Organic farming techniques in	AICRP (Spices),	20

Sl. No.	Date	Details of Training Program	Centre/Organizer	No. of Participants
		horticultural crops (Melur)	Yercaud	
60	03.09.2024	Farmers–Scientists interaction meeting	AICRP (Spices), Yercaud	40
61	12.09.2024	Capacity building programme and inputs distribution	AICRP (Spices), Yercaud	50
62	26.12.2024	Kisan Gosthi and training on harvesting & post-harvest techniques of pepper and coffee	AICRP (Spices), Yercaud	100
63	31.12.2024	Post-harvest processing, value addition and packing of horticultural crops	AICRP (Spices), Yercaud	47
64	19–23 Mar 2024	5-day training on Integrated Farming System sponsored by ATMA, Nawada	BAU, Kanke	150
65	22.11.2024	SCSP Meeting	AICRP (Spices), Kalyani	50
66	10.04.2024	Farmers' Meet	AICRP (Spices), Kalyani	25
67	20.05.2024	Farmers' Meet	AICRP (Spices), Kalyani	30
68	21.02.2024	Training on "Cultivation Technologies in Pepper" under GOI-MIDH	AICRP (Spices), Pechiparai	75 (33 M, 42 F)
69	16.03.2024	Farmers' Awareness Programme – AICRP on Spices (Tribal Sub Plan)	AICRP (Spices), Pechiparai	25
70	16.07.2024	Expert Consultative Meeting with Kani Tribals of Kanyakumari District	AICRP (Spices), Pechiparai	100 (20 M, 80 F)
71	28.12.2024	Farmers' Training Programme under Tribal Sub Plan	AICRP (Spices), Pechiparai	25
72	21.02.2024	Training on "Cultivation Technologies in Pepper" under GOI-MIDH	AICRP (Spices), Pechiparai	75 (33 M, 42 F)
73	15.02.2024	Training on "Packaging practices in Organic Ginger Cultivation"	AICRP (Spices), Nagaland	38
74	16.02.2024	Training on "Packaging practices in Organic Ginger Cultivation"	AICRP (Spices), Nagaland	34
75	29.11.2024	Training on "Production and Processing of Turmeric"	AICRP (Spices), Nagaland	25
76	18.01.2024	Spice Clinic, Suruk, West Bengal	AICRPS, Gangtok (ICRI)	25
77	19.01.2024	Spice Clinic, Suruk, West Bengal	AICRPS, Gangtok (ICRI)	26
78	18.07.2024	Training Programme under NEH, Radha Khandu, Gyalshing, Sikkim	AICRPS, Gangtok (ICRI)	32
79	21.11.2024	Meeting cum Input Distribution under NEH – Large Cardamom Nursery Model, Radu Khandu, Gyalshing, Sikkim	AICRPS, Gangtok (ICRI)	67

Sl. No.	Date	Details of Training Program	Centre/Organizer	No. of Participants
80	06.12.2024	Field Training under NEH, Radu Khandu, Gyalshing, Sikkim	AICRPS, Gangtok (ICRI)	27
81	01.05.2024	Twelve radio talks on cultivation, crop management & value addition of spices	AICRPS,, Sakleshpur	Broadcast (AIR Hassan & Madikeri)
82	19–23 Mar 2024	5-day training on “Advanced Techniques for Healthy Nursery Production of Ginger, Turmeric and Vegetable Crops”	ICAR Research Complex for NEH Region, Umiam, Meghalaya	50
83	07.02.2024	Sustainable livelihood enhancement of tribal farmers through mixed farming	Manjakuttai	30
84	08.02.2024	Sustainable livelihood enhancement of tribal farmers through mixed farming	Arangam	30
85	17.02.2024	Sustainable livelihood enhancement of tribal farmers through mixed farming	Semmanathami	30
86	26.06.2024	ICM in pepper & coffee and marketing technologies of horticultural crops	HRS, Yercaud	20
87	28.06.2024	Establishment and maintenance of kitchen garden in horticultural crops	Melur	20
88	16.07.2024	New varieties and technologies of horticultural crops	HRS, Yercaud	40
89	01.08.2024	IPDM technologies in pepper and coffee	Senthittu	20
90	12.09.2024	Harvesting and post-harvesting of horticultural crops	Arangam	50
91	04.11.2024	Harvesting and post-harvesting of horticultural crops	HRS, Yercaud	30
92	10.12.2024	Training on harvesting and post-harvesting of horticultural crops	HRS, Yercaud	40
93	23.12.2024	Capacity building programme of organic farming practices	HRS, Yercaud	20
94	26.12.2024	Capacity building programme on harvesting, post-harvesting techniques & Exhibition on bio-inputs	Thalaisolai	100
95	31.12.2024	IPDM & Packing, branding and marketing in horticultural crops and Exhibition on bio-inputs	HRS, Yercaud	47

Publications

RESEARCH PAPERS

Coimbatore

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- Mughunth, R. J., Velmurugan, S., Mohanalakshmi, M., & Vanitha, K. (2024). A review of seaweed extract's potential as a biostimulant to enhance growth and mitigate stress in horticulture crops. *Scientia Horticulturae*, 334, 113312. **NAAS Score- 8.77**
- Vaishnavi, B. A., Venkatesan, K., Senthil, N., Mohanalakshmi, M., Paranitharan, V., Thamaraiselvi, S. P., & Vellaikumar, S. (2024). Variation in the volatile oil composition and antioxidant activity of Zingiberaceae: A comparative investigation. *Annals of Phytomedicine*, 13(1), 1008-1018. **NAAS Score- 8.7**
- Thanusha M, Mohanalakshmi M, Rajasree V, Renuka R and Meenakshi P. (2024). Assessment of growth and essential oil profiling in leafy coriander (*Coriandrum sativum* L.) genotypes. *Plant science Today*, 11(SP4), 01-011. **NAAS Score- 6.9**
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- Vaishnavi, B. A., Venkatesan, K., Senthil, N., Mohanalakshmi, M., Paranitharan, V., & Thamaraiselvi, S. P. (2024). Exploring genetic diversity in Indian ginger (*Zingiber officinale* Rosc.) through microsatellite markers. *Plant Science Today*, 11(sp4), 01-07. **NAAS Score- 6.9**
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- Srinu, B., Tanuja Priya, B., Sailaja, V., Giridhar, K., & Kalpana, M. (2024). Performance of turmeric (*Curcuma longa*. Linn) genotypes at nursery stage. *International Journal of Advanced Biochemistry Research*. 8 (18), 324-326. **NAAS Score- 5.29**
- Harshitha, C., Sudha Vani, V., Tanuja Priya, B., Sujatha. R.V. & A Vijaya kumar. (2024). Standardization of essential oil from fresh and dried leaves of Turmeric. *International Journal of Research in Agronomy*, SP-7(10),170-171. **NAAS Score- 5.20**
- Reshma, A., Sadarunnisa Syed, Syamsundar Reddy, P., Tanuja Priya, B., Naga Madhuri, K.V., & Padmaja, V. V. (2024). Studies on germination and graft compatability of wild solanum spp with solanaceous crops. *International Journal of Advanced Biochemistry Research*. 8 (10), 30-34. **NAAS Score- 5.29**
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23

Awards and Recognitions

Best AICRP Centre Award

Department of Genetics and Plant Breeding, NMCA, NAU, Navsari was awarded the Best AICRP Centre (Spices) during the 35th Annual Group Meeting held from 15th to 17th October 2024 at CCSHAU, Hisar, Haryana, for exemplary contributions in research, varietal development, and extension activities.

Major Individual Awards from National/International Societies

Individual Performance

- **Dr. Srikant L. Sawargaonkar (IGKV, Raipur)**
 - ❖ Felicitated with the Best Spices Breeder Certificate of Appreciation on 16th October 2024 for the release and notification of 7 spices and 2 groundnut varieties.
 - ❖ Received Vice-Chancellor Appreciation Certificate from Dr. Girish Chandel, IGKV, Raipur, for outstanding contributions to the field of spices and aromatic crops.
- **Dr. G. Malathi (HRS, Yercaud)**
 - ❖ Best Faculty in Horticulture Award at SRM University Symposium on Advances in Agriculture, 2024.
 - ❖ Best Extension Worker Award in Fruit Science during the International Conference on Precision Horticulture held at HC&RI, TNAU, Periyakulam.
 - ❖ Award of Excellence in Writing in Tamil on National Science Day 2024 at HC&RI, TNAU, Coimbatore.
 - ❖ Best Poster/Presentation Awards at ICPHTV 2024, IIHR Bengaluru, and National Seminar of Society of Krishi Vigyan.
- **Dr. M.H. Khan and Dr. Alie (Pampore)**
 - ❖ Achiever of the Year 2024 for saffron production technology under temperate conditions of Kashmir Valley.
 - ❖ Best Poster Presentation Award at the JK Agri-Med Science Congress, 27–28 November 2024 at SKUAST-K, Srinagar.
- **Dr. Meenu Gupta (Solan)**
 - ❖ Best Oral Presentation Award on garlic soil-borne disease at the International Conference on Emerging Trends in Basic Sciences, 22–23 November 2024 at CPU, Hamirpur.

- ❖ Rapporteur, co-chairperson, and nominated Board member of the College of Horticulture (Nauni and Mandi).
- **Dr V. Siva Kumar (HRS Chintapalli)**
 - ❖ Received best oral presentation award at National Conference on Hill and Tribal Agriculture conducted by RARS Chintapalli, ANGRAU at Chintapalli from 29th – 31st January 2024.
- **Dr. Sanju Balan (PRS, Panniyur)**
 - ❖ Best Oral Presentation during National Conference on Plant Health for Food Security, ICAR-IISR, Lucknow, 1–3 February 2024.
- **Dr. Reena Nair (JNKVV, Jabalpur)**
 - ❖ Second Best Oral Presentation Award at the 35th National Convention of Agricultural Engineers, JNKVV, Jabalpur, 12–13 September 2024.
- **Dr. N.R. Patel (SDAU, Jagudan)**
 - ❖ P.P. Singhal Memorial P.I. Industries Award (2023), 3rd Asian Congress, ISMPP, SDAU, SK Nagar, February 2024.
- **Dr. Parshuram Sial (OUAT, Pottangi)**
 - ❖ Eminent Speaker, 5th Pon Majal CII Erode Turmeric Conclave, 17 December 2024, Gobichettipalayam, Erode.
- **Dr. Preethy T.T. (CRS, Pampadumpara)**
 - ❖ Presented paper on genetic diversity of cardamom at National Symposium on Integrating Traditional and Modern Plant Breeding, 20–22 December 2024.
 - ❖ **Dr. B. Tanuja Priya (Guntur)** Meritorious Service Certificate, Republic Day, 26 January 2024, PG Ground, Guntur.
- **Ch. Pallavi Sri Padma (Student, Guntur)**
 - ❖ Best M.Sc. Thesis Award, 27 January 2024, Society for Advancement of Science and Social Environment, Lucknow.
- **Dr. Ramesh (Mandore)**
 - ❖ Best Oral Presentation, Seed Spices Conf. & Industry Meet, ICAR–NRCSS, Ajmer, 13–15 March 2024.

Team Performance

- **AICRPS Jobner (SKNAU, Jobner)**
 - ❖ Third Prize, Poster Presentation, ISSK 2024, KAU, Thiruvananthapuram, 5–7 June 2024.
- **AICRPS Jagudan (SSRS, Jagudan)**
 - ❖ AICRPS Jagudan: Best Oral Presentation at NRCSS Seed Spices Conf., Ajmer and 3rd Asian Congress, ISMPP, Udaipur (2024).
- **AICRPS Jobner (SKNAU, Jobner)**
 - ❖ Third Prize, Poster Presentation, ISSK 2024, KAU, Thiruvananthapuram, 5–7 June 2024.
- **Dr. M. Sowmya and team:** Third Best Oral Presentation, ISSK 2024, RARS, KAU. M. Sowmya, M., Giridhar, K., Tanuja Priya, B., Vijaya Lakshmi T. and Kalpana, M. secured

third best oral presentation on paper “Morphological, biochemical, histological and molecular interventions of coriander against fusarium wilt “

- **Pechiparai Team (R. Rajarajan et al.):** Best Poster Presentation Award, ISSK 2024. R. Rajarajan, A. Jaya Jasmine, J.D. Nirmalatha and M. Sabaraivasan, received best poster presentation award for the research paper entitled “Effect of plant growth regulators on the rooting of cuttings in cinnamon” during the International Seminar on Spices, organised by the regional Research Station (Southern Zone), Kerala Agricultural University from 5th -7th June 2024.

Awards to Contact Farmers

- ❖ Shri Sachin Karekar (Dapoli): Rashtrapati Award for turmeric excellence.
- ❖ Shri Kalu Ram (Jodhpur): Lead FLD farmer under SCSP cumin programme, Dr. B.R.C. ARS, Mandor.
- ❖ Ashok (Nizamabad): Best Farmer Award, District Collector, Independence Day 2023, for organic turmeric.
- ❖ Shri Laxmana Gowda G.M. (Mudigere): Dr. Y.R. Sarma Memorial Best Farmer Award – 2024
- ❖ Swamy Reddy & Srinivasa Reddy (Guntur): Felicitated by Andhra Pradesh Govt. for turmeric cultivation.

STAFF POSITION

PROJECT COORDINATORS OFFICE

- | | | |
|-------------------------------|---|----------------------|
| 1. Project Co-ordinator | : | Dr. D. Prasath |
| 2. Scientist (Plant Genetics) | : | Mr. Mukesh Sankar. S |
| 3. Chief Technical Officer | : | Mr. R. Bharathan |
| 4. Personal Assistant | : | Vacant |
| 5. Skilled Supporting Staff | : | Vacant |

COORDINATING CENTRES

1. Cardamom Research Station, KAU, Pampadumpara

- | | | |
|-------------------------|---|---------------------|
| 1. Jr. Horticulturist | : | Dr. Nimisha Mathews |
| 2. Laboratory Assistant | : | Mr. Anil Kumar |

2. Pepper Research Station, KAU, Panniyur

- | | | |
|--------------------|---|--|
| 1. Horticulturist | : | Dr. Resmi Paul (01-01-2024 to 01-07-2024) |
| | : | Dr. Vikram H.C. (03-07-2024 to till date) |
| 2. Jr. Pathologist | : | Dr. Sanju Balan (01-01-2024 to 31-12-2024) |
| 3. Lab Assistant | : | Mr. Mohanan P.V. |

3. Horticultural Research Station (UAHS), ZAHRS, Mudigere

- | | | |
|------------------------|---|----------------|
| 1. Horticulturist | : | Dr. Ullasa M.Y |
| 2. Technical Assistant | : | Vacant |

4. Horticultural Research Station (UHS), Sirsi

- | | | |
|------------------------|---|-----------------------|
| 1. Horticulturist | : | Mr. Sudheesh Kulkarni |
| 2. Jr. Pathologist | : | Dr. Kirankumar K.C. |
| 3. Technical Assistant | : | Mr. Laxman A. Padanad |

5. Horticultural Research Station (TNAU), Yercaud

- | | | |
|-----------------------|---|----------------|
| 1. Jr. Horticulturist | : | Dr. G. Malathi |
|-----------------------|---|----------------|

2. Lab Assistant : Mrs. K. Leela
- 6. Department of Spices & Plantation Crops (TNAU), Coimbatore**
 1. Jr. Horticulturist : Dr. M. Mohanalakshmi
 2. Jr. Pathologist : Dr. S. Sundravadana
 3. Technical Assistant : Th. D. Gopalakrishnan
- 7. Turmeric Research Station (SKLTSHU), Kammarpally**
 1. Jr. Pathologist : Dr. B. Mahender
 2. Jr. Horticulturist : Dr. P. Srinivas
 3. Technical Assistant : Mr. K. Vijaya Kumar
- 8. Horticultural Research Station (Dr. YSR Horticultural University), Chintapalle**
 1. Horticulturist : Dr. V. Sivakumar (till 27-09-2024)
: Mrs. Chetti Bindhu (from 28-09-2024 till date)
 2. Technical Assistant : Vacant (Contract Basis)
- 9. Horticultural Research Station (Dr. YSR Horticultural University), Guntur**
 1. Horticulturist : Dr. Ramireddy Nagalakshmi
 2. Breeder : Dr. Tanuja Priya
 3. Technical Assistant : Vacant
- 10. Department of Vegetable Crops (Dr. YSPUHF), Solan**
 1. Jr. Pathologist : Dr. Meenu Gupta
 2. Technical Assistant : Mr. Surat Singh Negi
- 11. High Altitude Research Station (OUAT), Pottangi**
 1. Jr. Breeder : Dr. Parshuram Sial
 2. Technical Assistant : Vacant
- 12. Department of Genetics and Plant Breeding (SKNAU), Jobner**
 1. Sr. Breeder : Dr. Shailesh Marker
 2. Jr. Pathologist : Sh. G. L. Kumawat
 3. Jr. Agronomist : Dr. A. C. Shivran
 4. Jr. Technical Assistant : Sh. S. R. Kumawat

13. Centre for Research on Seed Spices (SDAU), Jagudan

- | | | |
|------------------------|---|------------------------|
| 1. Pathologist | : | Dr. N. R. Patel |
| 2. Jr. Breeder | : | Dr. Surabhi S. Chauhan |
| 3. Technical Assistant | : | Mrs. Rekha Chaudhari |

14. Department of Vegetable Crops, (CCS HAU), Hisar

- | | | |
|-------------------|---|----------------------|
| 1. Pathologist | : | Dr. Suresh K. Tehlan |
| 2. Horticulturist | : | Dr. Makhan Lal |

15. Department of Horticulture, Tirhut College of Agriculture (RAU), Dholi

- | | | |
|------------------------|---|------------------|
| 1. Jr. Horticulturist | : | Dr. C. Mukhim |
| 2. Jr. Pathologist | : | Dr. A. K. Mishra |
| 3. Technical Assistant | : | Sh. A. N. Mishra |

16. Department of Vegetable Science (NDUAT), Kumarganj

- | | | |
|------------------------|---|------------------|
| 1. Jr. Pathologist | : | Dr. Pradip Kumar |
| 2. Horticulturist | : | Dr. D.K Upadhyay |
| 3. Technical Assistant | : | Sh. R. K. Gupta |

17. Department of Horticulture (UBKV), Pundibari

- | | | |
|------------------------|---|------------------------|
| 1. Horticulturist | : | Dr. Ram Krishna Sarkar |
| 2. Pathologist | : | Dr. Anamika Debnath |
| 4. Technical Assistant | : | Sh. Murari Krishna Roy |

18. Department of Horticulture (Dr. BSKKV), Dapoli

- | | | |
|------------------------|---|---------------------|
| 1. Horticulturist | : | Dr. R. C. Gaibhiye |
| 2. Jr. Breeder | : | Dr. A.V. Bhuwad |
| 3. Technical Assistant | : | Shri. R. G. Nachare |

19. College of Agriculture and Research Station (IGKV), Raigarh

- | | | |
|------------------------|---|--|
| 1. Jr. Pathologist | : | Dr. Ajith Kumar Singh |
| 2. Jr. Breeder | : | Dr. Shrikant Laxmikant Sawargaonkar |
| 3. Technical Assistant | : | Mr. Mahendra Kumar Sahu (Joined on 01-09-2023) |

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Capacity Building Programme

Sl. No	Name of the staff	Details of programme	Duration	Venue	Organisers
1	Smt. Chetti Bindhu	Presented paper at National Conference on Hill & Tribal Agriculture	29.01.2024 - 31.01.2024	RARS, ANGRAU, Chintapalli	RARS, ANGRAU
2	Dr. R. C. Gajbhiye	Attended International Seminar on Spices on Innovative and Green technologies for Sustainability	06.06.2024 - 09.06.2024 2024	KAU, College of Agriculture, Vellayani	KAU
3	Dr. R. C. Gajbhiye	Attended XXXIII Annual Group meeting of AICRP on Palm-Arecanut	21st to 23rd August, 2024	BAU, Sabour	BAU, Sabour
4	Dr. R. C. Gajbhiye, Dr. A. V. Bhuwad	Attended Annual Group meeting of AICRP on Spices	14th to 17th October, 2024	HAU, Hisar	CCSHAU, Haryana
5	Dr. A. V. Bhuwad	Attended QRT meeting of Spices	17th to 19th January, 2024	IISR, Kozhikode, Kerala	IISR, Kozhikode
6	Dr. A. V. Bhuwad	Attended International Seminar on Spices on Innovative and Green technologies for Sustainability	6th - 9th June, 2024	KAU, College of Agriculture, Vellayani	KAU, Thrissur
7	Dr. A. V. Bhuwad	Participated and attended the Krishi Motsav	20th to 24th August, 2024	Parli Vajinath, Beed, Maharashtra	Agriculture Department of Maharashtra
	D. K. Gothwal S. Marker A.C. Shivran G. L. Kumawat Ram Kunwar	Organised Quinquennial Review Team Meeting at Jobner	February 28th to March 1, 2024	Deptt. GPB, AICRP on spices SKNAU, Jobner	Deptt. GPB, AICRP on spices SKNAU, Jobner & ICAR-AICRP on Spices, Kozhikode & participants: 15 centres
15	Dr. R. Sutha Raja Kumar, Asst.Professor (Pl.Pathology)	Cultivation of Oyster mushroom for the FPO group	11.01.2024	Pechiparai	-
16	Dr. A. Jaya Jasmine, Professor	Cultivation Technologies in Pepper	21.02.2024	Pechiparai	GOI-MIDH

and Head, Dr. C.
Gailce Leo Justin,
Professor
(Entomology), Dr.
D. Rajakumar,
Assoc. Professor
(Agronomy), Dr.
Darling. B. Suji,
Asst. Professor
(Extn.), Dr. G.
Samind Sujin,
Asst. Professor
(Hort.), Dr. R.
Sutha Raja Kumar,
Asst. Professor
(Path.), Dr. K.
Sivakumar, Asst.
Professor
(Microbiology), Dr.
J. D. Nirmalatha,
Teaching Assistant,
Dr. K.R.
Manikandan,
Senior Research
Fellow

17	Dr. A. Jaya Jasmine, Professor and Head, Dr. C. Gailce Leo Justin, Professor (Entomology), Dr. D. Rajakumar, Assoc. Professor (Agronomy), Dr. Darling. B. Suji, Asst. Professor (Extn.), Dr. G. Samind Sujin, Asst. Professor (Hort.), Dr. R. Sutha Raja Kumar, Asst. Professor (Path.), Dr. K. Sivakumar, Asst. Professor (Microbiology), Dr. J. D. Nirmalatha,	AICRP on Spices – Tribal sub plan – Farmers Awareness Programme	16.03.2024	Pechiparai	AICRP on Spices
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	Teaching Assistant, Dr. K.R. Manikandan, Senior Research Fellow				
18	Dr. T Raj Pravin	Expert Consultative Meeting	16.07.2024	Pechiparai	-
19	Dr. R. Sutha Raja Kumar, Asst. Prof. (Pathology)	Cultivation of oyster mushroom	18.12.2024	Pechiparai	Tamil Nadu state Rural Livelihoods Mission Group
20	Dr. G. Samlind Sujin, Asst. Professor (Hort.)	Tribal sub plan training programme	28.12.2024	Pechiparai	AICRP on Spices
26	Dr. Sanju Balan	National Conference on Plant Health for Food Security: Threats and Promises	1.02.2024 to 3.02.2024	ICAR-IISR, Lucknow	ICAR-IISR, Lucknow
34	Dr. Resmi Paul, Dr. Sanju Balan	Collaborative Online training program on Innovations in Production, Value addition and Marketing of spices in India	10.06.24-14.06.24	ICAR IISR & MANAGE, Hyderabad	ICAR IISR & MANAGE, Hyderabad
38	Dr. Vikram H.C.	Participated and delivered talks at Krishi Mela	27.10.2024	Brahmavar, Udupi, Karnataka	Government of Karnataka
	Dr. Vikram,	Basics of Data Analysis using 'R'	09 to 13 September	Centre for e-Learning in collaboration with College of Agriculture, Vellanikkara, Thrissur	Dept. of Agricultural Statistics, College of Agriculture, Vellanikkara, Kerala Agricultural University, Thrissur
42	Dr. D. K. Gothwal, S. Marker, A.C. Shivran, G. L. Kumawat, Ram Kunwar	Quinquennial Review Team Meeting	February 28th to March 1, 2024	Deptt. GPB, AICRP on spices SKNAU, Jobner & ICAR-AICRP on Spices, Kozhikode	Deptt. GPB, AICRP on spices SKNAU, Jobner & ICAR-AICRP on Spices, Kozhikode
64	BA Alie, MH Khan et al.	Organized five training cum awareness programme for field functionaries of Department of Agriculture for promotion of Saffron in Non-	-	Advanced Research Station for Saffron and Temperate Seed Spices, SKUAST-K, Pampore	Advanced Research Station for Saffron and Temperate Seed Spices, SKUAST-K

65	Traditional areas of J&K				
	BA Alie, MH Khan et al.	Organized three training cum awareness programme for field functionaries of Department of Agriculture for promotion of Kalazeera in Non-Traditional areas of J&K	-	Advanced Research Station for Saffron and Temperate Seed Spices, SKUAST-K, Pampore	Advanced Research Station for Saffron and Temperate Seed Spices, SKUAST-K
66	Dr Shrikant Sawargaonkar	Oral presentation & Chaired session in National Seminar on Spices and Aromatic Crops: Prospects and Potential in Chhattisgarh	14-15 March, 2023	BTC CARS, Bilaspur, IGKV, Raipur	BTC CARS, Bilaspur, IGKV, Raipur in collaboration with DASD, Ministry of Agriculture and Farmers Welfare, Calicut, Kerala, NBARD, Raipur and CG Council of Science and Technology, Raipur
67	Dr Shrikant Sawargaonkar	Invited lecture in Promotion of Turmeric in Madhya pradesh training programme	- Sahadol, 12/4/2022.	Office of Deputy Director Farmers Welfare and Agriculture Development, Shahadol, Madhyapradesh	Collector Order
90	Scientist/resource person from BAU	17th Annual Review Meeting	08-09.06.2023	Agriculture Research Station, Mandor, Jodhpur, Rajasthan	Agriculture University, Jodhpur, Rajasthan
91	Scientist/resource person from BAU	35th AGM of AICRP – Spices	15-17 Oct. 2024	CCS HAU	CCS HAU, AICRPS
102	Scientists from IISR Kozhikode	Organised and gave lectures during training Programme on “Technological Solutions for Sustainable Spice Production and Processing”	23-27 September 2024	ICAR-IISR, Kozhikode	Meghalaya Basin Management Agency (MBMA), Meghalaya
4	Dr. S Mukesh Sankar	Training on Genome utilization and editing of plant for useful traits	07 February to 27 February	ICAR-NIPB, New Delhi	ICAR
5	Dr. M Shamsudheen	ISO/IEC 17025:2017- General Requirement for the Competence of Testing &	13 February	Ministry of Commerce & Industry,	Ministry of Commerce & Industry

		Calibration		New Delhi	
7	Dr. CM Senthil Kumar	Analysis: Generative AI Tools for Agriculture	22-24 July	ICAR-NAARM, Hyderabad	ICAR
8	Dr. R Sivaranjani	Multivariate analysis using R	26-30 August	ICAR-NAARM, Hyderabad	ICAR
9	Dr. S Mukesh Sankar	Phenomics and High Throughput Phenotyping: Dissecting Traits for Abiotic Stress Tolerance	27 August to 02 September	ICAR-IASRI, New Delhi	ICAR
11	Dr. M Shamsudheen	Remotely piloted aircraft system (RAPS)	30 September	Drone Destination Limited, Gurugram, Haryana	Drone Destination Ltd
1	Dr. C Sarathambal, Dr. H J Akshitha, Dr. Honnappa Asangi	3rd Indian Horticulture Summit-cum-International Conference-2024	1-3 February	Rajasthan Agricultural Research Institute, Jaipur	Society for Horticultural Research and Development
2	Dr. S Aarthi, Dr. A Ishwara Bhat, Dr. CN Biju, Dr. R Praveena	National Conference on Plant Health for Food Security: Threats and Promises	1-3 February	ICAR-Indian Institute of Sugarcane Research, Lucknow	ICAR
8	Dr. MS Shivakumar	1st ASIA-Pacific Congress on Alternate Crops: Alternate crops for health and nutritional Security	9-12 September	The Assam Royal Global University, Guwahati	Guru Krishi University
10	Dr. Balaji Rajkumar	10th International Conference on Recent Advances in Agriculture, Engineering, Applied & Life Sciences	23-25 October	Uttaranchal University, Dehradun	Uttaranchal University
11	Mr. Muhammed Nissar	National Conference on Managing Agro Biodiversity in North Eastern India (NCMAN-2024)	23-25 October	North Eastern India	NCMAN

Meteorological Data

CHINTAPALLI						
Month	Rainfall (mm)	No. of Rainy days	Temperature (°C)		RH (%)	
			Max.	Min.	I	II
Jan-24	0	0	27.1	14	97.5	57.4
Feb-24	0	0	30	13.4	97.1	49
Mar-24	3.3	2	32.5	16	95.2	41.3
Apr-24	35.2	2	36	19	87.1	43.2
May-24	175.3	12	33.6	22.4	91.7	58.4
Jun-24	220	17	32.1	22.1	94.8	68.3
Jul-24	416.2	27	28.3	21.6	96	83.9
Aug-24	220.2	19	29.5	21.6	96	77.4
Sep-24	313	23	29	20.9	97	80.5
Oct-24	126.2	8	29.5	19.7	97.4	70.8
Nov-24	99.5	5	27.9	15.9	98.2	64.1
Dec-24	77.2	11	26.8	15.5	97.3	66.1

GUNTUR						
Month	Rainfall (mm)	Rainy Days	Temperature (°C)		R.H. (%)	
			Max	Min	I	II
Jan-24	0	0	31.1	19.5	98.8	68.6
Feb-24	0	0	33.7	21	98.3	63.2
Mar-24	0	0	36.5	24.3	97.5	57.1
Apr-24	0	0	40.3	27	98	48.3
May-24	0	0	38.9	28.6	97.6	52.6
Jun-24	158	7	35.3	28.6	89.3	48.3
Jul-24	217.2	11	32.3	26.7	98.1	74.9
Aug-24	171.8	5	34.3	26.9	98.2	64.3
Sep-24	363.2	14	32.4	26.1	98.9	66.6
Oct-24	125.4	11	32.5	25.2	98.5	66.5
Nov-24	1.2	0	31.7	21.8	98.3	69.1
Dec-24	22.8	3	30.3	20.1	99	70.6

KUMARGANJ						
Month	Rainfall (mm)	No. of rainy days	Temperature (°C)		RH (%)	
			Max.	Min.	I	II
Jan-24	5	1	16.3	7.2	88.8	66.1
Feb-24	16.2	3	23.8	9.6	88.5	56.7
Mar-24	7.8	1	30	13	87.3	51.8
Apr-24	0	0	38.9	20	81.8	44.4
May-24	0	0	38.2	24.2	79.1	41.3
Jun-24	96	3	40	26.7	77.1	41.4
Jul-24	189.4	11	34.1	26.6	92.2	65.4
Aug-24	283.2	13	32.5	25.1	92.5	64.4
Sep-24	252.6	12	32.4	24.7	89.2	64.9
Oct-24	0	0	32.6	21.4	86	59.4
Nov-24	0	0	27.8	31.1	84.6	47.8
Dec-24	0	0	23.8	7.4	84.7	44.6

ICRI MYLADUMPARA				
Month	RH	Rainfall (mm)	Temperature (°C)	
			Max.	Min.
Jan-24	91.89	18.91	24.97	11.36
Feb-24	88.36	0	27.65	11.54
Mar-24	85.82	20.5	29.9	11.45
Apr-24	87.13	23.5	31.05	13.91
May-24	92.18	13.97	29.23	14.72
Jun-24	91.92	17.9	25.82	13.23
Jul-24	95.65	22.71	23.37	12.87
Aug-24	93.17	8.66	22.77	12.83
Sep-24	91.73	8.47	25.71	12.44
Oct-24	92.28	8.78	26.75	12.8
Nov-24	91.46	13.62	25.34	11.97
Dec-24	92.16	19.98	25.59	11.11

PAMPADUMPARA				
Month	No. of rainy days	Rainfall (mm)	Temperature °C	
			Max.	Min.
Jan-24	6	83.4	20.94	18.91
Feb-24	0	0	22.65	19.53
Mar-24	1	2	24.67	21.51
Apr-24	1	2	26.75	23.42
May-24	20	371.4	24.7	21.45
Jun-24	20	237.2	21.75	19.66
Jul-24	26	522.4	21.52	18.41
Aug-24	21	172.8	22.63	19.48
Sep-24	16	127	21.72	18.71
Oct-24	23	293.2	23.16	20.01
Nov-24	15	129.88	22.11	18.99
Dec-24	10	166	21.85	18.67

JAGUDAN				
Month	Rainfall (mm)	Temperature °C		Humidity (%)
		Max.	Min.	
Nov-23	25.66	32.19	20.9	81.41
Dec-23		27.03	15.84	82.93
Jan-24		28.48	13.83	84.21
Feb-24		30.12	17.81	79.1
Mar-24		32.24	18.85	80.22

ICRI GANGTOK				
Month	Rainfall (mm)	No. rainy days	Temperature (°C)	
			Max.	Min.
Jan-24	19	6	12	4
Feb-24	31	8	11	4
Mar-24	212	9	17	7
Apr-24	252	15	20	11
May-24	313	18	24	12
Jun-24	1167	28	21	15
Jul-24	798	30	24	16
Aug-24	561	28	22	16
Sep-24	514	19	22	14
Oct-24	283	14	18	11
Nov-24	15	2	16	6
Dec-24	9	1	11	4

SOLAN				
Month	Temperature (°C)		R.H (%)	Rainfall (mm)
	Max.	Min.		
Jan-24	17.5	2.56	61.24	39.2
Feb-24	20.5	4.75	52.48	7.2
Mar-24	22.75	7.7	63.77	130.6
Apr-24	25.5	9.87	51.14	114.3
May-24	26	12.8	65	15.4
Jun-24	28.1	17.5	62	190
Jul-24	24.25	20.3	81	340.2
Aug-24	28.4	19.75	79	216.6
Sep-24	25.67	15.4	76	224.3
Oct-24	24.85	8.78	53	26
Nov-24	20.7	6	59	24.8
Dec-24	17.62	1.97	58	21.6

JABALPUR					
Month	Temperature		Relative Humidity (%)		Rainfall (mm)
	Max.	Min.	Max.	Min.	
Oct-23	30	13.9	73	41	0
Nov-23	29.1	13.6	84	46.8	39.2
Dec-23	24.7	10	90.8	51	10.8
Jan-24	23.2	9.9	89	56.5	14.9
Feb-24	26.9	12.1	85	50	20.1

KAMMARPALLI						
Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)	
			Max	Min	I	II
Jun-24	166.2	8	37.6	25.8	77.7	50.2
Jul-24	351.6	19	31.3	24.2	88.5	73.9
Aug-24	299.1	17	32.2	24.1	89.5	71.9
Sep-24	332.5	13	31.9	23.5	90.8	75.8
Oct-24	0.8	0	34.4	24.5	90.6	63.5
Nov-24	0	0	32.1	19.4	90.7	50.9
Dec-24	0	0	28.6	15.8	89.4	44.6

MIZORAM					
Months	Rainfall (mm)	RH _{min} (%)	RH _{max} (%)	Temperature (°C)	
				Max.	Max.
Jan-24	0	62.07	90.65	11.88	21.25
Feb-24	93.3	51.42	79.99	13.82	23.44
Mar-24	64.6	48.92	79.28	17.14	26.75
Apr-24	287.3	61.39	79.24	20.39	31.01
May-24	476.3	70.99	85.15	21.43	29.62
Jun-24	495.8	80.25	89.98	22.51	28.77
Jul-24	478.7	80.46	92.93	23.38	29.89
Aug-24	591.1	86.35	92.18	22.64	27.91
Sep-24	251.8	80.51	92.66	23.32	29.87
Oct-24	204.1	86.12	93.95	21.51	27.93
Nov-24	60.1	80.39	91.21	18.08	26.6
Dec-24	21.7	62.42	88.24	13.97	24.25

POTTANGI						
Month	Rainfall (mm)	No of Rainy days	Temperature (°C)		RH	
			Max.	Min.	I	II
Jan'24	0	0	28.6	13.1	86.1	37.2
Feb'24	0	0	32	16.1	74.5	29
Mar'24	0	0	34.3	19.3	61.4	23.1
Apr'24	73	4	38.4	23.4	52.2	22.3
May'24	135	10	36	23.4	67.7	30.3
Jun'24	181.4	9	35.7	24.1	80.9	49.1
Jul'24	292.7	14	30.4	22.5	88.1	74.8
Aug'24	162.2	11	31.2	22.7	89.7	68.7
Sep'24	256.2	13	31.8	22.1	93	71.3
Oct'24	56.4	7	32.3	22.3	92.1	61.9
Nov'24	6.2	1	29.8	17.4	88.1	46.8
Dec'24	46.1	8	26.9	14.8	88.7	55.3

PECHIPARAI					
Month	Temperature (°C)		RH (%)	Rainfall (mm)	Rainy days (no.)
	Max.	Min.			
Jan-24	34	24	85	28	3
Feb-24	34	24.5	80	43	2
Mar-24	33.5	24.5	81	2	0
Apr-24	34	24	80	133.3	10
May-24	35	24.5	82	601.7	19
Jun-24	34	24	80	262	19
Jul-24	34	24	80	185.6	14
Aug-24	33.8	24.2	82	228.4	11
Sep-24	33	24	84	76.7	10
Oct-24	32	24	83	286.9	12
Nov-24	32	24	82	234.5	13
Dec-24	31	24	85	35.3	6

SIRSI						
Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)	
			Max	Min	I	II
Jan-24	4	1	31.7	16.9	80	73
Feb-24	0	0	35	18.9	69	57
Mar-24	0	0	37.2	22.1	66	55
Apr-24	12	1	38.5	23.8	64	51
May-24	162.2	7	36.3	22.6	78	68
Jun-24	404	16	30.8	21.9	94	90
Jul-24	1888	30	28.1	21	97	95
Aug-24	611	24	28.7	21	93	92
Sep-24	167.2	17	30.3	20.6	94	91
Oct-24	257.4	13	30.7	21.5	93	88
Nov-24	33.2	2	30	17.4	81	64
Dec-24	49.4	4	29.4	17.9	84	76

HISAR					
Month	Total rainfall (mm)	Temperature (°C)		Relative humidity (%)	
		Max.	Min.	I	II
Jan-24	0	14.2	6	99	78
Feb-24	13.1	22.3	7.5	93	49
Mar-24	43.2	28.1	12.1	87	38
Apr-24	6.8	35.6	17.8	66	22
May-24	0	41.8	24.2	51	17
Jun-24	38.4	41.3	27.5	58	31
Jul-24	103	36.7	28.1	85	61
Aug-24	274.4	33.5	26.9	91	71
Sep-24	67.7	33.8	25.2	92	66
Oct-24	0	35.4	19.5	87	33
Nov-24	0	29.1	13.1	94	41
Dec-24	26.2	21.1	6.2	95	49

PASIGHAT						
Month	Temperature (°C)		RH %		Rainfall (mm)	Rainy Days
	Max.	Min	I	II		
Jan-24	22.97	10	47.68	44.71	11.6	3
Feb-24	20.93	10.36	62.04	61.14	163.5	11
Mar-24	25.16	18	62.19	66.61	97.5	6
Apr-24	25.63	18.27	73.53	76.53	209	10
May-24	28.13	21.97	73.35	64.35	171.3	15
Jun-24	29.93	25.17	83.2	78.13	810.4	11
Jul-24	31.16	25.48	81.55	80.33	728.9	17
Aug-24	32.13	26	79	70.42	400.4	13
Sep-24	34.7	27.1	66.03	68.57	227.1	7
Oct-24	27.32	20.39	62.87	68.81	165.66	7
Nov-24	30.03	17.07	53.83	49.73	0.5	0
Dec-24	25.1	14.3	55.5	49.9	44.3	2

MANDOR					
Month	Rain fall (mm)	Temperature (°C)		RH	
		Max	Min	I	II
Nov-23	0	32.4	17.5	58.9	41.4
Dec-23	14.6	27.1	12.8	74.3	47.7
Jan-24	0	25.2	9.6	80.4	37.1
Feb-24	9.4	27.3	14.1	64.5	32.4
Mar-24	0	34	19.5	39.8	21.3

AMBALAVAYAL				
Month	Temperature (°C)		RH	
	Max.	Min.	I	II
Jan-24	27.3	15.6	98	72
Feb-24	30.3	15.4	93	64
Mar-24	31.9	19.2	89	58
Apr-24	32.6	19.4	87	55
May-24	29.3	19.6	93	65
Jun-24	26.2	19.1	95	84
Jul-24	24.5	19.2	96	86
Aug-24	25.9	18.9	96	82
Sep-24	26.1	19.1	96	81
Oct-24	26.3	18.9	97	80
Nov-24	27	17.4	96	75
Dec-24	26.7	14.4	94	71

SANAND				
Month	Rainfall (mm)	No. Rainy Days	Temperature (°C)	
			Max.	Min.
Apr-23	0	0	38.4	22
May-23	19	3	40.1	25.6
Jun-23	16	4	37.2	27.2
Jul-23	276	11	33.3	26.7
Aug-23	8	5	32.3	26
Sep-23	80	5	33.9	25.4
Oct-23	0	0	35.3	20
Nov-23	25	1	33.2	16.6
Dec-23	0	0	28.1	14.7
Jan-24	0	0	27.6	10.6
Feb-24	0	0	30.4	13
Mar-24	0	0	34.9	16.5

THRISSUR				
Month	Temperature (°C)		Rainfall (mm)	RH (%)
	Max.	Min.		
Jan-24	32.9	23.4	124.1	62
Feb-24	35.7	23.9	8.1	60
Mar-24	37.1	25.5	0	67
Apr-24	37.9	27	7.3	67
May-24	33.8	25.6	491.3	81
Jun-24	31.1	24.7	628.9	88
Jul-24	30.2	23.8	984.8	89
Aug-24	31.2	24.3	341	84
Sep-24	31.7	24.2	168.9	81
Oct-24	32	24.4	206.6	84
Nov-24	33.3	24.1	91.5	71
Dec-24	32.2	23.2	170.9	76

MODIGER			
Month	Normal rainfall (mm)	Actual rain fall (mm)	Departure from
Jan-24	1.8	32	1661
Feb-24	2.5	31.7	637
Mar-24	15.2	0.7	-95
Apr-24	85	44.8	-47
May-24	118	204.9	74
Jun-24	453.6	367.1	-19
Jul-24	702	1413.9	101
Aug-24	446	444.6	0
Sep-24	224.6	252.3	12
Oct-24	189.8	283.6	49
Nov-24	65.7	56.8	-8
Dec-24	11.2	46	311
Total Rainfall	2315.4	3146.4	36%

ICRI SAKLECH		
Month	Rain fall (mm)	Rainy days
Jan-24	88	2
Feb-24	-	-
Mar-24	-	-
Apr-24	31	3
May-24	423	14
Jun-24	591	22
Jul-24	2363	31
Aug-24	581	21
Sep-24	405	22
Oct-24	127	10
Nov-24	97	4
Dec-24	22	1

YERCAUD		
Month	Rainfall (mm)	No. of rainy days
Jan-24	20.2	2
Feb-24	-	-
Mar-24	-	-
Apr-24	-	-
May-24	188.6	14
Jun-24	153.6	14
Jul-24	72.2	6
Aug-24	298	13
Sep-24	58.8	6
Oct-24	226.6	16
Nov-24	60.4	8
Dec-24	398.8	8

PANNU					
Month	Rainfall (mm)	No. of Rainy days	Temperature (°C)		RH (%)
			Max	Min	
Jan-24	41.8	7	32.1	23.78	99.06
Feb-24	0	0	36.82	23.74	97.66
Mar-24	0	0	38	25.73	95.35
Apr-24	0	0	39.58	27.29	95.1
May-24	493.5	15	35.54	26.9	93.84
Jun-24	717.4	24	31.04	26.08	97.77
Jul-24	1274.8	31	29.84	25.08	99
Aug-24	505.4	29	31.14	25.77	99.29
Sep-24	407.7	23	32.05	24.99	99.04
Oct-24	238.1	15	32.79	24.88	96.94
Nov-24	93.7	8	34.58	24.88	99
Dec-24	167.3	7	33.63	23.41	98.33

DAPOLI					
Month	Rainfall (mm)	Temperature (°C)		RH (%)	
		Max.	Min.	I	II
Jan-24	0	30.4	12.6	93.3	51.3
Feb-24	0	34.1	13.2	87.8	42
Mar-24	2.8	33.3	16.6	85.5	49
Apr-24	0.6	32.4	19.9	84.4	56.4
May-24	36.2	32.8	22	83.3	62.9
Jun-24	677.8	32.3	23.8	85	70.7
Jul-24	1922.4	27.9	23.2	95.4	91.9
Aug-24	513.4	28.9	23.3	93.2	85.5
Sep-24	764	29.2	22.7	93.2	84
Oct-24	126.2	32.3	21.4	92.7	70.4
Nov-24	1.4	33.4	18.5	90.7	51.3
Dec-24	0	32.8	14.9	91.5	48.4

PONDIBAR					
Month	Temperature (°C)		RH		Rainfall (mm)
	Max.	Min.	Max %	Min %	
Apr-23	32	26.2	71.5	57.1	78.8
May-23	32.9	21.3	75.9	59.5	171.2
Jun-23	31.5	22.1	89.7	75.7	961.8
Jul-23	32.1	22.1	91.8	79.5	890.6
Aug-23	31.6	22.1	92.9	84.2	675.6
Sep-23	32.9	21.9	86.2	76	378.8
Oct-23	31.5	19.7	82.6	69	262.4
Nov-23	31.3	15.8	73.6	52.4	0
Dec-23	27.7	12.7	82.7	55.1	0.1
Jan-24	21.9	9.9	92.6	63.5	0
Feb-24	25.6	11.5	82.8	48.4	0.4
Mar-24	29.4	15.9	75.9	48.3	53

KANKE						
Months	Rainfall (mm)	No. of rainy days	Temperature (°C)		RH (%)	
			Max.	Min.	I	II
Jan-24	3	1	28.4	2.5	86	70
Feb-24	49.2	5	30	4.5	86	70
Mar-24	117.4	5	34.5	11.5	87	70
Apr-24	0	0	40.2	13.4	87	70
May-24	32.2	2	40.2	20.6	86	70
Jun-24	81.2	6	41.4	21.4	86	69
Jul-24	473	18	38.4	21.3	86	69
Aug-24	657	21	36.2	21.2	87	70
Sep-24	407	13	33.5	19.8	87	70
Oct-24	63	4	33.5	15.6	87	70
Nov-24	0	0	30.3	6.4	86	70
Dec-24	2	0	28.4	2.5	86	70

NAVSARI						
Month	Rain fall (mm)	No. of rainy days	Temperature (°C)		Relative humidity	
			Max.	Min.	I	II
Jun-23	384	7	33.2	26.8	84.5	70.8
Jul-23	1010.7	23	29.7	24.9	96.9	89
Aug-23	69	9	30.7	25.1	91.6	75.6
Sep-23	289	12	31.7	24.3	94.5	74.8
Oct-23	0	0	35.1	22.3	92.8	50.5
Nov-23	42	2	33.5	19	82	43.6
Dec-23	0	0	31.1	17	86	44.3
Jan-24	0	0	30.2	14.2	91	43.1
Feb-24	0	0	32.6	15.1	91	41

KOTA						
Month	Rainfall (mm)	No. of rainy days	Temperature (°C)		RH (%)	
			Max.	Min.	I	II
Jan-24	27	2	19.55	7.47	89.72	66.97
Feb-24	6	1	25.66	9.42	87.38	58.76
Mar-24	0	0	33.6	14.7	65.35	36.37
Apr-24	7.8	1	39.17	22.55	47.77	16.92
May-24	1.8	0	44.04	28.44	33.18	11.92
Jun-24	233.3	6	40.4	29.7	55	32.6
Jul-24	370.3	14	34.45	27.35	88.15	69.35
Aug-24	374.5	16	31.96	25.88	91.56	81.36
Sep-24	188.3	7	32.65	25.45	89.85	74.7
Oct-24	16	2	35.1	23.03	75.98	54.1
Nov-24	0	0	32.14	15.82	74.82	50.92
Dec-24	13.8	1	24.38	8.28	93.15	68.93

AICRPS CENTRES

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