भाकृअनुप
ICAR

भाकृअनुप-अखिल भारतीय समन्वित मसाला अनुसंधान परियोजना की XXXV वीं वार्षिक समूह बैठक

XXX V Annual Group Meeting of ICAR-All India Coordinated Research Project on Spices

15 - 17 अक्टूबर 2024
15 - 17 October 2024

एजेंडा नोट
AGENDA NOTES

चौधरी चरण सिंह हरियाणा कृषि विश्वविद्यालय (CCS-HAU), हिसार, हरियाणा
Choudhary Charan Singh Haryana Agricultural University (CCS-HAU), Hisar, Haryana

भाकृअनुप-अखिल भारतीय समन्वित मसाला अनुसंधान परियोजना
ICAR-ALL INDIA COORDINATED RESEARCH PROJECT ON SPICES
ICAR-Indian Institute of Spices Research
Kozhikode-673012, Kerala

XXXV Annual Group Meeting of
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Hisar, Haryana

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ICAR-ALL INDIA COORDINATED RESEARCH PROJECT ON SPICES
INDIAN INSTITUTE OF SPICES RESEARCH
KOZHIKODE – 673 012, KERALA

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PROGRESS REPORT OF THE PROJECTS

GENETIC RESOURCES AND CROP IMPROVEMENT

BLACK PEPPER

Project Code	PEP/CI/1.1	**Project Title**	Germplasm collection, characterization, evaluation and conservation
Centres	Ambalavayal, Dapoli, Panniyur, Pundibari, Sirsi, Yercaud		
Date of start		**Date of closure/ duration**	Long term
Work done/achievements during 2023-24 (centre-wise)			
Ambalavayal	A total of 12 accessions are maintained in the germplasm including released varieties like Panniyur 1, Panniyur 2, Panniyur 3, Panniyur 4, Panniyur 5, Panniyur 6, Panniyur 7, Panniyur 8, Sreekara, 9 IISR Thevam, 10 IISR Girimunda, 12 IISR Malabar Excel. The age-old and senile vines were removed and cuttings were newly planted. **The accessions are in juvenile stage.**		
Dapoli	Germplasm collected from various locations in the Konkan region is being maintained in the germplasm block, at the Department of Horticulture. Vine height ranged from 3.1 to 7.6 m. Among the different accessions, maximum vine height was observed in DBSKKVPN-28 (7.6 m), while the minimum height was in DBSKKVPN-15 (3.10 m). DBSKKVPN-19 had the highest number of spikes/vine (158), whereas DBSKKVPN-17 had the fewest (28). Maximum dry berry yield per vine was recorded in accession DBSKKVPN-19 (1.200 kg), while the minimum yield in DBSKKVPN-23 (0.180 kg vine^{-1}).		
Panniyur	At present 343 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 the year 2023-2024, 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 followed by PRS 62 with 12.5 kg green berry yield and 806 spikes/vine. 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 maximum for PRS 17 (22 g) followed by PRS 158 (12.07). The per cent dry recovery was maximum for PRS 62 (35.26 %) followed by PRS 158 (35.07 %) and PRS 124 (34.24 %).		
Pundibari	Twenty-two black pepper entries were maintained in 2023-24. Eleven improved varieties of black pepper (Panniyur – 1, 2, 3, 4, 5, 6 & 7, Sreekara, Subhakara, Pournami, & Panchami) were collected from IISR, Calicut during the year 2000 and 2015. One genotype (Kottanadan) was collected from CPCRI, Mohitnagar, Jalpaiguri in the year 2002. In earlier years seven new genotypes were collected from Sub-Himalayan region adjoining Bhutan boarder (including Totopara). In 2014 – 2015, one new genotype was collected from Terai region of West Bengal. All the germplasm are now being maintained in rapid propagation shade. Cuttings are also being prepared for multiplication, evaluation and distribution. For this conservation, black pepper germplasms were planted in the university field.		
Sirsi	Totally 54 accession and 21 released varieties are being maintained and evaluated. Among the different accessions, V_2 recorded significantly greater mean height (198.60 cm) compared to others.		
Yercaud	The spike length of different accessions ranged from 9.90 cm to 14.75 cm. The highest spike length was observed in PN 11 (14.75 cm) and the lowest spike length		

	was observed in PN 77 (9.90 cm). The same accession PN 11 recorded maximum mean number of berries per spike (102.18) followed by PN 54 (99.42) and PN 84 (97.70). The maximum green berry yield was recorded in PN 1 (10.64 kg vine^{-1}). The maximum dry berry yield was recorded in PN 33 (3.84 kg vine^{-1}) followed by PN 1 (3.71 kg vine^{-1}).

Project Code	PEP/CI/3.7	**Project Title**	CVT on black pepper 2018-Series IX
Centres	Ambalavayal, Chintapalli, Dapoli, Kozhikode, Panniyur, Sirsi, Yercaud		
Date of start	2018	**Date of closure/ duration**	TBD
Experimental details	Entries: 11 1. HP 780 (IISR) 2. HP 1411 (IISR) 3. OPKM (IISR) 4. HP 117 x Thommankodi (IISR) 5. Kumbakkal (IISR) 6. Ponmani (IISR) 7. PRS 137 (Panniyur) 8. SV 7 (Sirsi) 9. Kurimalai (Sirsi) 10. IISR Thevam (check) 11. Panniyur 1 (check) Design: RBD; Replications:3; Plot size/spacing: 6 standards/ plot (3x3 m), 2 plants/ standard		
Observation recorded	1. Plant height (m) 2. Number of branches per vine 3. Average spike length (cm) 4. % of male, female & bisexual flowers 5. Average number of berries per spike (observation to be taken in 50 spikes) 6. Percent fruit set (%) 7. Fresh berry yield (kg vine^{-1}) 8. Dry berry yield (kg vine^{-1}) 9. Percent Bold berries (%) 10. 1000 berry weight (g) 11. Dry Recovery (%) 12. Bulk density (g L^{-1}) 13. Quality Parameter (Piperine, Oleoresin, Essential oil content) 14. Incidence of pest and diseases		
Work done/achievements during 2023-24 (centre-wise)			
Ambalavayal	A total of 10 entries including national check, Panniyur 1 were maintained well and are the in vegetative stage.		
Chintapalle	The trail was initiated during 2020 and the crop is at vegetative stage		
Dapoli	The trial was planted in November 2018. The variety OPKM was found to be significantly superior over the rest of the varieties which recorded a maximum height of 3.28 m, also had highest number of berries per spike (70.24), as well as the greatest fresh and dry weight of berries (0.640 kg & 0.222 kg) and the highest dry weight of berries at highest berries per spike (102.3), fresh weight of berries (334.82 g), and dry weight of berries (132.10 g), whereas the lowest plant height (1.52m) was recorded in IISR Thevam. While maximum recovery was noted in Panniyur 1 (37.03 %). The greater number of spikes (44) per plant was recorded by HP-780.		

Kozhikode	Among enties evaluated at IISR EF, Peruvannumuzhi, HP 117 x Thommankodi recorded highest yield followed by OPKM. Highest number of berries per spike were recorded in HP 117 x Thommankodi followed by Kumbakal.
Panniyur	There was significant difference among the treatments with respect to plant height. SV 7 recorded highest plant height of 4.68 m which was on par with Kumbakkal (3.99 m) followed by OPKM (3.54 m), Kurimalai (3.41 m) and Panniyur 1 (3.21 m). There was no significant difference between the treatments for no. of branches per vine.
Sirsi	Among the different accessions, check Panniyur 1 (274.50 cm) significantly greater mean height followed by HP 117 X Thommanakodi (239.00 cm) compared to others. Spikes was observed in only six accessions v*iz*., HP 117 x Thommanakodi, SV -7, Thevam, Panniyur 1, HP 1411 and HP 780
Yercaud	Among the different entries evaluated, the highest vine length of 3.58 m was recorded by HP 780. another variety SV 7 recorded the highest spike length of 12.32 and the maximum number of berries per spike was recorded in Kurimalai (66.70). The highest green berry yield recorded in HP 1411 (0.557 kg). Highest dry berry yield was recorded by HP 1411 (0.557 kg vine^{-1}).

CARDAMOM

Project Code	CAR/CI/1.1	**Project Title**	Germplasm collection, characterization, evaluation and conservation
Centres	Mudigere, Pampadumpara		
Date of start	2010	**Date of closure/ duration**	Long term
Work done/achievements during 2023-24 (centre-wise)			
Mudigere	Among the 90-germplasm evaluated, maximum plant height is observed in M-2 (372.84 cm), MCC-309 (362.00 cm), PDP-1 (368.73 cm), M-3 (352.45 cm) and M-1(341.74 cm). Maximum tillers per clump was observed in 12-7-D11 (45), 26-16-D-11 (41), CCS-800 (30) and M-1(30).		
Pampadumpara	The existing cardamom accessions in the gene bank are growing well at the new site where they were replanted during the last year. However, they are not yet ready for harvest in the current season. The replanting was successful, and the accessions are adapting to the relocated new site. From this year onwards harvesting can be done. 107 accessions has got IC number from NBPGR.		

Project Code	CAR/CI/3.9	**Project Title**	CVT 2018 on hybrids of cardamom-Series IX
Centres	Appangala, Mudigere, Myladumpara, Pampadumpara, Sakaleshpura		
Date of start	2018	**Date of closure/ duration**	TBD
Experimental details	Design: RBD; Replications:3; Plot size/spacing: 3×3m,12plants/plot **Genotypes** 1. (GG×NKE19)×Bold (Appangala) 2. Bold × (GG×CCS 1) (Appangala) 3. GG × NKE 19 (Appangala) 4. MH.C-1 (Myladumpara) 5.MH.C-2 (Myladumpara) 6. SHC – 1 (Sakleshpura) 7. SHC-2 (Sakleshpura) 8. PH-13 (Pampadumpara)		

	9. PH-14 (Pampadumpara) 10. Njallani Green Gold (check)
Observation recorded	1. Plant height (m) 2. Number of tillers 3. Number of bearing tillers 4. Number of panicles 5. Panicle length (cm) 6. Number of capsules 7. Yield (kg ha^{-1})
Work done/achievements during 2023-24 (centre-wise)	
Appangala	During 2023-24, hybrid Bold × IC 547219 recorded the highest fresh weight per plant (1.71 kg $plant^{-1}$) as well as dry weight per plant (0.32 kg $plant^{-1}$) followed by PH-13 with 1.43 kg $plant^{-1}$ and 0.27 kg $plant^{-1}$ fresh and dry weight per plant, respectively. Essential oil content varied from 7.25 % (PH – 13) to 9.13 % (Njallani green gold). The hybrid Bold × IC 547219 (67.47 %) which recorded the higher yield also recorded high percentage of > 7 mm capsules followed by PH-13 (58.89%).
Mudigere	Among the 10 Hybrids, **(**GG × Bold) × Appangala-1 was observed highest plant height (286.80 cm) followed by (GG × NKE 19) × Bold (275.40 cm). More number of suckers obseved in MHC2.
Myladumpara	A total of nine hybrids wer laid out in Randomized Block Design (RBD) with three replications and 12 plants per plot adopting a spacing of 3 m x 3 m. More number of tillers (23.97) was found in MHC 2 and height of the tallest tiller was more (201.71 cm) in MHC 1 compared to other genotypes. Yield was more (89.23 kg ha^{-1}) in MHC 1. Low incidence of pests and diseases was noticed in all the genotypes.
Pampadumpara	As the replanting process has been completed two year back, the cardamom plants are currently started to yielding. At this point, only data related to vegetative characteristics is available for evaluation. We have to wait for another one year for getting uniform data on yield characters. As the plants continue to progress, further data on their growth, yield, and other traits will be collected and analyzed, for performance and potential.
Sakaleshapura	During the reporting season, data on growth and yield character were recorded and analysed. SHC-2 produced significantly more yield (218.5 kg ha^{-1}) followed by Bold × IC 547219 (194.6 kg ha^{-1}).

Project Code	CAR/CI/4.4	**Project Title**	Multilocation evaluation of thrips-tolerant cardamom lines
Centres	Appangala, Mudigere, Myladumpara, Pampadumpara, Sakaleshpura		
Date of start	2017	**Date of closure/ duration**	TBD
Experimental details	Genotypes: 6 1. IC 349362 2. IC 349364 3. IC 349370 4. IC 349606 5. *Njallani* Green Gold 6. Local check from respective centre Design: RBD; Replications:4; Plot size/spacing: 3×3m, 12 plants/plot		
Observation recorded	1. Plant height (m)		

	2. Number of tillers 3. Number of bearing tillers 4. Number of panicles 5. Panicle length (cm) 6. Number of capsules 7. Yield (kg ha^{-1})
Work done/achievements during 2023-24 (centre-wise)	
Appangala	Among the thrips tolerant genotypes, IC 349364 (T_3) recorded the highest plant height (199 cm), the highest average number of panicles (12.8), the longest panicle length (142.6 cm), and the highest number of capsules (12.4). The percent average of thrips damage on capsules were ranged from 6.4 to 25.8 percent across all the treatments. The lowest thrips damage (6.4%) was recorded in the genotype IC 349606 (T_2), followed by IC 349370 (7.1%),
Mudigere	Continued the trial. Crop is in vegetative stages and vegetative data were recorded.
Myladumpara	Infestation of thrips (nymphs) was assessed in the leaf sheaths of all the lines. Observations on thrips population were recorded at monthly intervals on different cardamom accessions. Among the accessions, IC 349370 has low thrips incidence than other genotypes.
Pampadumpara	The experiment comprises six cardamom accessions, namely IC 349362, IC 349364, IC 349370, IC 349606, Njallani green gold, and PV 2. This experiment is in its initial stage of growth and development. The varieties are yielding now. The stabilized yield data can be supplemented in future
Sakaleshapura	The trial was laid out during August, 2017. As per the data recorded during the reporting year, thrips population was high in Njallani followed by IC 349362. The percentage of thrips damage (capsule) was less in IC 349364 followed by IC 349606.

Project Code	CAR/CI/4.5	**Project Title**	MLT on leaf blight tolerant lines of small cardamom
Centres	Appangala, Myladumpara, Pampadumpara, Sakleshpur, Mudigere		
Date of start	2017-18	**Date of closure/ duration**	TBD
Experimental details		Leaf blight resistant accessions: IC – 349650 IC – 547222, IC – 547223, IC – 547156, IIC – 349649, IC – 349648 Susceptible check: IISR Vijetha Resistant checks: Appangala 1, Njallani Green Gold 1.	
Work done/achievements during 2023-24 (centre-wise)			
Appangala	The trial with all the entries has been planted in 2020 and established under field. The yield and PDI of second year have been recorded and fresh yield ranged from (88 to 275 kg ha^{-1}) and disease incidence ranged from 11.66 to 23.11 and maximum disease incidence was recorded in IISR Vijetha and least incidence was recorded in Njallaani Green Gold, IC349650 and IC349649. The disease incidence was recorded during September and November 2023.		
Myladumpara	During 2023, data on growth characters such as tillers/clump, tiller height (cm) and percent disease index (PDI) were recorded. The PDI was least in IC 349648 (5.95) followed by IC 547223 (6.33). The susceptible check IISR Vijetha showed highest PDI (8.97) followed by IC 547156 (8.52).		
Pampadumpara	In this experiment, a total of six cardamom accessions, namely IC 349650, IC 547222, IC 547223, IC 547156, IC 349649, and IC 349648, have been evaluated		

	alongside three check varieties: IISR Vijetha (susceptible check), Appangala 1, and Green Gold (resistant check). The genotypes are giving stabilized yield and observation on blight characters and yield characters are taking regularly.
Sakleshpura	Among the accessions, lowest PDI was observed in IC547156 (6.66) and IC 349656 (8.33). Whereas highest PDI value observed with accession IISR Vijetha (30.0). The number of panicles were more in IC349649 (14.5) followed by IC547222 (12.0). Highest yield was recorded in IC 349649 (204 kg ha^{-1}) and IC 547222 (198.6 kg ha^{-1}).
Mudigere	Continued the trial. Crop is in vegetative stages and vegetative data were recorded.

LARGE CARDAMOM

Project Code	LCA/CI/1.1	**Project Title**	Germplasm collection and evaluation of large cardamom
Centres	ICAR Regional Station, Gangtok, ICRI Regional Research Station, Gangtok		
Date of start	2008-09	**Date of closure/ duration**	Long term
Work done/achievements during 2023-24 (centre-wise)			
ICAR Regional Station, Gangtok	Germplasm exploration survey was carried out in Sikkim and two new accessions were collected in collaboration with ICRI, Tadong. Characterisation and evaluation of existing germplasm has been initiated.		
ICRI Regional Research Station, Gangtok	Germplasm exploration survey was carried out in Sikkim and Arunachal Pradhesh. Since 2009-10, 59 accessions collected. In 2023-24, two new Amomum genotypes from Seya Village, Arunachal Pradesh, showing unique capsule traits. Five accessions received IC numbers.		

Project Code	LCA/CI/2.1	**Project Title**	CVT on large cardamom 2023 – Series I
Centres	ICAR Regional Station, Gangtok, ICRI Regional Research Station, Gangtok, CAU, COH, Pasighat, Arunachal Pradesh		
Date of start	2023-24	**Date of closure/ duration**	3 years
Experimental details	Design: RBD; Replications:3; Plot size/spacing: 30 m^2 per entry, spacing- 5 ft x 5 ft **Genotypes (10 nos.)** 1. SCC 216 (Ramla) 2. SCC 217 (Ramla) 3. SCC 213(Golsey) 4. SCC 214 (Golsey) 5. SCC 242 (Ramsey) 6. SCC 264 (Sawney) 7. SCC 307 (Varlangey) 8. ICRI Sikkim 1 (National Check) 9. Local Check//Farmers Traditional cultivar (Sawney) 10. Zonal Check/Farmers Traditional cultivar (Seremna)		
Observation recorded	**Plant Morphological and agronomic data** 1. Plant height (cm) 2. Number of leaves/tiller 3. Number of tillers/clump 4. Number of productive tillers 5. Leaf length (cm)		

	6. Leaf breadth (cm) 7. Number of days to flowering 8. Number of days to maturity 9. Number of spike/clump 10. Number of capsule/spike 11. Number of seed/capsule 12. Fresh yield/ plant (g) and per hectare (kg) 13. Dry yield/plant (g) and per hectare (kg) 14. Diseases and insect pests (if any) 15. Quality aspects such as color and grade of the capsules, oil content etc. 16. Economics. BC ratio **Weather parameters** 1. Maximum & minimum temperatures 2. Maximum & minimum humidity 3. Rainfall 4. Rainy days 5. Others **Edaphic factors** 1. pH 2. Nutrient status 3. Other physico - chemical parameters of soil Nutrient applied (N, P, K & others)
Work done/achievements during 2023-24 (centre-wise)	
ICAR Regional Station, Gangtok	Among the different large cardamom germplasms, SCC 214 (Golsey) performed significantly better in term of plant height, number of leafs per plant, leaf area index, leaf length, leaf width and number of tillers per plant which was statistically at par with SCC 213 (Golsey) and significantly higher than local and national check
ICRI Regional Research Station, Gangtok	The experiment was started during 2023 with 10 treatments. Growth data was recorded for the initial year from ICRI Pangthang farm. It is observed that number of immature tillers/clump was more in T_2 (5.3) followed by T_1 (5.1), T9 (5.0) and T_3 (5.0).
ICAR-KVK, Anjaw Arunachal Pradesh	Since CAU Pasighat, Arunachal Pradesh was not suitable for large cardamom; the trial was initiated at ICAR-KVK, Anjaw Arunachal Pradesh. Crop went failure due to wild animal damge

GINGER

Project Code	GIN/CI/1.1	**Project Title**	Germplasm collection, characterization, evaluation and conservation
Centres	Barapani, Dholi, Kumarganj, Pottangi, Pundibari, Raigarh, Solan		
Date of start	1993	**Date of closure/ duration**	Long term
Work done/achievements during 2023-24 (centre-wise)			
Barapani	Thirty two (32) accessions of ginger having Accession No. from IC-584322 to IC-584364 were maintained and evaluated. Among the accessions wider variability was observed for all the agro morphological traits. The plant height ranged from 53.80 cm – 77.50 cm, and the highest plant height was recorded in IC-584332 (77.50cm) followed by IC-584325 (74.17cm). Likewise, leaf length ranged from 20.2 cm to 28.8 cm and the highest length was observed in IC-584325 (28.8cm),		

	followed by IC584337 (25.37cm). IC-584325 also recorded the highest leaf breadth (3.2cm). However, the lowest leaf breadth was found in IC-584351 (1.8 cm). The number of tillers per plant ranged from 3.30-6.37 and the maximum number of tillers was in IC-584337 (6.37) followed by IC-584364 (6.10). Similarly, the highest number of leaves per plant was recorded highest in IC-584332 (38.13) followed by IC-584335 (34.97) and the lowest in IC-584356 (21.20). Further, yield per plant ranged from 142.50-375.60 per plant and highest yield per plant was recorded from the accession IC-584363 (375.60g) followed by IC-584353 (346.40g) and IC-584322(333.40g). IC-584363 (16.69 t) also recorded the highest yield in terms of t ha^{-1}. After biochemical analysis, the highest oleoresin content was recorded in IC-584346 (6.20%) followed by IC584325 (5.96%), while IC-584341 recorded the highest dry matter content (22.60%). IC584359 recorded the highest essential oil (2.90%)
Dholi	Among 40+2 check ginger accessions evaluated, accession RG-10 registered highest yield of (23.91 t ha^{-1}) followed by RG-44 (23.78 t ha^{-1}) and RG-60 (23.62 t ha^{-1}) as compared to check variety, Nadia (20.61 t ha^{-1}).
Kumarganj	Total collected 66 Germplasm are maintained at the station. All the 66 Germplasm were evaluated and found promising NDG-6 (165 g $plant^{-1}$) followed by NDG-28 (152 g $plant^{-1}$) and NDG-47 (148 g $plant^{-1}$).
Pottangi	Out of 198 ginger germplasm studied, 35 entries yielded more than 5 Kg fresh rhizomes per $3m^2$ plot with the mean yield of 4.2 **Kg $3m^{-2}$** during 2023-24. The range of plot yield being 0.8 **Kg $3m^{-2}$** (PGS-119) to 8.3 **Kg $3m^{-2}$** (S-62) in tested germplasms.
Pundibari	Thirty-eight (38 germplasm +2 released varieties) germplasm of ginger were grown for during 2023-24 at Pundibari centre, Uttar Banga Krishi Viswavidyalaya. Lowest rhizome rot and wilt disease incidence was recorded in the germplasm GCP 5 (14.29%) followed by GCP-14 (14.29%), GCP 9 (14.44%), GCP 30 (15.33%) and GCP 4 (15.33%). 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 32, GCP 56, GCP 14, GCP 5, GCP 4 and GCP 3 showed yield more than 10 t ha^{-1}. Two new ginger genotypes collected in the year 2023-24 from Manikchak, Malda (GCP 58) and Suripara, Alipuduar (GCP 59) at Pundibari Centre. These lines planted in the year 2023-24 for characterization. The two lines showed yield of 12 t ha^{-1} and 10 t ha^{-1} respectively and moderately resistant to rhizome rot and wilt disease.
Raigarh	At present at AICRP on Spices, CARS, Raigarh total 41 (38 germplasms and three checks Suprabha, Suruchi and IISR Varda) germplasms of Ginger maintained. For rhizome yield Indira Ginger -14 (20 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}). For rhizome yield two genotypes IG-1 and IG 10 recorded 18 t ha^{-1} rhizome yield followed by IG 13 (15 t ha^{-1}) and IG 14 (14.6 t ha^{-1}) over two checks Suprabha and Suruchi (9 t ha^{-1} respectively).
Solan	Ginger genotype SG19-11 gave the highest fresh rhizome yield of 216.28 g $plant^{-1}$ with 3.72% oleoresin content, out of forty genotypes.

Project Code	GIN/CI/2.5	**Project Title**	CVT on disease tolerance in ginger 2019 – Series X

Centres	Barapani, Chintapalli, Gangtok, Kozhikode, Nagaland, Pottangi, Pundibari, Raigarh		
Date of start	2019	**Date of closure/ duration**	3 years
Experimental details	Design: RBD; Replications:3; Plot size/spacing: 3×1m, spacing- 25x 25 cm Genotypes 1. R 1.25/4 (M1) (IISR) 2. G 1.00/4 (M2) (IISR) 3. HP 05/15 (M3) (IISR) 4. HP 0.5/2 (M4) (IISR) 5. V 0.5/2 (M5) (IISR) 6. V1E4 1 (Pottangi) 7. V1E4 5 (Pottangi) 8. V2E5 2 (Pottangi) 9. Indira Ginger (Raigarh) 10. IISR Varada (control)		
Observation Recorded	1. Sprouting percentage 2. Plant population at 50 DAS 3. Plant height (cm) 4. Number of tillers per clump 5. Fresh weight of clump (g) 6. Fresh rhizome yield per ha (t) 7. Dry rhizome yield per ha (t) 8. Dry recovery (%) 9. Boldness of rhizome 10. Fiber content 11. Oleoresin (%) 12. Essential oil (%) 13. Disease (bacterial wilt, rhizome rot) and pest (shoot borer) incidence, if any		
Work done/achievements during 2023-24 (centre-wise)			
PC Unit: Pooled analysis report	This trial assesses different ginger genotypes for fresh rhizome yield along with disease tolerance reaction towards soft rot and bacterial wilt under natural conditions across multiple locations and years (2020–2023), aiming to identify varieties harbouring high yield as well as multiple disease-tolerance. Here are the key observations: *Top Performers for yield & disease tolerance analysed individually:* • **Indira Ginger** emerged as the highest-yielding genotype with a grand mean of **16.5 t ha^{-1}**, ranking 1st with a positive index of competition with check (%IOC) of **2.19%** giving the top three performance in 10 out of 24 experiments. R 1.25/4 was the second-best performer with a yield of 16.2 t ha^{-1}. IISR Varada (control), genotype, maintained stable performance with a yield of 16.2 t ha^{-1}, ranking 3rd, showing high adaptability across locations like Kozhikode and Raigarh. • **HP 05/15** emerged as the most Soft rot disease-tolerant entry with the lowest PDI (**15.8%**). Its increment over check (%IOC) was **34.47%,** indicating strong competitiveness against disease across environments. **HP 0.5/2** followed closely with PDI of **18.4%** and a high %IOC of **23.52%,**		

indicating a high degree of disease tolerance compared to the national check, IISR Varada.

- **HP 05/15** demonstrated the best resistance to bacterial wilt incidence, with a minimum PDI score of **7.8%,** ranking 1st among the tested genotypes. Its %IOC was the highest at **53.25%,** signifying a strong competitive advantage against bacterial wilt across all tested environments. Following R 1.25/4 also showed a mean PDI of 8.6, with %IOC of 48.01%.

Top Performers for simultaneous selection on yield & disease tolerance:

The main aim of this coordinated varietal trial is to identify ginger genotypes that perform well under disease pressure, particularly focusing on bacterial wilt and rhizome rot, while maintaining good fresh rhizome yield (FRY).

Traits Considered for Selection:

Fresh Rhizome Yield per hectare (t ha^{-1}): The primary indicator of productivity.
Rhizome Rot (% Disease Incidence): Measures susceptibility to rhizome rot disease.
Bacterial Wilt (% Disease Incidence): Measures susceptibility to bacterial wilt disease.

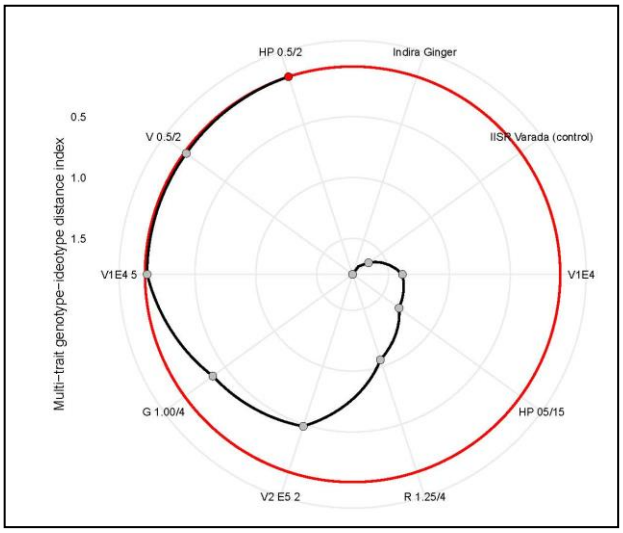
Weightage Assigned:

- Rhizome Rot and Bacterial Wilt are given full weightage (-1) in negative direction (-1) due to the goal of enhancing disease resistance.
- Fresh Rhizome Yield is considered with a positive selection direction, aiming for higher yields, with full weight of 1.

Selection Method: The Multi-trait Genotype-Ideotype Distance Index (MGIDI) was used for simultaneous selection. The MGIDI index identifies genotypes that are close to the ideotype (ideal genotype). Lower MGIDI values indicate genotypes closer to the ideal in terms of the traits measured.

Genotypes and MGIDI Scores:

Sl. No	Genotype	MGIDI
1	HP 0.5/2	0.0891
2	V 0.5/2	0.105
3	V1E4 5	0.106
4	G 1.00/4	0.375
5	V2 E52	0.484
6	R 1.25/4	1.06
7	HP 15/5	1.32
8	V1E4 1	1.39
9	IISR Varada	1.63
10	Indira Ginger	1.8



Inferences from MGIDI Index:

- **Top-performing genotypes** like *HP 0.5/2* 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 yield and disease resistance traits.

Conclusion:

The selection of genotypes using the MGIDI index shows a balance between disease resistance and yield traits. *HP 0.5/2* was the most promising genotypes, showing the lowest MGIDI values and a good balance between disease resistance and yield. Although the selection process slightly reduced yield, the substantial gains in disease resistance (both for rhizome rot and bacterial wilt) indicate that these genotypes are well-suited for environments with high disease pressure.

Barapani	Among the nine genotypes under evaluation, HP 0.5/2 showed the highest fresh rhizome yield of 9.59 t ha^{-1}, significantly outperforming the check, IISR Varada (5.62 t ha^{-1}). In terms of rhizome rot resistance; HP 0.5/2 exhibited the best disease resistance with PDI of 17%. G 1.00/4 exhibited the tallest plant height (68.6 cm), while HP 05/15 displayed the highest number of tillers per plant (3.0). HP 0.5/2 also excelled in fresh rhizome per clump (316.7 g), over IISR Varada (116.7 g).
Chintapalli	The pooled data (2021-22 to 2023-24) revealed that among the 10 genotypes, Indira local recorded the highest plant height (69.94 cm) followed by M1 (66.33 cm) and number of tillers were highest in V1E4 1 (10.18). IISR-Varada recorded the highest fresh weight of the rhizome per plant (230.95 g) and fresh rhizome yield/ha (16.53 t ha^{-1}) whereas less rhizome rot disease incidence was recorded in M3 (17.14%).
Gangtok	Maximum fresh rhizome yield (15.9 t ha^{-1}) was recorded in HP 05/15, which was followed by Indira ginger, but significantly higher than remaining cultivars
Kozhikode	Nine entries (five from ICAR-IISR, four from OUAT and one from IGKV) along with check, IISR Varada were evaluated for the year 2023-24. The maximum yield was recorded HP0.5/2 (47.60 t ha^{-1}) followed by V1E4 5 (42.08 t ha^{-1}) which were on par. Least soft rot incidence (<10%) was recorded in HP 0.5/2, HP 0.5/15, V 0.5/2 and V1E4 5.
Nagaland	Under the Nagaland foot hill agro-climatic conditions, IISR Varada (control) had the highest fresh rhizome yield (18.60 t ha^{-1}), followed by V 0.5/2 (16.44 t ha^{-1}). HP 05/15 demonstrated strong resistance to rhizome rot (21.29%) and bacterial wilt (5.89%), outperforming the location mean and making it a top choice for disease resistance. Indira Ginger excelled in vegetative growth with the highest number of tillers (10.3). IISR Varada had the highest frsh rhizome yield per clump (132.4 g), followed by V2 E5 2 (118.5 g).
Pottangi	It was revealed from the observations during 2020-21 and replicated data of 2021-22, 2022-23 and 2023-24 that it was revealed from analyzed data that IISR Varada showed maximum bacterial wilt symptoms (5.7%) followed by Indira Local (5.2%). The highest yield (16.2 t ha^{-1}) was recorded with V1 E4-5 followed by V 0.5/2 (16.0 t ha^{-1}), V1 E4-1 (15.9 t ha^{-1}) and V2 E5-2 (15.5t ha^{-1}) at Pottangi.
Pundibari	Highest rhizome yield was obtained in case of M4 (10.57 t ha^{-1}) which is closely followed by M5 (9.86 t ha^{-1}). Lowest rhizome rot and wilt incidence was recorded in IISR-M4 (11.57%) followed by and M5(12.65%). Highest plant height was recorded in Varada (64.20 cm) followed by Raigarh ginger (61.99 cm). Highest dry recovery recorded in M4 (21.09%) followed by V1E4-1 (20.50%). Highest tiller no recorded in IISR M5 (6.33). No bacterial wilt incidence recorded.
Raigarh	Evaluation of CVT on ginger revealed that range for rhizome yield recorded 13 t ha^{-1} by G 1.00/4 to highest 28.9 t ha^{-1} by Indira Ginger-1. For rhizome yield IG-1 (28.9 t ha^{-1}), recorded maximum rhizome yield followed byV1E45 (22.8 t ha^{-1}) over national checkIISRVarada (21.8 t ha^{-1}) while R1.25/4 (20.9 t ha^{-1}) at par with check IISR Varda.

Project Code	GIN/CI/2.6	**Project Title**	CVT on bold ginger trial Series-2023.
Centres	Appangala, Kozhikode, Pottangi, Raigarh, Sikkim.		
Date of start	2023	**Date of closure/ duration**	3 years
Experimental details	Design: RBD; Replications:3; Plot size/spacing: 3×1m, spacing- 25x 25 cm Genotypes (10)		

	1. G2023-01 2. G2023-02 3. G2023-03 4. G2023-04 5. G2023-05 6. G2023-06 7. G2023-07 8. G2023-08 9. G2023-09 10. G2023-10
Observation Recorded	1. Sprouting percentage 2. Plant population at 50 DAS 3. Plant height (cm) 4. Number of tillers per clump 5. Fresh weight of clump (g) 6. Fresh rhizome yield per ha (t) 7. Dry rhizome yield per ha (t) 8. Dry recovery (%) 9. Boldness of rhizome 10. Fiber content 11. Oleoresin (%) 12. Essential oil (%) 13. Disease (bacterial wilt, rhizome rot) and pest (shoot borer) incidence, if any
Work done/achievements during 2023-24 (centre-wise)	
Appangala	During 2023-24 sufficient planting material for taking up the trial was multiplied and in the current season 2024-25 trial is planted with three replications
Kozhikode	The CVT, replicated trial has been planted and under vegetative phase.
Pottangi	Seed multiplication was done in 2023-24. This trial is initiated during 2024-25 in replication
Raigarh	New trial on CVT on bold ginger was started at the centre from *Kharif* 2023. Seed multiplication of all the entries *via* protray techniques was done after screening for disease. Plant growth & yield parameters will be evaluated during *Kharif* 2024 in 3 m x 1m plot size.
Gangtok	Maximum fresh rhizome yield (12.3 $t\ ha^{-1}$) was found in G2023-6 which was statistically at par with G2023-2 and G2023-3 but significantly higher than remaining genotypes, respectively. Ginger genotype G2023-6 followed by G2023-2 and G2023-3 performed better under organic management condition in Sikkim Himalayas.

Project Code	GIN/CI/2.7	**Project Title**	CVT on high essential oil ginger genotypes.
Centres	Appangala, Kozhikode, Nagaland, Pottangi, Umiam,		
Date of start	2023	**Date of closure/ duration**	3 years
Experimental details	Design: RBD; Replications:3; Plot size/spacing: 3×1m, spacing- 25x 25 cm Genotypes (09) 1. G2023-11 2. G2023-12 3. G2023-13		

	4. G2023-14 5. G2023-15 6. G2023-16 7. G2023-17 8. G2023-18 9. G2023-19
Observation Recorded	1. Sprouting percentage 2. Plant population at 50 DAS 3. Plant height (cm) 4. Number of tillers per clump 5. Fresh weight of clump (g) 6. Fresh rhizome yield per ha (t) 7. Dry rhizome yield per ha (t) 8. Dry recovery (%) 9. Boldness of rhizome 10. Fiber content 11. Oleoresin (%) 12. Essential oil (%) Disease (bacterial wilt, rhizome rot) and pest (shoot borer) incidence, if any
Work done/achievements during 2023-24 (centre-wise)	
Appangala	During 2023-24 sufficient planting material for taking up the trial was multiplied and in the current season 2024-25 trial is planted with three replications.
Kozhikode	The CVT, replicated trial has been planted and under vegetative phase.
Nagaland	Sowing of new trial on CVT on high essiential oil genotypes was completed and data recording progressing.
Pottangi	Seed multiplication was done in 2023-24. This trial is initiated during 2024-25 in replication
Umiam	Ten (10) accessions, viz. G 2023-11, G 2023-12, G 2023-13, G 2023-14, G 2023-15, G 2023-16, G 2023-17, G 2023-18, G 2023-19 and local check were evaluated for growth, yield and quality parameters. Highest sprouting % (90.37%) was found in G 2023-14, while the highest plant height was recorded in G 2023-16 (64.87 cm). However, fresh weight/clump (300.87g) and yield t ha^{-1} (11.29 t ha^{-1}) were found highest in Local Check while, G 2023-14 recorded the highest oleoresin (5.03%). The Highest essential oil % was found in G 2023-13 (2.50%)

Project Code	GIN/CI/4.3	**Project Title**	Evaluation of genotypes of ginger for vegetable purpose
Centres	Chintapalli, Gangtok, Kozhikode, Mizoram, Nagaland, Pottangi, Pundibari,		
Date of start	2018	**Date of closure/ duration**	2022-23 (4 years)
Experimental details	Design: RBD; Replications: 3; Plot size/spacing: 3×1m, spacing- 25x 25 cm Genotypes 1. Gorubathani (Pundibari) 2. Bold Nadia (Nagaland) 3. Bhaise (Gangtok) 4. John's Ginger (IISR) 5. PGS 121(Pottangi) 6. PGS 95 (Pottangi)		

	7. PGS 102 (Pottangi)
Observation Recorded	1. Sprouting percentage 2. Plant population at 50 DAS 3. Plant height (cm) 4. Number of tillers per clump 5. Fresh weight of clump (g) 6. Fresh rhizome yield per ha (t) 7. Dry rhizome yield per ha (t) 8. Dry recovery (%) 9. Boldness of rhizome 10. Fiber content 11. Oleoresin (%) 12. Essential oil (%) 13. Disease (bacterial wilt, rhizome rot) and pest (shoot borer) incidence, if any
Work done/achievements during 2023-24 (centre-wise)	
PC Unit: Pooled analysis report	The experiment evaluated ginger genotypes across multiple years and locations to assess their performance for fresh rhizome yield, targeting suitability for vegetable purposes. Here are the key insights: **Performance Across Genotypes:** Bold Nadia emerged as the top-performing genotype across all locations and years with a mean yield of **12.21** t ha^{-1} **with 9.12%** better performance over check. It showed Potiential performance, especially in the Nagaland location during 2019 (25.51 t ha^{-1}). Following Bold Nadia, PGS-121 performed well, with a mean yield of **12.14** t ha^{-1} **with 8.49%** IOC, John's Ginger also showed relatively high mean yields of **12.02** t ha^{-1} with 7.42% IOC with at par performance. **Environmental Influence:** The environment influenced the yield performance, with variations across locations and years. Pottangi ranked first in location means (15.49 t ha^{-1}) and Mizoram showed relatively lower yields (6.55 t ha^{-1}), suggesting environmental factors like soil and climatic conditions and disease pressure may have impacted productivity in these regions. **Variation and Stability:** GGE biplot illustrates the fresh rhizome yield performance of 10 ginger genotypes across different environments. The two principal components (PC1 and PC2) together account for 80.68% of the total variation, providing a comprehensive view of genotype-by-environment interactions. **A. 'Which-won-where' Biplot:** The red lines in the biplot divide the plot into five distinct sectors, each representing a specific environment or group of similar environments. The vertex genotype in each sector is considered the "winning genotype" for that particular environment, indicating superior performance and suggesting specific environmental preferences or sensitivities for those genotypes. Starting from top to clock-wise direction, 1. Sector I: Bhiase performed best, specifically in the Sikkim environment. 2. Sector II: This sector did not include any genotypes or environments, indicating a lack of significant interactions or data here. 3. Sector III: Kozhikode and Pottangi environments are located in this sector, with John's Ginger and PGS-95 identified as the winning genotypes. 4. Sector IV: Bold Nadia emerged as the top performer in this sector, excelling in environments like Nagaland, Pundibari, and Chintapalle. These genotypes demonstrated broader adaptability across different environments.

5. Sector V: This sector included the Mizoram environment, where PGS-102 outperformed other genotypes, showing superior performance in this setting.

This biplot highlights the environmental specificity of certain genotypes, with some genotypes like Bold Nadia displaying broader adaptability, while others like PGS-102 exhibit more targeted performance.

B. Mean vs Stability Biplot:

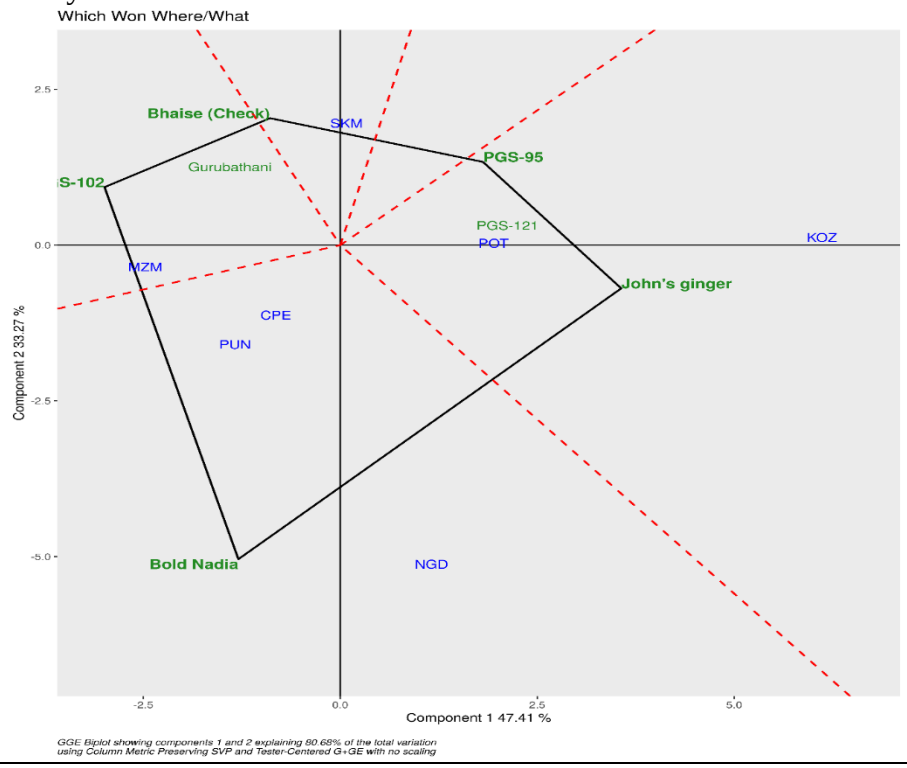
A GGE biplot is a powerful tool for visualizing genotype-environment interactions (GEI), particularly focusing on mean performance and stability biplot. This specific biplot includes two key lines: (i) the AEC (Average Environment Coordinate) abscissa (horizontal) and (ii) the ordinate (vertical).

The AEC abscissa (horizontal line) ranks genotypes by their mean performance, with the arrow pointing towards increasing values. Genotypes positioned further along this line, in the direction of the arrow, indicate higher mean performance (i.e., better yield) across environments. Conversely, genotypes located further from the arrow in opposite direction have lower mean performance.

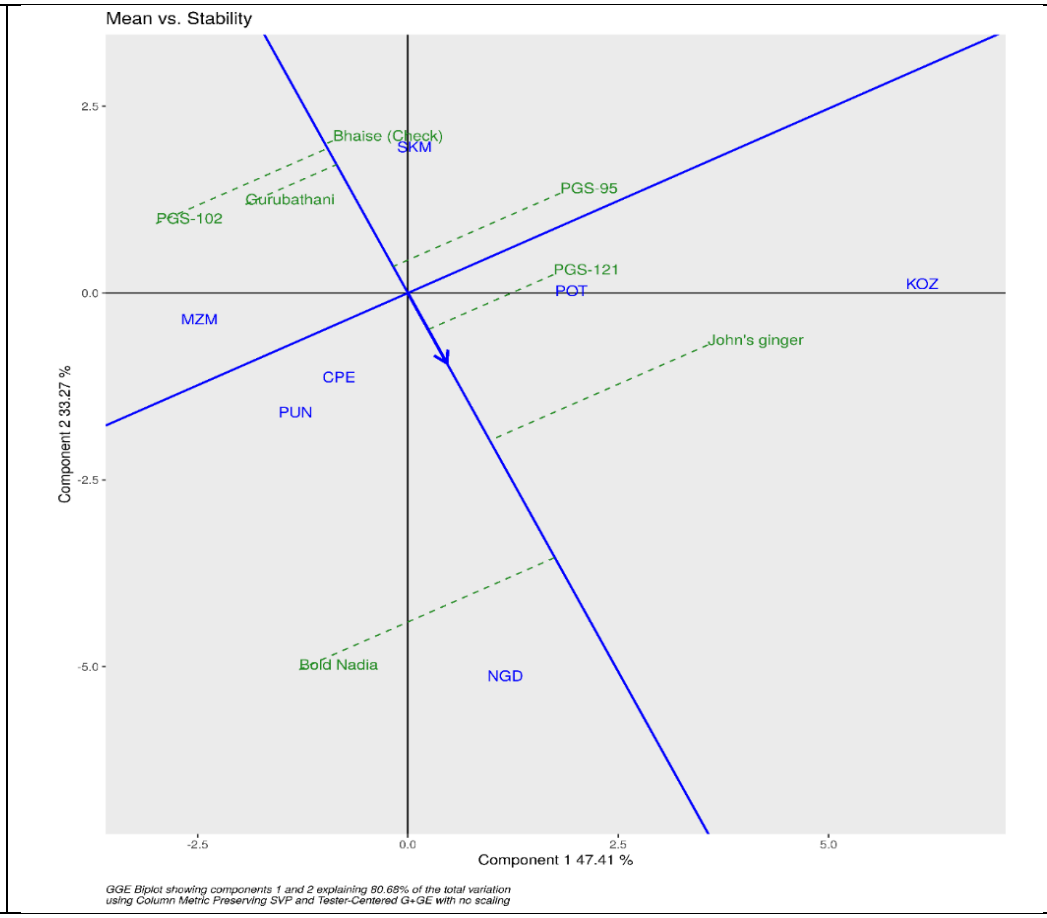
In the figure, Bold Nadia, followed by John's Ginger, are positioned furthest along the AEC abscissa in the direction of the arrow, making them the highest-yielding genotypes. Other genotypes, positioned further back opposite to arrow, suggest lower yielding types.

The AEC ordinate (vertical line) represents stability. Genotypes close to the horizontal AEC abscissa, with little or no projection from the vertical axis, are considered more stable. The greater the projection from the horizontal axis, the less stable the genotype is, indicating greater sensitivity to environmental changes. Bhiase (Check) and Gurbathani are very close to the AEC abscissa with minimal projection, indicating high stability.

However, when considering both yield and stability, John's Ginger shows a narrower projection from the AEC ordinate compared to Bold Nadia, indicating relatively more stable performance than Bold Nadia. Although Bold Nadia exhibits superior fresh rhizome yield, John's Ginger offers a better balance of high yield and stability.



GGE Biplot showing components 1 and 2 explaining 80.68% of the total variation using Column Metric Preserving SVP and Tester-Centered G+GE with no scaling



TURMERIC

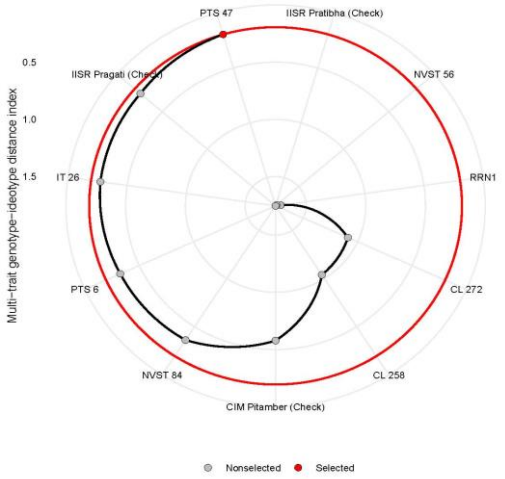
Project Code	TUR/CI/1.1	**Project Title**	Germplasm collection, characterization, evaluation and conservation
Centres	Barapani, Coimbatore, Dholi, Guntur, Kammarpally, Kumarganj, Pasighat, Pottangi, Pundibari, Raigarh, Solan		
Date of start	1999	**Date of closure/ duration**	Long Term
Work done/achievements during 2023-24 (centre-wise)			
Barapani	Twenty nine (29) accessions of turmeric were evaluated at ICAR Research complex for NEH Region Umiam, Meghalaya. Among the accessions, the plant height ranged from 84.07cm-108.10. The highest plant height was recorded in IC-586753 (108.10 cm) followed by IC-586780 (104.30cm). Likewise, leaf length (53.40 cm) and width (17.57cm) was highest in IC-586753 and lowest in IC-58770 (39.17and 12.57) respectively. Moreover, IC-586753 also recorded the highest no. of leaves (16.17). However, the no. of tillers was found highest in IC-586768 (5.17). As far as yield is concerned, the high yielding accessions were IC-586767 (375.78g $plant^{-1}$) followed by IC-586776 (368.35). Likewise, yield t ha^{-1} was also found highest in IC-586767 (15.77t), while highest curcumin content was recorded in IC-586777 (5.86%). Dry matter content (22.3%) was found to be highest in IC-586771.		
Coimbatore	A total of 277 genotypes maintained in the germplasm were raised in the field condition during 2023 - 2024. A set 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 200 genotypes evaluated, CL 180 recorded the highest fresh rhizome yield per clump (565.60 g) followed by CL		

	171 (558.50 g), CL 161 (545.50 g) CL 99 (542.60 g) and CL 229 (512.25 g). Dry recovery per cent among the 200 genotypes was highly significant. The mean value for dry recovery per cent was 24.00. The highest dry recovery was recorded in CL 9 (21.95 %) followed by CL 5 (21.54 %), CL 209 (21.50 %), CL 258 (20.80 %) and CL 154 (20.56 %). The total curcuminoid content (ASTA) among the genotypes also varied significantly. The highest total curcuminoid content was registered in CL 272 (5.87). This was followed by CL 253 (5.73 %), CL 257 (5.17 %), CL 242 (5.11 %) and CL 258 (5.09 %).
Dholi	Among 68+2 check turmeric accessions evaluated, accession RH-432 recorded highest yield of (54.82 tha^{-1}) followed by RH-448 (54.69 tha^{-1}) and RH-435 (52.23 tha^{-1}) as compared to check variety, Rajendra Sonali (47.73 tha^{-1}).
Guntur	During 2023-24, One hundred and two turmeric germplasm lines evaluated LTS-68 (1092 g/clump), LTS-88 (804.8 g/clump), LTS-87 (798.1 g/clump), LTS-81 (787 g/clump) and LTS-34 (741.9 g/clump) recorded significantly higher fresh clump weight over the best checks BSR-2 (569.2 g/clump) and Mydukuru (526.1 g/clump).
Kammarapally	In this experiment 318 germplasm lines were evaluated for growth & yield characters using DUS description . Among these lines 50 top yielders were selected for further estimation of dry recovery and cucumin content. Among the selected 50 lines PTS-16 has been recorded maximum yield of 42.79 $t\ ha^{-1}$ followed by No-95-02 second highest yield of (41.59 t/h) compare 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 %)
Kumarganj	A total of 186 collected germplasm were maintained and evaluated at the station. Out of 33 early maturing germplasm NDH-74 (290 g $plant^{-1}$), NDH-88 (282 g $plant^{-1}$) and NDH-173 (274 g $plant^{-1}$) gave higher yield. While among 116 medium maturing germplasm NDH-14 (272 g $plant^{-1}$), NDH-135 (270 g $plant^{-1}$) and NDH-147 (275g $plant^{-1}$) gave higher yield. Out of 37 late maturing germplasm NDH-11 (280 g $plant^{-1}$), NDH-56 (265 g $plant^{-1}$) and NDH-93 (270g $plant^{-1}$) performed well.
Pasighat	Among the 75 diverse collections from the NE region evaluated, the maximum fresh rhizome yield per plant and estimated rhizome yield per hectare were recorded in genotype CHFT-36 (270.06 g, 28.27 t ha^{-1}) which was statistically at par with CHFT-8 (261.05 g, 28.05 t ha^{-1}) and CHFT-56 (256.02 g, 27.66 t ha^{-1}).
Pottangi	Among 168 turmeric accessions evaluated in 2023-24 at HARS, Pottangi. Out of 168 *Curcuma longa* accessions 75 entries yielded more than 5Kg $3m^{-2}$ plot and 25 entries with more than 10 Kg $3m^{-2}$ fresh rhizome yield. The range in fresh rhizome yield per plot in C. longa was varied from 2.2 Kg/3 m2 (TU-4) to 22.9 Kg $3m^{-2}$ (PTS-3) with the mean of 6.8 Kg $3m^{-2}$among tested germplasms. High yielder was PTS-3(22.9 Kg $3m^{-2}$), PTS-47 (21.4 Kg $3m^{-2}$), Kuchipudi (21.0 Kg $3m^{-2}$), The projected yield was ranged from 4.88 t ha^{-1} (TU-4)-50.8 t ha^{-1}(PTS-3) with the mean of 15.0 t ha^{-1} during 2023-24.
Pundibari	Out of 181 genotypes of turmeric, thirty-two (32) genotypes recorded higher rhizome yield above 35 t ha^{-1}; 15 genotypes showed rhizome yield between 30 t ha^{-1} to 35 t ha^{-1} and 17 genotypes recorded rhizome yield between 25 t ha^{-1} to 30 t ha^{-1}. In respect to disease resistance 62 germplasm showed low leaf botch disease incidence (PDI 0.00 to 10) i.e. they are highly resistance to leaf blotch and 65 germplasm showed low leaf spot (PDI 0.00 to 10) disease incidence i.e. they are highly resistance to leaf spot. Two new turmeric genotypes were

	collected in the year 2023-24 from Malda and Kalimpong distrcits at Pundibari Centre. These lines planted in the year 2024-25 for characterization.
Raigarh	Total 114 (97 *Curcuma longa*, 7 *Curcuma amada*, 5 *C. caesia* germplasm and 5 released varieties) of Turmeric maintained at CARS, Raigarh during *kharif* 2023. Evaluation of Plant Genetic Resources of turmeric *Curcuma longa* revealed significant diversity among all the genotypes for rhizome yield and yield attributing traits. The highest rhizome yields recorded by 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), CGHaldi-2 (22.5 t ha^{-1}) and BSR 2 (17.8). Maintenance of Nucleus seeds of Turmeric: Total 200,300 and 500 SPS of three varieties of turmeric viz; Chhattisgarh Haldi-1, Chhattisgarh Haldi-2 and CG Raigarh Haldi-3 respectively maintained in 4-meter row length. So total 1000 SPS of Turmeric varieties maintained during *Kharif* 2023.Expected nucleus seeds of 2 quntal, 5 quintal and 10 quantal from receptively. Breeder Seeds of Turmeric: Planting of Breeder seeds of turmeric varieties CG Haldi-2 and CG Raigarh Haldi-3 did at farm of CARS, Raigarh during Kharif 2024. Expected fresh rhizome yield of 1 ton of CG Haldi-2 and 2 ton of CG Raigarh Haldi-3 from Breeder seeds planting *Kharif* 2024.
Solan	Among the forty genotypes evaluated, the genotype $ST_1$9-27 recorded the highest fresh rhizome yield of 393.1 g $plant^{-1}$ with 3.62% curcumin content.

Project Code	TUR/CI/2.8	**Project Title**	CVT on high yield and high curcumin
Centres	Coimbatore, Guntur, Kammarpally, Kanke, Kozhikode, Navsari, Pasighat, Pottangi, Raigarh		
Date of start	2020	**Date of closure/ duration**	3yr (2023-24)
Experimental details	No. of treatments/genotypes:11 1. RRN1 (IISR) 2. CL 258 (TNAU) 3. CL 272 (TNAU) 4. PTS 47 (Pottangi) 5. PTS 6 (Pottangi) 6. IT 26 (Raigarh) 7. NVST 56 (Navsari) 8. NVST 84 (Navsari) 9. IISR Pratibha (control) 10. IISR Pragati (control) 11. CIM Pitamber (control) Replications-3, Design: RBD. Plot size/spacing: 3×1 m, spacing-25x 25 cm		
Observation Recorded	1. Sprouting percentage 2. Plant population at 50 DAS 3. Plant height (cm) 4. Number of tillers per clump 5. Fresh weight of clump (g) 6. Fresh rhizome yield ha^{-1} (t) 7. Dry rhizome yield ha^{-1} (t) 8. Dry recovery (%)		

	9. Curcumin content (%) 10. Oleoresin (%) 11. Essential oil (%) 12. Disease (rhizome rot) and pest (shoot borer) incidence, if any
Work done/achievements during 2023-24 (centre-wise)	
PC Unit: Pooled analysis report	This trial assesses 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. Here are the key observations: *Top Performers for yield & curcumin content analysed individually:* • **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 2**6** 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. 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%.** *Top Performers for simultaneous selection on yield & high curcumin content:* The main aim of this coordinated varietal trial is to identify turmeric genotypes that tailored to habour high yield along with high curcumin content, particularly focusing on industrial utitliy purpose. **Traits Considered for Selection:** **Fresh Rhizome Yield per hectare (**t ha^{-1}**)**: The primary indicator of productivity. (FRY) **Curcumin Content (%)**: Measures curcumin content (Cur). **Weightage Assigned:** • Rhizome Rot and Bacterial Wilt are given full weightage (-1) in negative direction due to the goal of enhancing disease resistance. • Fresh Rhizome Yield is considered with a positive selection direction, aiming for higher yields, with full weight of 1. **Selection Method:** At a selection intensity of 10%, selecting for FRY led to an increase of 0.159 t ha^{-1} (0.685% improvement). For Curcumin Content, however, there was a negative differential of -0.135 % (-3.95%), suggesting a slight decrease in curcumin content when selecting for higher yield. Multi-trait Genotype-Ideotype Distance Index (MGIDI) was used for simultaneous selection. The MGIDI index identifies genotypes that are close to the ideotype (ideal genotype). MGIDI index ranks the genotypes based on their performance in terms of Fresh Rhizome Yield (FRY) and Curcumin Content (Cur). Here is the order of the genotypes based on their MGIDI score, with lower scores indicating better performance in balancing both traits

<table>
<tr><td></td><td>
Genotypes and MGIDI Scores:
<table>
<tr><th>Sl. No</th><th>Genotype</th><th>MGIDI</th></tr>
<tr><td>1</td><td>PTS 47</td><td>0.195</td></tr>
<tr><td>2</td><td>IISR Pragati</td><td>0.258</td></tr>
<tr><td>3</td><td>IT 26</td><td>0.274</td></tr>
<tr><td>4</td><td>PTS 6</td><td>0.326</td></tr>
<tr><td>5</td><td>NVST 84</td><td>0.361</td></tr>
<tr><td>6</td><td>CIM Pitamber</td><td>0.578</td></tr>
<tr><td>7</td><td>CL 258</td><td>1.04</td></tr>
<tr><td>8</td><td>CL 272</td><td>1.09</td></tr>
<tr><td>9</td><td>RRN1</td><td>1.71</td></tr>
<tr><td>10</td><td>NVST 56</td><td>1.75</td></tr>
<tr><td>11</td><td>IISR Pratibha</td><td>1.76</td></tr>
</table>


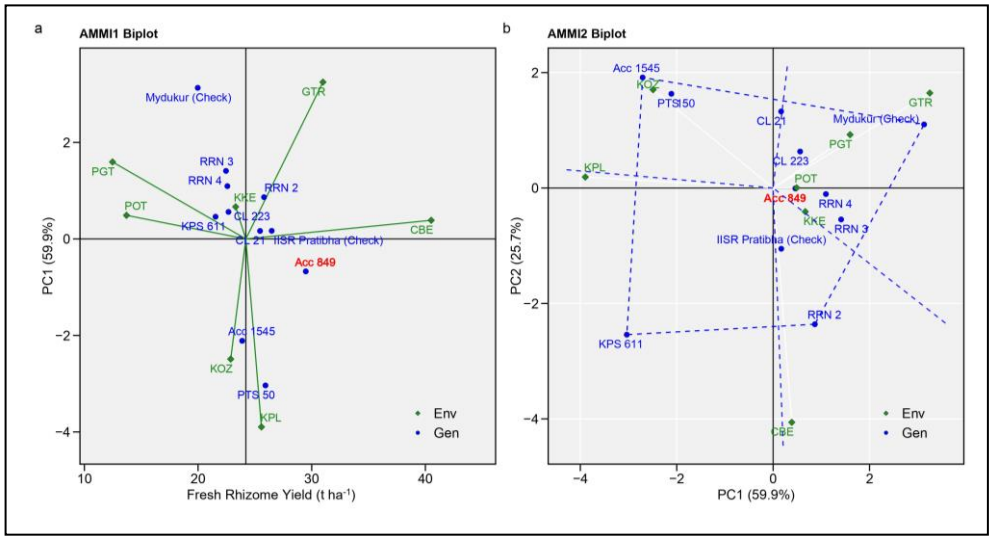
<h3>Inferences from MGIDI Index:</h3>

Top-performing genotypes like 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.

<h3>Conclusion:</h3>
The selection of genotypes using the MGIDI index shows a balance between disease resistance and yield traits. PTS 47 was the most promising genotypes, showing the lowest MGIDI values and a good balance between disease curcumin content and yield. Although the selection process slightly reduced yield, the substantial gains in curcumin indicate that these genotypes are well-suited for industrial useage.
</td></tr>
<tr><td>Coimbatore</td><td>CVT trial on high yield and high curcumin content eight entries were evaluated along with four check. Among the entries PTS6 recorded a greater number of tillers (7.13) and maximum plant height (100.26cm). Fresh rhizome yield per hectare differed significantly among the genotypes which ranged from 32.87 t ha^{-1} (IT 26) to 40.53 <b>t ha^{-1} (CL258). The curing per cent ranged from5.962 (IISR Pragathi) to 8.30 (CL258). On evaluating the quality parameters viz., curcumin, essential oil and oleoresin of the turmeric genotypes, PTS 6 recorded the highest curcumin (3.26 %) and oleoresin content (8.47 %). However, PTS 6 recorded the lowest essential oil content of 2.81 %.</td></tr>
<tr><td>Guntur</td><td>In Coordinated Varietal trial on Turmeric (High yield and curcumin), CL-272 (35.7 t ha^{-1}) followed by NVST-56 (34.3 t ha^{-1}), recorded significantly higher fresh yield per ha than the best check Prathibha (30.7 t ha^{-1}).</td></tr>
<tr><td>Kammarpally</td><td>in this trial, 11 high curcumin varieties were evaluated, among the lines, T$_3$ (IT-26) recorded maximum yield (36.67 t ha^{-1}) followed by T$_3$ (PTS-47) (23.33 t ha^{-1}). when compare to the control. The dry recovery percent maximum in T$_3$ (IT-26) (23.3 %) followed by T$_3$ (PTS-47)(22.2 %).</td></tr>
<tr><td>Kanke</td><td>Altogether there were 11 genotypes of Turmeric tested at Kanke centre. The highest yield of PTS 47 (Pottangi) was observed as 27.353 t ha^{-1} followed by IT 26 (Raigarh) which yielded 26.927 t ha^{-1}. Similarly, PTS 6 (Pottangi), CL 258, NVST 56 (Navsari) and Cl 272 yielded 26.063t ha^{-1}, 25.923t ha^{-1}, 24.893t ha^{-1} and 24.563t ha^{-1}, respectively in comparison with IISR Pratibha (24.387 t ha^{-1} and IISR Pragathi 23.130 both as controls. Yield attributing characters also reflected similar trend supporting the yield results.</td></tr>
<tr><td>Kozhikode</td><td>Eight entries were evaluated for yield and curcumioids along with three checks</td></tr>
</table>

	during 2023-24. Significantly high fresh yield was recorded in PTS 47 (42.98 **t ha^{-1}**) and IISR Pragati (38.95 **t ha^{-1}**).
Navsari	Among the ten genotypes along with two checks evaluated at Navsari, NVST-56 (47.4 t ha^{-1}) and NVST-84 (40.6 t ha^{-1}) were found significantly superior in performance for green rhizome yield over both the national checks IISR-Pragati (32.3 t ha^{-1}) and IISR-Pratibha (30.1 t ha^{-1}). NVST-56 also recorded significantly superior values for other related yield-attributing characters.
Pasighat	Results showed significant difference for all parameters. Highest sprouting percentage (96.67 %) and highest plant population (29.00) was recorded in IISR Pragati and lowest in CL258 (81.11, 24.33, respectively). Highest plant height (97.27 cm) was recorded in IISR Pragati and lowest in NVST84 (58.41 cm). Maximum number of tillers/clump (2.8) was observed in CIM Pitamber and lowest in CL272 (1.67). As far as yield is concerned, highest yield/clump (135.10 g) and yield (13.40 t ha^{-1}) was recorded in IISR Pragati followed by CIM Pitamber (120.38 g, 11.73 t ha^{-1}, respectively) compared to the lowest in CL258 (61.53 g, 6.23 t ha^{-1}, respectively). Highest curcumin content (4.39%) was recorded in IISR Pratibha followed by CL272 (3.92%) compared to the lowest in NVST84 (1.06%)
Pottangi	It was revealed from the analyzed data of 2021-22, 2022-23 and 2023-24 that the entry PTS-47 (16.0 t ha^{-1}) was the top yielder followed by PTS-6(15.7 t ha^{-1}) and RRN1(15.3t ha^{-1}). The dry rhizome yield Roma (4.2t ha^{-1}) was highest followed by PTS-47(3.6 t ha^{-1}), PTS-6(3.5t ha^{-1}) and RRN1(3.4 t ha^{-1}).
Raigarh	Evaluation of turmeric genotypes for high yield and high curcumin contents revealed that for rhizome yield IT 26 (24 t ha^{-1}) recorded highest rhizome yield followed by RRN-1 (22.2 t ha^{-1}) and PTS 47 (19 t ha^{-1}) over the check IISR Pragati (18.8 t ha^{-1}).

Project Code	TUR/CI/2.9	**Project Title**	CVT on light yellow colour turmeric for speciality market
Centres	Coimbatore, Guntur, Kammarpally, Kanke, Kozhikode, Pasighat, Pottangi		
Date of start	2020	**Date of closure/ duration**	3yr (2023-24)
Experimental details	No. of treatments/genotypes: 11 1. RRN 3 (IISR) 2. RRN 4 (IISR) 3. RRN 2 (IISR) 4. Acc 849 (IISR) 5. Acc 1545 IISR) 6. CL 223 (TNAU) 7. CL 21 (TNAU) 8. PTS 50 (Pottangi) 9. KPS 611 (Kammarpally) 10. IISR Prathiba (control) 11. Mydukur (control) Replications-3, Design: RBD. Plot size/spacing: 3×1 m, spacing-25x 25 cm		
Observation Recorded	1. Sprouting percentage 2. Plant population at 50 DAS 3. Plant height (cm) 4. Number of tillers per clump 5. Fresh weight of clump (g) 6. Fresh rhizome yield per ha (t)		

	7. Dry rhizome yield per ha (t) 8. Dry recovery (%) 9. Curcumin content (%) 10. Oleoresin (%) 11. Essential oil (%) 12. Disease (rhizome rot) and pest (shoot borer) incidence, if any
Work done/achievements during 2023-24 (centre-wise)	
PC Unit: Pooled analysis report	The experiment evaluated light coloured turmeric genotypes across multiple years and locations to assess their performance for fresh rhizome yield, targeting suitability for industrial utilitty for specific markets. Here are the key insights: **Performance Across Genotypes:** **Acc 849** showed the highest mean yield (**30.1** t ha^{-1}), with significant yield advantages across most years, demonstrating superior performance overall. Acc 849 consistently outperforms national check, IISR Pratibha with up to 12.5% higher yields in 2021 and an overall increase of **10.9%** with Acc 849 appearing **in 14 out of 20 top-three instances.** **Environmental Influence:** The environment influenced the yield performance, with variations across locations and years. **Coimbatore** ranked first in location means (40.5 t ha^{-1}) and **Pasighat** showed relatively lower yields (12.5 t ha^{-1}), suggesting environmental factors like soil and climatic conditions and disease pressure may have impacted productivity in these regions. **Variation and Stability:** AMMI biplots illustrates the fresh rhizome yield performance of 11 turmeric entries across different environments. The two principal components (PC1 and PC2) together account for **85.6%** of the total variation, providing a comprehensive view of genotype-by-environment interactions.  **A. AMMI1 Biplot:** The x-axis represents the main effect (Fresh Rhizome Yield in t ha^{-1}) with increasing trend towards RHS, while the y-axis shows the first principal component (PC1) of the interaction. Genotypes (blue dots) and environments (green dots) that are close to the horizontal line (PC1 = 0) contribute less to the genotype-environment interaction, indicating more stability across environments. Here ***Acc 849*** tend to placed on extream right compared to thers and lies near to PC1 = 0 regarded as high yielding and stable

	one, **B. AMMI2 Biplot:** The x-axis represents the first principal component (PC1) of the interaction, while the y-axis shows the second principal component (PC1) of the interaction. Genotypes (blue dots) and environments (green dots) that are close to the horizontal line (PC1 = 0) and vertical line (PC2 =0) ie near to origin will contribute less to the genotype-environment interaction, indicating more stability across environments. Here ***Acc 849*** tend to placed near to origin compared to others indicating the stable nature.
Coimbatore	Among the nine entries evaluated along with three checks for light yellow colour rhizome, the highest fresh rhizome weight was recorded in RRN2 (484.56g) followed by PTS 50(480.30 g). Evaluation turmeric genotypes for curcumin, oleoresin and essential content revealed that ACC 849 registered the highest curcumin content (2.99 %) which was higher than national check IISR Prathiba (2.26%) and local check CO2 (2.57 %) but slightly lesser than Mydukur (3.02%). However, the oleoresin and essential oil content in ACC 849 was 7.17 % and 4.00 % respectively. Among the genotypes, CL 223 registered the highest oleoresin content of 7.80 % followed by KPS 11 (7.60 %) and PTS 50 (7.54 %).
Guntur	Nine entries along with two checks were evaluated in RBD. In Coordinated Varietal trial on Turmeric (Light yellow & specialty market), CL-21 (39.9 t ha^{-1}), recorded higher fresh yield per ha than the check Mydukur (36.0 t ha^{-1}).
Kammarpally	In this trial 11 lines entries of light yellow color were evaluated , among the lines T_3-CL 223 recorded maximum yield (20.07 t ha^{-1}) followed by T_3-ACC-1545 (18.30 t ha^{-1}) when compare to control. Maximum dry recovery % was observed in T_3-CL 223 (30.0 %) followed by T8 (29.33)
Kanke	Out of 12 genotypes yield were found to be statistically significant. Yields fresh rhizomes of ACC 849 (IISR), RRN 4 (IISR), RRN 2(IISR) RRN 3 (IISR), KPS 611 (Kammarpalli) and PTS 50 (Pottangi) yielded 24.567 **t ha^{-1}**, 24.423 **t ha^{-1}**, 24.420 **t ha^{-1}**, 24.007**t ha^{-1}**, 23.84637**t ha^{-1}** and 23.653**t ha^{-1}** respectively as compared with IISR Pratibha as control (24.950**t ha^{-1}**). These were at par to each other. The yield attributing characters were found to be in similar trend supporting the yield data.
Kozhikode	Nine entries were evaluated for yield along with two checks (one national and one local) during 2023-2024. Maximum fresh yield was recorded in Acc 849 (34.94 **t ha^{-1}**) followed by Acc. 1545(33.53 **t ha^{-1}**), which were on par.
Pasighat	For, CVT on on light yellow colour Turmeric for the speciality market, 11 genotypes were evaluated and the results showed significant difference for all parameters. Highest sprouting percentage (95.56 %) and highest plant population (28.67) was recorded in Acc 849 and lowest in RRN 3 (82.22, 24.67, respectively). Highest plant height (90.05 cm) was recorded in Mydukur and lowest in PTS 50 (63.50 cm). Maximum number of tillers/clump (2.60) was observed in Mydukur and lowest in KPS 611 (1.87). As far as yield is concerned, highest yield/clump (141.12 g) and yield (14.22 t ha^{-1}) was recorded in Mydukur followed by Acc 849 (134.33 g, 13.47 t ha^{-1}, respectively) compared to the lowest in PTS 50 (77.00 g, 7.71 t ha^{-1}, respectively). Highest curcumin content (4.66%) was recorded in IISR Pragati followed by RRN 4 (3.79%) compared to the lowest in KPS 611 (2.01%).
Pottangi	It was revealed from the analyzed data of 2021-22, 2022-23 and 2023-24 that that the entry Acc-849(16.7t ha^{-1}) was the top yielder with the yield advantages of 18.4 % than the national check variety Pratibha (14.1 t ha^{-1}) followed by PTS-50(15.5

	t ha^{-1}) and RRN3(14.1t ha^{-1}). The dry rhizome yield of Acc-849(3.6t ha^{-1}) was the top yielder with the yield advantages of 18.9% than Pratibha (3.0t ha^{-1})

Project Code	TUR/CI/2.11	**Project Title**	CVT on black turmeric *Curcuma caesia*
Centres	Barapani, Coimbatore, Kozhikode, Kumarganj, Mizoram, Navsari, Pottangi, Pundibari		
Date of start	2022	**Date of closure/ duration**	2023-2025 (3years)
Experimental details	Entries: 1. NBT 1 (Navsari) 2. NBT 2 (Navsari) 3. BT 162 (Pundibari) 4. NDHCc1 (Kumarganj) 5. Acc. 292 (IISR) 6. Acc.751 (IISR) 7. PCC-1 (Pottangi)		
Observation recorded	1. Sprouting percentage 2. Plant population at 50 DAS 3. Plant height (cm) 4. Number of tillers per clump 5. Fresh weight of clump (g) 6. Fresh rhizome yield per ha (t) 7. Dry rhizome yield per ha (t) 8. Dry recovery (%) 9. Oleoresin (%) 10. Essential oil (%) 11. Disease (rhizome rot) and pest (shoot borer) incidence, if any		
Work done/achievements during 2023-24 (centre-wise)			
All Centres	After confirming the botanic identity of entries to *Curcuma caeisa* the trial was initated during the planting season 2024-24 at all centre.		

TREE SPICES

Project Code	TSP/CI/1.1	**Project Title**	Germplasm collection, characterization, evaluation and conservation of clove, nutmeg and cinnamon
Centres	Dapoli, Pechiparai		
Date of start		**Date of closure/ duration**	Long term
Work done/achievements during 2023-24 (centre-wise)			
Dapoli	**Nutmeg:** Among the different germplasm collections of nutmeg planted during the year 1996–97, eighteen promising genotypes have been identified. The highest nut yield per tree (1840) was recorded by accession, 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. Additionally, DBSKKVMF 9772 recorded maximum dry nut yield/tree (12.62 kg) and dry mace yield (2.85 kg) followed by genotype DBSKKV 65 which recorded dry nut yield/tree (11.41 kg) and dry mace yield (1.93 kg). Considering the fruit yield parameters, the genotype DBSKKVMF 9772 was found promising genotype among evaluated entries. **Clove:** Among the germplasm of clove planted during 1996-97, four promising genotypes were selected. The plant height varied from 4.92 m to 6.21 m., girth from 68.82 to 90.42 cm, and spread from 3.98 to 4.32 m. No flowering was		

	observed during the year 2023-24. From all these growth parameters, genotype DBSKKVSA-1 was found superior to other genotypes.
Pechiparai	Clove:Twenty four accessions are maintained in clove. Morophological characters, yield attributing traits are being evaluated to identify promising accessions. The maximum height was observed in SA-1 and the tree height was 13.92 m. This was followed by SA-3(12.96m). The lowest tree height was seen in SA-23 where the tree height was 5.50 m. The accession SA-3 was significantly superior to other accessions and recorded highest stem girth (52.46 cm) compared with local check (42.24 cm). The accession SA-3 recorded the highest leaf length (12.93 cm), leaf breadth (7.75 cm), number of branches (21.26 nos). Among the 24 accessions, SA3 had been identified as the best performer as the dry bud yield is 1.97 kg/tree while the local check recorded 0.66 kg/tree Nutmeg: In Nutmeg, 24 accessions are maintained. MF-1 recorded maximum tree height (12.77 m) and stem girth (67.12 cm). The maximum leaf length was recorded in MF-4 the value being 20.61 cm, leaf breath (8.24 cm). Among the 24 accessions, MF-4 recorded maximum number of fruits 713.24 fruits /tree and the single fruit weight was also highest in MF-4 (58.73 g), and mace yield recorded per tree was 1431.30g/tree. Local check recorded 525.34 fruits /tree, single fruit weight (45.27 g) and mace yield (914.32 g/tree). Cinnamon: Morphological characters and yield attributing traits are being evaluated to identify promising accessions. Among twelve accessions, CV-5 recorded maximum tree height one year after coppicing (6.53 m), stem girth (18.37 cm) number of rejuvenation shoots (43.34 nos.) against local check with plant height (5.65 m) and rejuvenation shoots (23.24 Nos.). The highest dry bark yield was recorded in CV-5(709 g/tree) and lowest in CV-3 with 249g/tree.

Project Code	TSP/CI/1.2	**Project Title**	Collection of unique germplasm in tree spices (Nutmeg)
Centres	Dapoli, Pechiparai		
Date of start	2005	**Date of closure/ duration**	Long term
Experimental details		Genotypes 1. Yellow mace type 2. Red 12 month type 3. Seedless 4. Nova 5. Monoecious bunch bearing 6. Acc 1 7. Acc 3 8. Acc 5 9. Acc 8 10. Acc. 9 11. Acc.12 12. Acc. 13 13. Acc. 20 14. Acc. 23 15. IISR Keralasree 16. IISR Viswashree	
Work done/achievements during 2023-24 (centre-wise)			
Dapoli	Among the different genotype of nutmeg the plant height varied from 2.1 m to 6.14 m, number of branches 52 to 82 and spread of tree 1.82 m to 3.42 m. The maximum plant height (6.14 m), average number of branches (82) and maximum plant spread		

	(3.42 m) was observed in genotype- Yellow mace type. Also, this genotype gave more number of nuts (126) per tree as compared to other genotypes.
Pechiparai	Among the various unique nutmegs, the maximum plant height was recorded in Visvashree (7.27 m), maximum branches (24.44 nos.) Whereas Acc-17 recorded lowest plant height (4.24 m) and branches (13.32 Nos.). Viswasree has recorded highest number of fruits (44.12), single fruit weight (48.46 g) and highest mace yield (74.58 g/ tree), local check has recorded minimum no of fruits (22), single fruit weight (34.38 g) and dry mace yield (37 g/tree).

Project Code	TSP/CI/2.4	**Project Title**	Coordinated Varietal Trial on farmers varieties of nutmeg
Centres	Dapoli, Pechiparai, Thrissur		
Date of start	2016	**Date of closure/ duration**	Long term
Experimental details		Genotypes 1. *Punnathanam Jathy* 2. *Kochukudy* 3. *Kadukkamakkan Jathy* 4. Improved nutmeg variety 5. Local check 6. National check	
Work done/achievements during 2023-24 (centre-wise)			
Dapoli	The trial was planted in August 2016. The data indicates significant differences for the growth parameters. The genotype Kochukudy recorded highest plant height (5.82 m) and shortest being Konkan Sugandha (Local check) with 3.46 m. The genotype, Punnathanam Jathy, produced maximum branches (68.44), while maximum plant spread (3.78 m) and highest yield (78 nuts tree^{-1}) was recorded in Kochukudy.		
Pechiparai	Among the farmers varieties improved Nutmeg variety recorded maximum plant height (4.35 m) with maximum branches (22.37 Nos.). Minimum plant height of 2.52 m and minimum branches (8.99 nos.) recorded in Local check.		
Thrissur	Trial has been laid out with four farmer varieties, one local check and one national check. The plants are of seven-year-old and their morphological performance was significant. Trial is under progress. All the accessions have started flowering and fruiting. Their morphological observations were recorded. Among the varieties FV1, FV2 and Local check were recorded significant growth and yield attributes.		
Project Code	TSP/CI/2.5	**Project Title**	Coordinated Varietal Trial on nutmeg-2023 Series
Centres	Dapoli, Kozhikode, Pechiparai, Thrissur		
Year of Start	2025	**Date of closure/ duration**	Long term
Experimental details		Genotypes 1. *DBSKKVMF-65 (Dapoli)* 2. *DBSKKVMF-66 (Dapoli)* 3. *MF-4 (Pechiparai)* 4. *MF-6 (Pechiparai)* 5. *Accession 15 (KAU, Thrissur)* 6. *Accession 43 (KAU, Thrissur)* 7. *Acc 590 (IISR)* 8. *Acc 562 (IISR)*	

	9. *Acc 530 (IISR)* 10. *Konkan Sanyukta (Check)** 11. *IISR Keralashree (Check)**
Work done/achievements during 2023-24 (centre-wise)	
PC Unit	Conducted two group meetings to evaluate the progress of planting material production at different centres
Dapoli	Planting materials production is under way
Kozhikode	Planting materials production is under way
Pechiparai	Planting materials production is under way
Thrissur	Thrissur is ready with planting material production

Project Code	TSP/CI/5.1	**Project Title**	Evaluation of nutmeg genotypes
Centres	Thrissur		
Date of start	2018	**Date of closure/ duration**	Long term
Experimental details		Genotypes 1. *Acc.1* 2. *Acc.5* 3. *Acc.12* 4. *Acc.13* 5. *Acc.14* 6. *Acc.17* 7. *Acc.20* 8. *Acc.21* 9. *Acc.23* 10. *Acc.28*	
Work done/achievements during 2023-24 (centre-wise)			
Thrissur	Budded plants of all the genotypes were showing significant growth. Plants have established well in the field. All the accessions have started flowering and fruiting (except Acc.28) and their morphological observations were recorded. Among the varieties Accession 5 was observed to be significantly superior in growth as well as mace and nut weight. Accession 23 was found to be higher in number of fruits per tree.		

CORIANDER

Project Code	COR/CI/1.1	**Project Title**	Germplasm collection, description, characterization, evaluation, conservation and screening against diseases
Centres	Coimbatore, Dholi, Guntur, Hisar, Jagudan, Jobner, Kumarganj, Raigarh		
Date of start	1975	**Date of closure/ duration**	Long term
Work done/achievements during 2023-24 (centre-wise)			
Coimbatore	A total of 276 genotypes maintained in the germplasm at Coimbatore were raised in field condition during the rabi season (Dec 2022 - March 2023). Among the 276 genotypes, the best performing genotypes of the previous year (2021-2022) in terms of yield were selected and evaluated for various parameters *viz.,* growth & yield parameters and powdery mildew incidence. Significantly higher seed yield was recorded in CS 95 (8.70 g plant^{-1}) compared to the best check CO(CR) 4 (7.20 g plant^{-1}). The other best performing genotypes were CS 162 (8.60 g plant^{-1}) and CS 131 (8.40 g plant^{-1}).		

Dholi	Eighty-one (81) accessions of coriander along with two checks (Pant Haritma and Rajendra Dhania-1) were evaluated for promising lines with respect to yield. Out of eighty-one accessions, only four accessions namely- RD-417, RD-412, RH-389 and RD-442 gave higher yield than check variety, Rajendra Dhania-1 (81.73 g per five plant) and Pant Haritma (74.26 g per five plant). The yield of best ten accessions ranged from 58.40 to 84.72 g per five plants. Among the promising accessions, RD-417 gave the highest yield 84.72 g per five plants, followed by RD-412 (84.69 g per five plant).
Guntur	During 2023-24, among thirty-five germplasm lines evaluated, 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.
Hisar	One hundred accessions of coriander were evaluated in two row plots of 3.0 meter length each using Hisar Sugandh, Hisar Bhoomit and Hisar Anand as checks during 2023-24. The seed yield of the germplasm material ranged from from 12.8 g plant^{-1} (DH-284) to 37.8g plant^{-1} (DH-280). The most promising lines for seed yield were DH-207, DH-212, DH-228, DH-234, DH-279, DH-280, DH-294-1, DH-297-1, DH-301 and DH-307.
Jagudan	During 2023-24, total 151 entries were evaluated along with the check G. Cor 3. UD 217, JCr 2013-9, UD 184, Lam-44, JCr-378, JCr 2013-11 were the highest yielding genotypes. Promising genotypes for yield and yield attributing characters were mentioned in table.
Jobner	Three hundred fifty one (351) 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. Each accession was sown in plots of 3 x 0.3 m^2 size accommodating one row spaced 30 cm apart. The trial was sown on 27.10.2023. One-meter uniform section of each plot was maintained by bagging with muslin cloth and on maturity, seeds were harvested separately to obtain the self-seed to raise in next season. Data on seed yield and other morphological traits were recorded on a random sample of five plants and averaged. 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)
Kumarganj	A total of 141germplasm of coriander were evaluated at MES, Kumarganj. The highest yield was recorded in NDCor-22 (32.50 g plant^{-1}) followed by NDCor-11 (30.75 g plant^{-1}), NDCor-12 (28.60 g plant^{-1}) and NDCor-32 (26.90 g plant^{-1}).
Raigarh	Total 32 germplasm of Coriander maintained at CARS, Raigarh during Rabi 2023. Evaluation of PGR revealed that maximum seed yield inICS 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 HisarAnand (37.15 g plant^{-1}), CG Shri Chandrahasini Dhaniya-2 (34.9 g plant^{-1}) and Rajendra Swati (24.85 g plant^{-1}). Nucleus seeds of all the three varieties of coriander CG Dhaniya -1 (3 Kg); CG Shri Chandrahasini Dhaniya-2 (40 Kg) and CG Raigarh Dhaniya-3 (25 Kg) maintained at AICRP on Spices, Raigarh.

Project Code	COR/CI/2.8	**Project Title**	Coordinated Varietal Trial on coriander 2021-Series XI
Centres	Ajmer, Coimbatore, Dholi, Guntur, Hisar, Jabalpur, Jagudan, Jobner, Kalyani, Kota, Kumarganj, Navsari, Pantnagar, Raigarh, Sanand		
Date of start	2021-22	**Date of closure/ duration**	2023-24
Experimental details	1. NCOR 102 (Navsari) 2. LCS-19-1 (Guntur) 3. SCr 24 (Sanand) 4. DH 316 (Hisar) 5. JCr 16-02 (Jagudan) 6. UD 565 (Jobner) 7. PD 7 (Pantnagar) 8. NDCor 22 (Kumarganj) 9. CS 46 (Coimbatore) 10. ICS 15 (Raigarh) 11. ACr 6 (Ajmer) 12. Hisar Anand (Check) 13. RCr 728 (Check) Design: RBD; 3 replications;		
Observations Recorded	1. Germination % 2. Days to 50% flowering 3. Plant height (cm) 4. Primary Branches per plant 5. Secondary Branches per plant 6. Days to maturity 7. Umbels per plant 8. Umbellets per umbel 9. Seeds per umbel 10. Test weight (g) 11. Seed yield (kg ha^{-1}) 12. Incidence of pests (mites, aphids) 13. Incidence of diseases (wilt, powdery mildew, stem gall, blight) 14. Quality		
Work done/achievements during 2023-24 (centre-wise)			
Ajmer	The analysis of variance revealed significant differences among the entries for all the traits including seed yield. The seed yield ranged from 1066.33 to 1454.00 **kg ha^{-1}**. Highest seed yield was recorded in COR-198 (1454.00) **kg ha^{-1}** followed by COR-194 (1407.00 **kg ha^{-1}**) while, the lowest seed yield of 1066.33 was recorded in COR-201.		
Coimbatore	The plant height of the genotypes ranged from 38.26cm to 66.33 cm. The highest number of umbels per plant was recorded by the genotypes COR 206 (31.56) followed by COR 205 (25.53) and COR 202 (22.86) COR 200 recorded the highest seed yield (971.76 kg ha^{-1}) followed by COR 198 (961.20kg ha^{-1}) and COR 203 (907.00kg ha^{-1}).		
Dholi	Thirteen entries and one check (Rajendra Dhania-1) were tested under coordinated varietal trial during the year 2023-24. Among the thirteen entries, COR-193 gave highest yield (1938.73 $kgha^{-1}$) over check variety, Rajendra Dhania-1 (1608.50 $kgha^{-1}$).		

Guntur	During 2023-24, among the 13 coded entries evaluated in CVT, COR-201 (1119.81 kg ha^{-1}), COR-198 (1031.8 kg ha^{-1}) and COR-205 (959.2 kg ha^{-1}) entries were found promising.
Hisar	The significant differences were obtained for all the parameters. The plant height ranged from 114.7 to 147.0 cm, number of branches 6.0 to 9.5, umbels per plant 44.8 to 68.0 and seeds per umbel 22.7 to 38.5. Maximum seed yield (1836 kg ha^{-1}) was recorded in COR-193 followed by COR-195 (1789 kg ha^{-1}) and COR-196 (1756 kg ha^{-1}).
Jabalpur	Thirteen genotypes of coriander were evaluated under a Coordinated Varietal Trial during the Rabi season of 2023-2024. The experiment was conducted using a Randomized Block Design (RBD) with three replications. The tallest plants were observed in Treatment COR-199 (115.07 cm), followed by COR-193 (112.52 cm). The highest seed yield was exhibited by genotype COR-199 (17.68 q ha^{-1}), which was comparable to COR-194 (15.73 q ha^{-1}). Additionally, the highest test weights were recorded in genotypes COR-199 (17.37 g) and COR-194 (16.47 g).
Jagudan	The yield differences among the entries were found significant and entries were tested with local check G.Co 3 which yield 1478 kg ha^{-1}. COR 204 (1623 kg ha^{-1}) found superior over the local check G.Co 3 with 9.8 per cent. Entries COR 195 (1602 kg ha^{-1}) and COR 194 (1532 kg ha^{-1}) were numerically higher than check G.Co 3 with 8.4 and 3.7 per cent, respectively.
Jobner	During *rabi*, 2023-24, thirteen (13) entries were evaluated in RBD with 3 replications in a plot size of 3 x 2.4 sq. m. accommodating eight rows spaced 30 cm apart with plant to plant distance of 10 cm maintained by thinning. The trial was sown on 26.10.2023. The analysis of variance revealed significant differences among the entries for seed yield and yield attributing characters. The seed yield ranged from 1315.28 kg ha^{-1} (COR-197) to 2149.54 kg ha^{-1} (COR-196). Out of the thirteen entries evaluated, COR-196 recorded maximum seed yield (2149.54 kg ha^{-1}) followed by COR-202 (1955.09 kg ha^{-1}), COR-194 (1953.89 kg ha^{-1}), COR-199 (1891.21 kg ha^{-1}) and COR-202 (1874.08 kg ha^{-1}) while lowest seed yield of 1315.28 kg ha^{-1} was recorded in COR-197.
Kalyani	In the 3rd year crop (2023-24) results showed that the maximum projected yield of 12.30 q ha^{-1} was recorded in CoR-200 followed by CoR-206 (11.06 q ha^{-1}) and CoR-194 (10.52 q ha^{-1}) as compared to lowest in CoR-199 (7.09 q ha^{-1}). Based on these results of the experiment, CoR-200 was found the most suitable germplasm in Gangetic alluvial plains of West Bengal followed by CoR-206 and CoR-194 in respect of growth and yield characters. The result followed the similar trend of last years observation.
Kota	During the third and final year of evaluation, **COR 204** was found to be the best performing entry in terms of seed yield, yielding **1503** kg ha^{-1} followed by **COR 196 (1490** kg ha^{-1}**)** and **COR 198 (1427** kg ha^{-1}**).** COR 201, COR 200 and COR 195 had the highest test weight of 21.90g, 21.00g, 20.50g respectively, while COR 193 and COR 202 had the lowest test weight of 8.10g and 10.50g, respectively. COR 199 and COR 194 had highest plant height (114cm and 112cm, respectively) while COR 197 and COR 205 was shortest (104 cm). COR 201 showed earliest flowering (69 days) and maturity (118 days) while COR 193 and COR 202 was the most late in flowering (82 days) and maturity (129 days and 127 days, respectively).
Kumarganj	Thirteen entries of coriander were evaluated under CVT Coriander. The highest yield was recorded in Cor-196 (17.54 q ha^{-1}) followed by Cor-197 (17.02 q ha^{-1}) and Cor-193 (16.47 q ha^{-1}). In three year (2021-22 to 2023-24) pooled data the

	highest yield was recorded in Cor-196 (16.85 q ha^{-1}) followed by Cor-199(15.44 q ha^{-1}) and Cor-200 (14.79 q ha^{-1}).
Navsari	Total of thirteen entries evaluated at Navsari, COR-194 (1708.69 kg ha^{-1}) recorded numerically highest seed yield followed by COR-202 (1640.97 kg ha^{-1}) and COR-199 (1615.93 kg ha^{-1}). The highest seed yielding genotype COR-194 has also exhibited higher yield contributing traits viz. umbels per plant, umbellates per umbel, primary branches per plant, secondary branches per plant and plant height.
Pantnagar	Among the genotypes evaluated, COR-199 achieved the highest seed yield with 2335.44 kg ha^{-1}, demonstrating moderate performance in terms of seeds per umbel (52.67) and number of primary branches per plant (5.00), with a longer maturation period of 143.00 days. Similarly, COR-200 had a high seed yield of 2310.28 kg ha^{-1} with comparable characteristics (52.67 seeds per umbel and 5.33 primary branches) and a maturation period of 142.67 days. COR-196, while yielding slightly lower at 1952.21 kg ha^{-1}, exhibited the highest number of seeds per umbel (58.33) and a similar maturation period of 141.67 days. The genotype COR-202 had the highest number of primary branches per plant (6.33) but a relatively lower seed yield of 1123.25 kg ha^{-1}. Overall, genotypes COR-199 and COR-200 stand out as the most promising for high seed yield, though with slightly extended maturation periods.
Raigarh	Evaluation of CVT coriander entries during Rabi 2023-24 revealed that COR 194 recorded highest seed yield (1800 **kg ha^{-1}**) followed by COR 205 (1799 **kg ha^{-1}**) and COR 203 (1714 **kg ha^{-1}**) over the Check CG Shri Chandrahasini Dhaniya-2 (1495 **kg ha^{-1}**) and CG Dhaniya-1 (998.8 **kg ha^{-1}**).
Sanand	Thirteen entries were tested under the CVT trial. The yield differences among the entries were found significant. Entry CoR 198 was top yielder with seed yield 3568 **kg ha^{-1}**. Entries CoR 194 (3123 **kg ha^{-1}**), CoR 195 (3465 **kg ha^{-1}**), CoR 196 (3252 **kg ha^{-1}**), CoR 197 (3157 **kg ha^{-1}**), CoR 202 (3041 **kg ha^{-1}**), CoR 203 (3103 **kg ha^{-1}**) and CoR 204 (3396 **kg ha^{-1}**) were yielded at par with top yielder entry. Entry CoR 193 and CoR 202 were noted as leafy type and late. Entry CoR 201 found earliest among all entries.

CUMIN

Project Code	CUM/CI/1.1	**Project Title**	Germplasm collection, characterization, evaluation, conservation and screening against diseases
Centres	Jagudan, Jobner, Mandor, Sanand		
Date of start	1975	**Date of closure/ duration**	Long term
Work done/achievements during 2023-24 (centre-wise)			
Jagudan	During 2023-24, 172 to 335 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. Promising genotypes yield attributing characters were mentioned in table.		
Jobner	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 in eight blocks with one row plots of 3 x 0.3 m^2 size. The trial was sown on 20.11.2023. One-meter uniform section of each row of a plot was maintained by bagging with muslin cloth and on maturity seeds were harvested separately to obtain the self-seed to raise in next season.		

	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)
Mandor	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 then 4.00 g 1000 seed weight.
Sanand	Total twenty two germplasm were sown to evaluated along with two checks viz., GC 2 and GC 4. All lines maintained successfully and significant difference were found among all germplasm lines for seed yield. Line Piplon-1 recorded highest seed yield (310 g/plot) among all germplasm lines.

Project Code	CUM/CI/2.5	**Project Title**	Coordinated Varietal Trial – 2021
Centres	Ajmer, Jagudan, Jobner, Mandor, Sanand		
Date of start	2021-22	**Date of closure/ duration**	3 years (2023-24)
Experimental details	Genotypes 1. CZC- 94 (CAZRI) 2. CZC- 135 (CAZRI) 3. MCU 73 (Mandor) 4. MCU 105 (Mandor) 5. JC 18-10 (Jagudan) 6. JC 18-09 (Jagudan) 7. UC 350 (Jobner) 8. UC 257 (Jobner) 9. UC 250 (Jobner) 10. SPS/166/2-3 (Ajmer) 11. BC 13 (Ajmer) 12. GC 4 (check) Design: RBD; Replication: 3; Plot Size: 3 x 2.4 m; spacing : 30 x 5 cm		
Observations Recorded	1. Germination % 2. Days to 50% flowering 3. Plant height (cm) 4. Primary branches per plant 5. Secondary branches per plant 6. Days to maturity 7. No. of pods per plant 8. No. of grains per pod 9. Length of pod (cm) 10. Test weight (g) 11. Seed yield (kg ha^{-1}) 12. Incidence of pests (mites, aphids) 13. Incidence of diseases (Blight, wilt, powdery mildew, cumin aphid, thrips etc.) 14. Quality (Oil Content in %)		

Work done/achievements during 2023-24 (centre-wise)	
Ajmer	Coordinated varietal trial (CVT) of coriander was carried out under AICRPS at ICAR –NRCSS, Ajmer during 2023-24. 13 entries were evaluated in three replications in RBD with checks in a plot size of 4 x 2.5 sq. m. The trial was sown on 07.11.2023. The analysis of variance revealed significant differences among the entries for all the traits including seed yield. The seed yield ranged from 1066.33 to 1454.00 kg ha^{-1}. Highest seed yield was recorded in COR-198 (1454.00) kg ha^{-1} followed by COR-194 *(*1407.00 kg ha^{-1}) while, the lowest seed yield of 1066.33 was recorded in COR-201.
Jagudan	Entries recorded very low yield and experiment mean yield was below national average yield data. So, the experiment was vitiated due to heavy yield loss due to severe blight infestation and unseasonal rainfall.
Jobner	Analysis of variance revealed significant differences among the entries for seed yield and yield attributing characters. The seed yield ranged from 422.68 kg ha^{-1} (CUM-51) to 1271.30 kg ha^{-1} (CUM-47). Out of twelve entries evaluated, CUM-47 recorded maximum seed yield of 1271.30 kg ha^{-1} followed by CUM-55 (1210.00 kg ha^{-1}), CUM-46 (1135.19 kg ha^{-1}) and CUM-44 (539.35 kg ha^{-1}). While lowest seed yield of 422.68 kg ha^{-1} was recorded in CUM-51.
Mandor	The CVT general mean was 507 kg ha^{-1} with CD (5%) 67 kg ha^{-1} and CV 7.8%. Seed yield ranged from 125 kg ha^{-1} (CUM-45) to 872 kg ha^{-1} (CUM-52). The ancillary data, entry CUM-47 was found earliest in days to 50% flowering (58 days) and days to maturity (118 days). Plant height varied from 27.4 cm (CUM-47) to 46.6 cm (CUM-52), the 1000 seed weight ranged from 3.4 (CUM-50) to 4.9 (CUM-52).
Sanand	Twelve entries were tested under the CVT trial. All entries were affected by cumin root rot and cumin blight disease. Although, characters including seed yield were recorded. Trial CV was 74.52 %. Trial considered as vitiated.

FENNEL

Project Code	FNL/CI/1.1	**Project Title**	Germplasm collection, characterization, evaluation, conservation and screening against diseases
Centres	Dholi, Hisar, Jagudan, Jobner, Kumarganj		
Date of start	1975	**Date of closure/ duration**	Long term
Work done/achievements during 2023-24 (centre-wise)			
Dholi	Forty-four (44) numbers of germplasm along with one check (Rajendra Saurabh) were evaluated for promising lines with respect to yield. Among 44 numbers of germplasm, only two germplasm, namely- RF-61 and RF-73 out yielded more than check variety, Rajendra Saurabh. Among these promising germplasm, highest yield was recorded in RF-61 (85.83 g per five plant) followed by RF-73 (84.60 g per five plant) against check variety, Rajendra Saurabh (82.40 g per five plant). Yield of top ten germplasm yielder ranged from 44.20 to 85.83 g per five plant.		
Hisar	One hundred thyirty eight accessions of Fennel were evaluated in two row plots of 3.0 meter length each using GF-2, Hisar Sawrup and Raj-Saurabh as checks during 2023-24. 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-125, HF-129, HF-134 HF-136 HF-167, HF-169, HF-180, HF-182, HF-197 HF-198 HF-199, HF-200 and HF-202.		

Jagudan	During the 2023-24, from 81to 160 genotypes were evaluated with the check variety GF 12. JF 351-5, JF 391, JF 531-1, JF 472-2, JF 303 were high yielding genotypes. Promising genotypes yield attributing characters were mentioned in table.
Jobner	Fifty-seven (57) Inbred lines of fennel were evaluated along with ten checks namely RF-101, RF-125, RF-143, RF-145, RF-157, RF-178, RF-205, RF-281, RF-289 and RF-290 in augmented design in 3 blocks with one row plot of 3 x 0.5 sq.m. size. The trial was sown on 22.10.2023. One-meter uniform section of each row of a plot was maintained by bagging with muslin cloth and on maturity seeds were harvested separately to obtain the self seed to raise the crop for next season. A wide range of variability was found for all the characters studied. Out of 57 inbred lines, 04 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)
Kumarganj	Total 100 germplasm of Fennel was evaluated and recorded maximum yield 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}).

Project Code	FNL/CI/2.8	**Project Title**	Coordinated varietal trial on fennel – 2021 Series XI
Centres	Ajmer, Dholi, Hisar, Jabalpur, Jagudan, Jobner, Kumarganj, Navsari, Pantnagar.		
Date of start	2021-22	**Date of closure/ duration**	3 years (2023-24)
Experimental details	Genotypes 1. HF 192 (Hisar) 2. HF 256 (Hisar) 3. JF 18-13 (Jagudan) 4. JF 18-03 (Jagudan) 5. UF 231 (Jobner) 6. UF 230 (Jobner) 7. AF 87 (Ajmer) 8. AF 17 (Ajmer) 9. RF 67 (Dholi) 10. NDF 59 (Kumarganj) 11. NDF 46 (Kumarganj) 12. RF-101 (check) 13. RF 205 (check)		
Observations Recorded	1. Germination % 2. Days to 50% flowering 3. Plant height (cm) 4. Primary branches per plant 5. Secondary branches per plant 6. Days to maturity 7. Umbels per plant 8. Umbellets per umbel 9. Seeds per umbel 10. Test weight (g) 11. Seed yield per plant (g) 12. Seed yield (kg ha^{-1}) 13. Incidence of pests (aphids)		

	14. Incidence of diseases (leaf blight, wilt, powdery mildew, gall, bacterial soft rot) 15. Quality
Work done/achievements during 2023-24 (centre-wise)	
Ajmer	Thirteen entries were evaluated along with checks in three replications in RBD with plot size of 4 x 2.5 sq. m. The trial was sown on 10.10.2023. The analysis of variance revealed significant differences among the entries for all the traits including seed yield. The seed yield ranged from 2382.33 kg ha^{-1} to 3423.67 kg ha^{-1}. Highest yield was recorded in FNL-137 (3467.23 kg ha^{-1}) followed by FNL-130 (3370.67 kg ha^{-1}). Whereas, the lowest seed yield 2382.33 was recorded in FNL-132.
Dholi	Among the thirteen test entries and one check, entries *viz*., FNL-136 followed by FNL-136 gave yield of 1782.23 kg ha^{-1} and 1771.68 kg ha^{-1} respectively as compared to check variety, Rajendra Saurabh (1613.48 kg ha^{-1}).
Hisar	The significant differences were obtained for all the parameters. The plant height ranged from 125.6 to 156.5 cm, number of branches 6.8 to 9.1, umbels per plant 31.5 to 41.8 and seeds per umbel 551.6 to 658.8. Maximum seed yield was recorded as 2138.7 kg ha^{-1} in FNL-130 followed by FNL-132 (2085.3 kg ha^{-1}) and FNL-131 (2010.7 kg ha^{-1}), respectively.
Jabalpur	In fennel, thirteen genotypes were evaluated under a Coordinated Varietal Trial using a Randomized Block Design with three replications during the Rabi season of 2023-24. Significant differences were observed for all the morphological and yield parameters studied. Early 50% flowering was recorded in genotypes FNL-132 (85 days) and FNL-137 (86 days). The genotype FNL-134 exhibited the maximum plant height (179.33 cm) and the highest number of branches (5.07) at maturity. The highest seed yield was recorded in FNL-141 (16.83 q ha^{-1}), which was comparable to FNL-142 (15.59 q ha^{-1}). Genotype FNL-142 also showed the highest number of umbels per plant (28.33) and umbellets per umbel (27.43). The maximum test weight was observed in FNL-141 (13.13 g).
Jagudan	The CVT experiment of fennel was conducted with thirteen entries and one local check variety GF 12. FNL 135 (2349 kg ha^{-1}) and FNL 134 (2319 kg ha^{-1}) was significantly superior to the best local check variety GF 12 (1838 kg ha^{-1}) with 27.8 and 26.2 per cent increase over.
Jobner	In *rabi* 2023-24, thirteen (13) entries were evaluated in RBD with 3 replications in a plot size of 3 x 2.5 sq. m. accommodating five rows spaced 50 cm apart with intra-row spacing of 20 cm maintained by thinning. The trial was sown on 22.10.2023. The analysis of variance revealed significant differences among the entries for all the characters studied including seed yield. The seed yield ranged from 1310.22 to 2151.55 kg ha^{-1}. Out of the thirteen entries evaluated, entry FNL-140 recorded maximum seed yield of 2151.55 kg ha^{-1} followed by FNL-131 (2091.55 kg ha^{-1}), FNL-141 (2019.11 kg ha^{-1}), FNL-134 (2018.66 kg ha^{-1}) and FNL-142 (2013.33 kg ha^{-1}), while lowest seed yield of 1310.22 kg ha^{-1} was recorded in FNL-133.
Kumarganj	A total of 13entries of fennel were tested in CVT and recorded maximum yield in FNL-134 (18.75 q ha^{-1}) followed by FNL-133 (18.06 q ha^{-1}) and FNL-132 (16.18 q ha^{-1}). In three year pooled data the highest yield recorded in FNL-134 (17.08 q ha^{-1}) followed by FNL-133 (15.85 q ha^{-1}) and FNL-132 (14.86 q ha^{-1})
Navsari	Among the thirteen entries at Navsari, entry FGK-145 (1262.03 kg ha^{-1}) recorded numerically higher seed yield followed by FGK-146 (1246.53 kg ha^{-1}), FGK-151 (1237.17 kg ha^{-1}), FGK-144 (1213.63 kg ha^{-1}) and FGK-142 (1211.63 kg ha^{-1}). The high seed yielding genotypes were also found numerically higher for other

	seed yield attributing characters viz. pods per plant, seeds per pod, pod length, primary branches per plant, secondary branches per plant and plant height. The genotype FGK-142 was found to be early in flowering (44.33 days) and maturity (100.00 days).
Pantnagar	Among the genotypes tested, FNL-135 demonstrated the highest seed yield with 1666.01 kg ha^{-1}, the maximum number of seeds per umbel at 402.00, and the highest number of primary branches per plant at 11.67, albeit with one of the longer days to maturity at 217.00 days. FNL-141, while exhibiting the highest number of primary branches per plant at 13.00, had a relatively lower seed yield of 1478.69 kg ha^{-1} and fewer seeds per umbel at 208.33. On the other hand, FNL-138 matured the fastest in 183.33 days but had a lower yield of 1230.26 kg ha^{-1}. Overall, FNL-135 appears to be the most promising genotype for higher seed yield and number of seeds per umbel, despite its longer maturation period.

FENUGREEK

Project Code	FGK/CI/1.1	**Project Title**	Germplasm collection, characterization, evaluation, conservation and screening against diseases
Centres	Dholi, Guntur, Hisar, Jagudan, Jobner, Kumarganj, Raigarh		
Date of start	1975	**Date of closure/ duration**	Long term
Work done/achievements during 2021-22 (centre-wise)			
Dholi	Sixty two (62) accessions of fenugreek along with two checks (Rajendra Kanti and Hisar Sonali) were evaluated for promising lines with respect to yield. Among 62 numbers of germplasm, only 4 nos. of germplasm, namely- RM-213, RM-212, RM-187 and RM-203 gave higher yield than best check varieties Rajendra Kanti. The performance of top ten promising accessions ranged from 78.65 to 93.28 g per five plant. Among the four promising germplasm, highest yield was recorded in RM-213 (93.28 g per five plant) followed by RM -187 (92.70 g per five plant) as against check varieties, Rajendra Kanti (76.21 g per five plant) and Hisar Sonali (74.37 g per five plant).		
Guntur	Among the 124 entries evaluated, ten entries recorded significantly higher yield than the best check Lam Methi-2 (3.03 g $plant^{-1}$). The top five performing entries are 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.		
Hisar	One hundred twentu accessions of fenugreek were evaluated along with Hisar Sonali, Hisar Suvarna and Hisar Mukta as checks during 2023-24. The seed yield of the germplasm material ranged from 9.2 g $plant^{-1}$ (HM-246) to 32.2 g $plant^{-1}$ (HM-440). The most promising lines for seed yield were HM-240, HM-259-1, HM-273, HM-278, HM-326, HM-331, HM-335, HM-338, HM-342-1, HM-429 and HM-440.		
Jagudan	During the 2023-24, total 82 germplasms were evaluated along with check variety GM 2. JFg-267, JFg-255, JFg-245, JFg-239 were the highest yielding germplasms.		
Jobner	One hundred ten (110) 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 having six blocks. Each accession was sown in plots of 3 x 0.3 m^2 size accommodating single rows spaced 30 cm apart. The trial		

	was sown on 06.11.2022. Data on seed yield and other morphological traits were recorded on a random sample of five plants and averaged. 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)
Kumarganj	A total of 148 germplasm of fenugreek were maintained and evaluated at the station. The highest yield was found in NDM-49 (12.70 g plant^{-1}) followed by NDM-37 (11.30 g plant^{-1}) and NDM-45 (10.80 g plant^{-1}).
Raigarh	Total 14 genotypes (11 germplasm + 3 released varieties) genotypes of fenugreek maintained during Rabi 2023-24 at CARS, Raigarh. The results of PGR of fenugreek reported that maximum seed yield recorded by genotype IFGS-6 (2796.9 kg ha^{-1}) followed by IFGS-11 (2458.3 kg ha^{-1}) and IFGS -09 (2395.8 kg ha^{-1}) over both national check Hisar Sonali (1489.6 kg ha^{-1}) and RMT 305 (1309.9 kg ha^{-1}) as well as over grand mean of trial (1828.7 kg ha^{-1}).

Project Code	FGK/CI/2.5	**Project Title**	Coordinated Varietal Trial of fenugreek 2021 – Series XI
Centres	Ajmer, Dholi, Hisar, Jabalpur, Jagudan, Jobner, Kalyani, Kota, Kumarganj, Navsari, Pantnagar, Raigarh		
Date of start	2021-22	**Date of closure/ duration**	3 years (2023-24)
Experimental details	Genotypes 1. HM 242 (Hisar) 2. HM 560 (Hisar) 3. JFg-17-02 (Jagudan) 4. JFg-17-06 (Jagudan) 5. NFG 201 (Navsari) 6. NFG 202 (Navsari) 7.UM 259 (Jobner) 8. UM 233 (Jobner) 9. PM 4 (Pantnagar) 10. AFg 9 (Ajmer) 11. AFg 10 (Ajmer) 12. IFGS6 (Raigarh) 13. KFG 12 (Kota) 14. KFG 17 (Kota) 15. NDM 119 (Kumarganj) 16. Hisar Sonali (check) 17. RMt 361 (check)		
Observations Recorded	1. Germination % 2. Days to 50% flowering 3. Plant height (cm) 4. Primary branches per plant 5. Secondary branches per plant 6. Days to maturity 7. No. of pods per plant 8. Seeds per pod 9. Pod length (cm) 10. Test weight (g) 11. Seed yield per plant (g)		

	12. Seed yield (kg ha^{-1}) 13. Incidence of pests (aphids, leaf eating caterpillar, pod borer) 14. Incidence of diseases (Downy mildew, damping off, rust, root rot, leaf spot *etc.*) 15. Quality
Work done/achievements during 2023-24 (centre-wise)	
Ajmer	The trial was sown on 07.11.2023. analysis of variance revealed significant differences among the entries for all the traits including seed yield. The seed yield ranged from 1033.67 kg ha^{-1} to 1597 ka/ha. Of the 17 entries evaluated, highest yield was recorded in FGK-147 *(*1597 kg ha^{-1}) followed by FGK-146 (1546. 33 kg ha^{-1}) and the lowest seed yield was recorded in FGK-153 (1033.67 kg ha^{-1}).
Dholi	Among seventeen entries and one check variety, entry, FGK-147 followed by FGK-155 was found to have higher yield per ha as compared to check variety, Rajendra Kanti. Entries *viz*., FGK-147 recorded highest yield (2033.44 kg ha^{-1}) followed by FGK-155 (2016.91 kg ha^{-1}) as compared to check variety, Rajendra Kanti (1545.70 kg ha^{-1}).
Hisar	The significant differences were obtained for all the parameters. Plant height ranged from 74.6 to 90.8cm, pods per plant 62.1to 88.4 and seeds per pod 15.0 to 18.4. Maximum seed yield (2322 kg ha^{-1}) was recorded in FGK-151 followed by FGK-143 (2260 kg ha^{-1}) and FGK-144 (2231 kg ha^{-1}), respectively.
Jabalpur	Seventeen genotypes of fenugreek germplasm were evaluated during the *Rabi* season of 2023-2024 at JNKVV, Jabalpur Centre. Among the promising entries and checks, the genotype FGK-144 exhibited the highest plant height at 105.27 cm, while FGK-145 recorded the minimum plant height at 80.73 cm. The highest seed yield was observed in genotype FGK-152 i.e. 22.96 q ha^{-1}, which was comparable to FGK-144 (22.37 q ha^{-1}) and FGK-151 (22.28 q ha^{-1}). Additionally, FGK-152 demonstrated the highest test weight (16.85 g).
Jagudan	Seventeen entries of fenugreek were evaluated along with local check GM 3. The entries tested under the trial were found significant differences for yield. FGK -155 (1859 kg ha^{-1}) and FGK-146 (1778 kg ha^{-1}) found superior over best check variety GM 3 (1630kg ha^{-1}) by 14.0 and 9.1 *per cent*, respectively.
Jobner	Analysis of variance revealed significant differences among the entries for seed yield and yield attributing characters. The seed yield ranged from 1145.84 kg ha^{-1} (FGK-153) to 2067.13 kg ha^{-1} (FGK-155). Out of the seventeen entries evaluated, entry FGK-155 recorded maximum seed yield of 2067.13 kg ha^{-1} followed by FGK-147 (2033.33 kg ha^{-1}), FGK-154 (2016.20 kg ha^{-1}), FGK-151 (1984.26 kg ha^{-1}) and FGK-148 (1977.78 kg ha^{-1}).
Kalyani	From the result of the 3rd year (2023-24) it is found that the following germplasm FGK-146, FGK-152, FGK-148, FGK-155 are found promising in this agro-climatic situation. Among them FGK-146 produced maximum yield of 11.75 q ha^{-1}.
Kota	During the third year of evaluation, FGK 146 was found to be the best performing entry in terms of seed yield, yielding 2479 kg ha^{-1} followed by FGK 141 (2218 kg ha^{-1}) and FGK 148 (2201 kg ha^{-1}) while FGK 145 had the lowest yield (1028 kg ha^{-1}). The mean test weight ranged from 8.80g (FGK 145) to 14.00g (FGK 154). FGK 154 had highest plant height (109 cm) while FGK 152 was shortest (81 cm). The genotypes FGK 148 (48 days), FGK 147, FGK 140 and FGK 141 showed earliest flowering (49 days) while FGK 142, FGK 153 and FGK 155 was the most late in flowering (56 days). FGK 147 and FGK 144 were earliest in maturity (134 days) while FGK 139 was the most late in maturity (139 days).

Kumarganj	A total of 17 entries of fenugreek were tested under CVT and recorded maximum yield in FGK-147 (23.29 q ha^{-1}) followed by FGK-139 (22.54 q ha^{-1}), FGk-156 (22.14 q ha^{-1}) and FGk-152 (21.07 q ha^{-1}). In three year yield pooled data the highest FGK-145 (22.49 q ha^{-1}) followed by FGK-147 (21.36 q ha^{-1}), FGk-1148 (19.31 q ha^{-1}) and FGk-139 (19.10 q ha^{-1})
Navsari	Seventeen genotypes were evaluated under coordinated varietal trial in randomized block design with three replications during Rabi- 2023 at Navsari. The genotype FGK-145 (1262.03 kg ha^{-1}) recorded numerically higher seed yield followed by FGK-146 (1246.53 kg ha^{-1}), FGK-151 (1237.17 kg ha^{-1}), FGK-144 (1213.63 kg ha^{-1}) and FGK-142 (1211.63 kg ha^{-1}). The high seed yielding genotypes were also found numerically higher for other seed yield attributing characters viz. pods per plant, seeds per pod, pod length, primary branches per plant, secondary branches per plant and plant height. The genotype FGK-142 was found to be early in flowering (44.33 days) and maturity (100.00 days).
Pantnagar	Among the genotypes, FGK-154 demonstrated the highest seed yield at 1987.49 kg ha^{-1}, along with the highest number of primary branches per plant (7.33) and a high seed count per pod (16.67), with a maturity period of 129 days. FGK-147 also showed high performance with a seed yield of 1954.16 kg ha^{-1} and a shorter maturity period of 135 days, but had a lower seed count per pod (11.26). FGK-145, while having a shorter maturity period of 128.33 days, achieved a seed yield of 1775.92 kg ha^{-1} and a high seed count per pod (16.00). FGK-151 and FGK-144 also performed well with seed yields of 1787.26 kg ha^{-1} and 1767.85 kg ha^{-1}, respectively, coupled with high seed counts per pod and reasonable maturity periods. Overall, FGK-154 stands out as the most promising genotype for high seed yield and favorable agronomic traits, despite the variation in the number of seeds per pod across genotypes. Other notable genotypes include FGK-147, FGK-145, and FGK-151, which balance high seed yields with shorter maturation periods.
Raigarh	The results of CVT of fenugreek revealed FGK 144 (2167 kg ha^{-1}) recorded highest seed yield followed by test entry FGK 141 (1736 kg ha^{-1}) and FGK 140 (1684 kg ha^{-1}) over mean value 1369.1 kg ha^{-1}).

AJWAIN

Project Code	AJN/CI/2.1	**Project Title**	Coordinated Varietal Trial–2022 Series
Centres	Ajmer, Guntur, Hisar, Jagudan, Jobner, Kumarganj, Raigarh		
Date of start	2022-23	**Date of closure/ duration**	3 years (2024-25)
Experimental details	Treatments/genotypes 1. MAS-19-1 (Jagudan) 2. LAS-19-2 (Jagudan) 3. HAJ-38 (Hisar) 4. HAJ-7 (Hisar) 5. JA-19-05 (Jagudan) 6. JA-19-01 (Jagudan) 7. AA-16 (Ajmer) 8. AA-45 (Ajmer) 9. AA-24 (Ajmer) 10. Ajmer Ajwain-2 (Check)		

	Design: RBD; Replications:3; Plot size/spacing: 4.00x2.5m^2 Spacing- 50x20cm;
Observations Recorded	1. Germination % 2. Days to 50% flowering (on plot basis) 3. Plant height (cm) 4. Primary branches per plant 5. Secondary branches per plant 6. Days to maturity 7. Umbels per plant 8. Umbellets per umbel 9. Seeds per umbel 10. Test weight (g) 11. Seed yield (kg ha^{-1}) 12. Disease and pest incidence, if any 13. Quality (essential oil %)
Work done/achievements during 2023-24 (centre-wise)	
Ajmer	Observations on growth parameters, yield attributes and yield were recorded. Plant height ranged from 86.66 to 109.33 cm, number of umbels/plant ranged from 256.46 to 372.16 and number of seeds/ umbellate ranged from 16.17 to 21.97. Maximum seed yield (1733.17 kg ha^{-1}) was recorded in AJN-22 followed by AJN-20 (1641 kg ha^{-1}). Maximum essential oil was obtained in AJN-25 (5.7%) genotype.
Guntur	Among the entries evaluated, AJN-28 (1470.1 kg ha^{-1}) significantly recorded higher yields and was on par with the entries AJN-27 (1429.0 kg ha^{-1}), AJN-25 (1389.6 kg ha^{-1}), AJN-24 (1386.6 kg ha^{-1}) and AJN-22 (1373.3 kg ha^{-1}).
Hisar	The significant differences were obtained for all the parameters. Plant height ranged from 108.2 to 125.3 cm, umbels per plant 216.3 to 378.3 and seeds per umbel 234.7 to 303.4. Maximum seed yield (1258.8 kg ha^{-1}) was recorded in AJN-21 followed by AJN-20 (1140.0 kg ha^{-1}) and AJN-26 (1107.5 kg ha^{-1}), respectively.
Jagudan	Total ten entries with local checks GA 1 and GA 2 were evaluated. The entries tested under the trial were found significant differences for seed yield. AJN 23 (2048 **kg ha^{-1}**) found significantly superior than the local check GA 2 (1830 **kg ha^{-1}**) by 24.6 per cent. AJN 25 (2048 **kg ha^{-1}**) and AJN28 (2031 **kg ha^{-1}**) was superior than the local check GA 2 by 11.9 and 11.0 per cent, respectively.
Jobner	Analysis of variance revealed significant differences among the entries for seed yield and yield attributing characters. Mean seed yield of the ten entries evaluated ranged from 931.11 to 1824.44 kg ha^{-1}., entry AJN-29 recorded maximum seed yield of 1824.44 kg ha^{-1} followed by AJN-28 (1356.89 kg ha^{-1}), AJN-25 (1284.44 kg ha^{-1}), AJN -26 (1242.22 kg ha^{-1}) and AJN -24 (1230.67 kg ha^{-1}), while lowest yield of 931.11 kg ha^{-1} was recorded in AJN-22**.**
Kumarganj	Among the entries tested, AJN -20 gave highest yield (10.56 q ha^{-1}) followed by AJN-26 (9.38 q ha^{-1}) and AJN 23 (9.10 q ha^{-1}).
Raigarh	The evaluation of CVT of Ajwain revealed that AJN 28 recorded highest seed yield (1093.8 kg ha^{-1}), AJN 25 (1034 Kg/h) and AJN 26 (1031.3 kg ha^{-1}) over local check Chhattisgarh Ajowain -1 (874.8 kg ha^{-1}) CG Ajwain-1 recently notified during 2024 for cultivation in Chhattisgarh State in CVRC meeting of horticulture crops held on 4th May 2023. 24 Kg nucleus seeds of CG Ajowain 1 produced during 2023-24.

SAFFRON

Project Code	Project mode	**Project Title**	Conservation, evaluation and utilization of exotic and indigenous saffron germplasm lines
Centres	Pampore		
Date of start	2019	**Date of closure/ duration**	Project period
Work done/achievements during 2023-24 (centre-wise)			
Pampore	During the current cropping season i.e., 2023-24, five germplasm lines were collected from Kishtwar growing areas of J&K making a total of 237 lines, however, 89 germplasm lines were culled out due to low performance and less distinctive traits. Therefore, 148 germplasm are presently under evaluation. Germplasm lines showed significant performance with regard to growth, quality, yield and yield-attributing traits. 11 Elite lines including Check (Shalimar Saffron-1) planted under Advanced Varietal Trial-II (AVT-II) showed significant variation with regard to yield and yield attributing traits. Also conducted the on-farm trials (OFTs) to demonstrate and promote the cultivation of elite lines of saffron so as to encourage adoption by local farmers.		

KALAZEERA

Project Code	Project mode	**Project Title**	Exploration, collection and conservation of kalazeera from high altitudes of Northern Himalayas
Centres	Pampore		
Date of start	2019	**Date of closure/ duration**	Project period
Work done/achievements during 2023-24 (centre-wise)			
Pampore	During 2023-24, 11 new accessions were collected from high altitudes of Drass and Kaksar region of Kargil Ladakh making a total of 103 accessions (98 tuber germplasm and 5 seed germplasm). Under evaluation, there was huge variability among the accessions for various morphological and yield characters. Conducted minikit trials of elite accession of Kalazeera identified as SRS/KZ/177 (Proposed name "Shalimar Kalazeera-2) to assess its performance and suitability for release as a new variety. Also conducted the on-farm trials (OFTs) to demonstrate and promote the cultivation of elite lines of Kalazeera so as to encourage adoption by local farmers.		

TECHNICAL SESSION II

CROP MANAGEMENT

Project code	Title	Centres
	Cardamom	
CAR/CM/5.5	Effect of micronutrients on growth and yield of small cardamom	Appangala, Mudigere, Myladumpara, Pampadumpara, Sakleshpur
CAR/CM/5.6	Site-specific recommendations for varying yield targets of cardamom.	Appangala, Mudigere, Myladumpara, Pampadumpara, Sakleshpur
	Large cardamom	
LCA/CM/5.1	Effect of mulching on yield of large cardamom	Pasighat, ICAR Gangtok, ICRI Gangtok
	Ginger	
GIN/CM/4.1	Evaluation of different ginger-based intercropping systems for higher yield and income	Chintapalle, Dholi, ICAR Gangtok, Kanke, Kalyani, Mizoram, Nagaland, Pottangi, Pundibari, Sirsi, Solan.
GIN/CM/5.1	Evaluation of Plant Growth Promoting Rhizobacteria, *Bacillus safensis* for Phosphorus (P) Solubilization Potential in ginger	Ambalavayal, Chintapalli, Kalyani, Kammarpally, Kumarganj, Pasighat, Pottangi, Pundibari, Raigarh,
GIN/CM/5.2	Evaluation of Plant Growth Promoting Rhizobacteria, *Bacillus safensis* for zinc (Zn) solubilization potential in ginger	Chintapalli, Kalyani, Kammarpally, Kumarganj, Pasighat, Pottangi, Raigarh,
	Turmeric	
TUR/CM/5.1	Evaluation of Plant Growth Promoting *Rhizobacteria*, *Bacillus safensis* for phosphorus (P) solubilization potential in turmeric	Chintapalli, Coimbatore, Kahikuchi, Kalyani, Kammarpally, Kozhikode, Pasighat, Pottangi, Pundibari, Raigarh, Solan.
TUR/CM/5.2	Evaluation of Plant Growth Promoting *Rhizobacteria*, *Bacillus safensis* for zinc (Zn) solubilization potential in turmeric	Chintapalli, Coimbatore, Dholi, Kahikuchi, Kalyani, Kammarpally, Kanke, Kumarganj, Kozhikode, Pasighat, Pottangi, Pundibari, Raigarh.
	Coriander	
COR/CM/5.1	Growth and yield of Coriander as influenced by AMF (Arbuscular Mycorrhizal Fungi)	Ajmer, Coimbatore, Dholi, Guntur, Jabalpur, Kota
COR/CM/6.1	Effect of growth regulators on yield and quality of coriander	Coimbatore, Guntur, Hisar, Jabalpur, Jobner, Kota, Raigarh
	Fenugreek	
FGK/CM/5.1	Growth and yield of fenugreek as influenced by AMF (Arbuscular Mycorrhizal Fungi)	Dholi, Kota, Mandor, Jabalpur
FGK/CM/6.1	Effect of growth regulators on yield and quality of fenugreek	Ajmer, Dholi, Hisar, Jobner, Kota

PROGRESS REPORT OF THE PROJECTS

CROP MANAGEMENT

CARDAMOM

Project Code	CAR/CM/5.5	**Project Title**	Effect of micronutrients on growth and yield of small cardamom
Centres	Appangala, Mudigere, Myladumpara, Pampadumpara, and Sakleshpur		
Date of start	2020	**Date of closure/ duration**	TBD
Experimental details	Design: FRBD; Replications: four; Variety: Any three varieties; Spacing/plot size:2×2m, 12 plants per plot Treatments T_1: Recommended package of practices (control) T_2: Recommended package of practices + IISR cardamom micronutrient four sprays at March, April, May, June @ 5 g L^{-1}		
Observation Recorded	• Physio chemical properties of the soil: pH, nutrient status (major, secondary and micro nutrients) • Growth parameters • Plant height (cm) • Number of tillers per clump • Number of bearing tillers per clump • Number of panicles per clump • Panicle length (cm) • Number of capsules per clump • Fresh capsule yield per panicle (g) • Fresh capsule yield per clump (g) • Fresh capsule yield per hectare (kg) • Dry capsule yield per hectare (g) • Dry recovery (%) • % of bold capsules (8 mm) • Oil content (%) • 1,8 cineole content (%) • Incidence of pests (shoot borer, shoot fly, thrips) • Incidence of diseases (rhizome rot, leaf blight)		
Work done/achievements during 2023-24 (centre-wise)			
Appangala	Treatments were imposed after establishment and growth and yield parameters were recorded as per schedule. Micronutrients spray recorded better growth and yield parameters. Size of capsule was better in micronutrient sprayed treatment in all genotypes. Yield ranged from 11.6 to 43.05 (kg ha^{-1}) in control and from 20.83 to 46.52 (kg ha^{-1}) 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 20023-24.		
Mudigere	Growth and yield attributes were significantly superior in treatments where cardamom power mix (IISR Micro nutrients formulation for cardamom) was used as compared to recommended package of practice**.** Response of cultivars for micronutrients as well as interaction was found to be non significant.		
Myladumpara	The maximum yield was obtained in MCC 260 where the application of IISR micro nutrient mix was applied as foliar application in $V3T_2$ (130.19 kg ha^{-1}) followed by		

	Thiruthali V1T_2 (108.82). There was significant improvement in number of racemes per panicle for V1 (Thiruthali) and V3 (MCC 260) which were on par with each other followed by ICRI 5 (V2).
Pampadumpara	The four sprays of IISR cardamom micronutrient were completed, and significant differences among the morphological and yield characters between the treatments and varieties were observed. Maximum plant height was recorded for KAU PV3 (292.806 cm) and also the maximum plant height was registered by T_2 (295.878cm). Maximum no. of tillers (39.00) and panicles (47.481) were recorded under T_2. KAU PV3 showed maximum number of panicles (55.611) and panicle length (79.500 cm).
Sakleshpur	Growth and yield attributes were significantly superior in treatments where cardamom power mix (IISR Micronutrients formulation for cardamom) was used (189.9 kg ha^{-1}) as compared to recommended package of practice. Among different treatments significantly higher plant height (182 cm), number of panicles/clump (7.8) and capsule yield (75.8 g $plant^{-1}$) was observed in IISR power mix treatment. Response of cultivars for micronutrients as well as interaction was found to be non-significant.

Project Code	CAR/CM/5.6	**Project Title**	Site-specific recommendation for varying yield target of cardamom
Centres	Mudigere, Myladumpara, Pampadumpara, and Sakleshpura.		
Date of start	2021	**Date of closure/ duration**	3 years
Experimental details		Crop variety: Popular improved variety of respective centre/area. Experimental design: RBD; Treatments: 4; Replication: 5 T_1: 20:170:0 kg ha^{-1} (N: P_2O_5: K_2O) for 6 q ha^{-1} yield T_2: 117.9:247.7:103 kg ha^{-1} for 8 q ha^{-1} yield T_3: 227.7:275:244.4 kg ha^{-1} for 10 q ha^{-1} yield T_3: 125:125:250 kg ha^{-1} as per the state POP. Plot Size: 2 x 2m, 12 plants per plot	
Observation Recorded		• Growth parameters • Yield and its attributes • Quality attributes • Soil test analysis before and end of cropping season growth • Economics- BCR, gross returns, net returns	
Work done/achievements during 2023-24 (centre-wise)			
Mudigere	Experiment was laid out in RBD design with four treatments and five replications Treatments were imposed as per the technical programme Among different treatments significantly higher plant height, number of panicles/clump and capsule yield was observed in treatment (T_3) receiving 202 g Urea/clump + 200 g rock phosphate/clump + 305 g MoP/clump.		
Myladumpara	The maximum yield was obtained in T_3 (108.55 kg / ha) followed by T_3 (108.02 kg / ha) and the yield difference was non-significant. The maximum number of tillers was recorded in T_3, maximum number of panicles was in T_3 and Maximum number of racemes per panicle and number of capsules per raceme was recorded from T_3.		
Pampadumpara	Superiority in plant height was observed in T_3 (255.786 cm) followed by T_3 (244.048 cm). Maximum number of tillers was observed in T_3 (42.542) chased by T_1 (41.458) and T_3 (41.354). More number of panicle was also recorded in T_3 (19.271). Maximum panicle length was registered in T_3 (48.667 cm).		

Sakleshpura	Initiated the trial during 2021. Treatments were imposed as per the technical programme and preliminary observation on growth characters were recorded. Among different treatments significantly higher plant height (201 cm), number of panicles/clump (8.1) and capsule yield (62.1 g plant^{-1}) was observed in treatment receiving 270.2: 250: 436.2 kg ha^{-1} - target yield - 8 q / ha (154.6 kg ha^{-1}). On the contrary, significantly higher numbers of tillers (18.2) were recorded in treatment receiving 380.0:275.0:550.0 kg NPK/ha with a target yield of 10q / ha.

LARGE CARDAMOM

Project Code	LCA/CM/5.1	**Project Title**	Effect of mulching on yield of large cardamom
Centres	ICAR Gangtok, ICRI Gangtok		
Date of start	2021	**Date of closure/ duration**	3 years
Experimental details		**Treatment details** T_1 – Leaf mould T_2 – Fresh leaf litter T_3 – Paddy straw T_3 – Paddy husk T_3 – Black polyethylene sheets T_3 – Control Place of Experiment: At farmers' fields Design: RBD; replications: 4; Plot size/spacing: 4.5 x 4.5 m and 1.5 x1.5 m	
Observation Recorded		• Plant height • Number of leaves/tiller • Number of tillers/clump • Number of productive tillers • Leaf length • Leaf breadth • Number of days to flowering • Number of days to maturity • Number of spike/clump • Number of capsule/spike • Number of seed/capsule • Fresh yield/ plant and per hectare • Dry yield/plant and per hectare • Physico - chemical parameters of soil : pH, nutrient status • Diseases and insect pests (if any) • Economics, BC ratio	
Work done/achievements during 2023-24 (centre-wise)			
ICAR Gangtok	Maximum number of immature tillers/clump and total number of tillers/clump were recorded under T_1 which was significantly higher than other treatments, respectively. Except T_2, significantly maximum dry capsule yield was noticed under T_1 as compared to other treatments.		

ICRI Gangtok	It was observed that T_1 shows the best result for number of productive tillers (8.5), number of spikes / clump (10.0) and capsules/spike (12.7). The yield was also found higher in T_1 (203.0 g/clump and 812.1 kg ha^{-1}). Treatment wise large cardamom samples were submitted for quality analysis and the result is awaited.

GINGER

Project Code	GIN/CM/4.1	**Project Title**	Evaluation of different ginger-based intercropping systems for higher yield and income
Centres	Chintapalle, Dholi, ICAR Gangtok, Kalyani, Mizoram, Nagaland, Pottangi, Pundibari, Solan.		
Date of start	2021-22	**Date of closure/ duration**	3 years (2021-22 to 2023-24)
Experimental details	**Treatments:** • T_1- Sole ginger • T_2- Ginger + Papaya + Leafy coriander (Grow papaya with a spacing of 180 x 180 cm. Between two lines of payaya ginger will be sown in a spacing of 30 x 25 cm and leafy coriander will be broadcasted in the border area. After harvesting of leafy coriander, the mulching will be done) • T_3- Ginger + Banana (Grow banana with a spacing of 200 x 200 cm. Between two lines of banana ginger will be sown in a spacing of 30 x 25 cm. Banana may be grown once in two years) • T_3- Ginger + Coriander + leafy vegetables (Grow ginger and coriander in 2:2 ratio. After harvesting of coriander, grow leafy vegetables in place of coriander • T_3- Ginger + Maize (2:1 or 2:2) (Grow sweet corn in Kharif, Rabi and Summer- 3 times) • T_3- Ginger + French bean (2:2) (Grow French bean in Kharif, Rabi and Summer- 3 times) • T_7- Ginger + Arhar (3:1) (Grow arhar in Kharif) • T_8- Ginger + Taro (2:2) (Grow taro in Kharif) Crop variety: Popular improved variety of respective centre/ area. Experimental design: RBD; Treatments: 8; Replications: 3		
Observation Recorded	• Growth parameters • Yield and its attributes • Test weight of seed spices • Essential oil of seed spices • Economics- BCR, Gross returns, net returns		
Work done/achievements during 2023-24 (centre-wise)			
Chintapalle	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 per plant (201.21 g) and yield (14.75 t ha^{-1}) was recorded in ginger grown as sole crop followed by Ginger + Arhar (3:1) cropping system (10.51 t ha^{-1}). The highest benefit cost ratio (13.48:1) was recorded in Ginger + Elephant foot yam followed by Sole Ginger (12.54:1).		

Dholi	Among different intercrops *viz*., coriander, fenugreek, french bean, pigeonpea, maize, leafy vegetables and elephant foot yam taken with ginger, highest yield of ginger (6.84 t ha^{-1}) was recorded in plot intercropped with elephant foot yam. Yield of ginger as sole crop was found 21.65 t ha^{-1}.
ICAR Gangtok	The results showed that significantly maximum ginger equivalent yield (28 t ha^{-1}) and system productivity (34 t ha^{-1}) was noticed under Ginger + Maize (2:1 or 2:2) (Grow sweet corn in Kharif, Rabi and Summer- 3 times) ginger fenugreek intercropping system followed by Ginger + Taro (2:2) as compared to other sole and intercropping system.
Kalyani	In the 3rd year (2023-24) the best combination was found in T_3 i.e., Ginger + French Bean (2:2), closely followed by T_7 i.e., Ginger + Elephant foot yam (2:2) & T_3 i.e., (Ginger + coriander+ Leafy)
Mizoram	The result from the study indicated that a significant highest fresh weight of clump was recorded in ginger + french bean (2:2) intercropping (145.12 g) while the lowest was recorded in ginger + taro intercropping (74.39 g). The number of rhizomes was significantly highest in ginger + arhar (7.80) which was at par with ginger + taro (7.74) and ginger + fenugreek (7.71). The ginger yield was significantly highest in ginger + coriander + leafy vegetables (10.84 t ha^{-1}) whereas the least was recorded in ginger + arhar (7.61 t ha^{-1}). Significant highest intercrop fresh yield (9.83 t ha^{-1}) was recorded in ginger + maize followed by ginger + taro (7.04 t ha^{-1}). The crop equivalent yield (t ha^{-1}) was highest in ginger + maize (14.61 t ha^{-1}) followed by ginger + coriander + leafy vegetables (14.32 t ha^{-1}) and ginger + taro (11.92 t ha^{-1}). The highest B:C ratio was recorded in ginger + coriander + leafy vegetables (3.82) followed by ginger + maize (3.68) and ginger + taro (3.01).
Nagaland	Out of the 7 treatment combinations, T_1-Sole ginger; T_2- Ginger+Fenugreek; T_3-Ginger+Coriander+leafy vegetables; T_3- Ginger+Maize (sweet corn)+ green mustard (laipata); T_3- Ginger+ French bean; T_3-Ginger+Tomato+Okra; T_7-Ginger+Colocasia, Plant height was recorded highest in T_3(54.33 cm) followed by T_3 (49.67 cm) and lowest height of the plant was recorded in T_3 (27 cm). The highest number of tillers was recorded in T_3 (7.33) followed by T_2 (7.00) and lowest was recorded in T_3 (3.00). The fresh yield per clump and yield /ha was recorded highest in T_1 (153.33g, 8.75 t ha^{-1}) followed by T_3 (95.67g, 6.92 t ha^{-1}) respectively whereas, lowest yield was recorded in T_3 (3.57 t ha^{-1}). Highest BC ratio was recorded in T_3 (2.56) followed by T_1 (2.38) and lowest was recorded in T_3 (1.99). Highest land equivalent ratio (LER) was recorded in T_3 (3.29) followed by T7 (2.43) and lowest was recorded in T_1 (1). Highest ginger equivalent yield (GEY) was recorded in T7 (16.14) followed by T_1 (8.75) and lowest was recorded in T_3 (1.30). Where, BCR: Benefit cost ratio, LER: Land equivalent ratio, GEY: Ginger equivalent yield
Pottangi	Return from coriander as inter crop in ginger was the highest followed by Maize in ginger .
Pundibari	From the analyzed data it is clear that maximum yield (12.86 t ha^{-1}) of the main crop *i.e.* ginger was obtained in T_1 treatment (sole ginger) and based on the B:C ratio of this trail, the maximum B:C ratio (3.16) was recorded in T_7 treatment (T_7: Ginger + EFY - 2:2) followed by T_3 treatment (T_3: Ginger + French bean -2:2) (2.43) and T_3 treatment (2.41) (T_3: Ginger + Coriander + Leafy vegetable - 2:2).
Solan	Ginger variety "Solan Giriganga" intercropped with sweet corn over three crop-seasons: *Summer, Kharif,* and *Rabi* with a planting ratio 2:2 resulted in the best

	yields for both ginger (186.25 q ha^{-1}) and sweet corn (444.16 q ha^{-1}). These crops also gave the highest net returns per hectare (₹ 5,99,842) and had a B:C ratio of 2.05 under mid-hill conditions in Himachal Pradesh.

Project Code	GIN/CM/5.1	**Project Title**	Evaluation of Plant Growth Promoting Rhizobacteria, *Bacillus safensis* for phosphorus (P) solubilization potential in ginger
Centres	Ambalavayal, Chintapalle, Kalyani, Kammarpally, Kumarganj, Pasighat, Pottangi, Pundibari, Raigarh		
Date of start	2020-21	**Date of closure/ duration**	3 years
Experimental details	Treatments: T_1- 100% recommended phosphorus(P) fertilizer T_2- 75% phosphorus (P) fertilizer T_3- 75% phosphorus (P) fertilizer and Bacillus *safensis* T_3- 50% phosphorus (P) fertilizer T_3- 50% phosphorus (P) fertilizer and Bacillus *safensis* T_3-*Bacillus safensis* alone T_7-Control without P Crop variety: Popular improved variety of respective centre/area. • Experimental design: RBD • Treatments: 7 • Replications: 4 • Bed size: 3 x1m • Spacing: 15x30 cm; Total no. of beds: 28 Bacteria application as soil drench: At the time of planting, 30 days after planting (DAP), 60 days after planting (DAP) • Methodology: Fertilizer application: As per the recommendation except P which may be taken up as per the treatment		
Observation Recorded	• Growth parameters (90 & 120 DAP) • Soil nutrients analysis –Available P & other major &minor nutrients(120DAP) • Nutrient uptake (harvest)- Leaf and rhizome • Yield and quality analysis • Economics		

Work done/achievements during 2023-24 (centre-wise)	
Ambalavayal	Among different treatments in ginger, the treatment T_3 showed maximum fresh weight of clump, dry yield, and dry recovery. Number of tillers was highest in T_1. Additionally, the phosphorus (P) levels were found to be the lowest in treatments T_3 and T_7 among all the treatments.
Chintapalli	It was observed that among different treatments in ginger, application of 75% phosphorus (P) fertilizer and Bacillus safensis recorded more number of tillers per clump (6.67), highest fresh weight of clump (165.00 g), highest fresh rhizome yield per hectare(12.33 t ha^{-1}), dry rhizome yield per hectare (2.66 t ha^{-1}).
Kalyani	Result showed that T_3 (75% phosphorus(P) fertilizer and *Bacillus safensis)* is found the best combination followed by T_3 (50% phosphorus(P) fertilizer and

	Bacillus safensis) and T_1 (100% recommended phosphorus(P) fertilizer). The experiment is continuing in this year (2024-25). The health of the treated crop is satisfactory in the field.
Kammarpally	To evaluation of PGPR – Phosphorus in ginger, different treatments (T_1- 100% recommended phosphorus(P) fertilizer, T_2- 75% phosphorus(P) fertilizer, T_3- 75% phosphorus(P) fertilizer and Bacillus safensis, T_3- 50% phosphorus(P) fertilizer, T_3- 50% phosphorus(P) fertilizer and Bacillus safensis T_3- Bacillussafensis alone, T7-Control without P) were tested, among them T_3- 75% phosphorus(P) fertilizer and Bacillus safensis (9.41 t ha^{-1}) followed by T_1-100% phosphorus (P) fertilizer (9.01 t ha^{-1}) were found effective and recorded maximum yield when compare to control (5.89 t ha^{-1}).
Kumarganj	Among the 7 different treatments tested for Evaluation of plant growth promoting rhizobacteria, *Bacillus safensis* for phosphorus (P) solubilization potential in ginger, Treatment T-3 (75% phosphorus fertilizer and *Bacillus safensis*) gave highest yield 85.00 q ha^{-1} followed by in treatment T-1 (100 % recommended phosphorus (P) fertilizer) 79.17 q ha^{-1}, T-5 (50% phosphorus fertilizer and *Bacillus safensis*) 77.50 q ha^{-1}, T-2 (75 % phosphorus (P) fertilizer) 75.00 q ha^{-1}, and T-7 (Control without P) gave lowest yield 65.42 q ha^{-1}
Pasighat	This experiment was conducted with Nadia variety and treatments were applied as per the technical programme. Among the treatments, the highest plant height (32.46 cm, 41.72 cm) at 90 and 120 days after planting, respectively, was recorded in T_3 (75% P + *Bacillus safensis*) followed by T_1 (100% P) with a plant height of 27.57 cm and 36.43 cm at 90 & 120 DAP, respectively. Number of tillers/clump was maximum in T_3 with 2.60 & 3.55 tillers/clump at 90 and 120 DAP, respectively. Similarly, number of leaves was also found to be highest in T_3 with 9.95 & 11.85 number of leaves at 90 and 120 DAP, respectively. As far as yield parameters is concerned, highest yield/clump (125.90 g) was found in T_3 and the projected yield per hectare was also found to be highest in T_3 (12.14 t ha^{-1}) and the lowest yield in control (7.14 t ha^{-1})
Pottangi	Application of P solubilization (16.1t ha^{-1}) gave 15.9% higher yield than control (13.9 t ha^{-1}) in Suprabha.
Pundibari	In this trial, effects of plant growth promoting rhizobacteria, *Bacillus safensis* for phosphorus (P) solubilizing potential, seven (7) treatments were evaluated. Analysis of the data revealed that the maximum number of tillers per plant (12.15) and fresh yield (17.93 t ha^{-1}) were recorded in T_3 (75% recommended phosphorus fertilizer and *Bacillus safensis*) followed by T_3 (50% recommended phosphorus fertilizer and *Bacillus safensis*) and T_1 (100% recommended phosphorus fertilizer). Whereas, all the parameters were found to be lowest in T_7 (Control i.e. without P fertilizer). Dry rhizome yield (3.67 t ha^{-1}) was also recoreded maximum in T_3 treatment.
Raigarh	Maximum plant height 50 DAS (29.53 cm) and 120 DAS (52.53 cm) and maximum yield 15.46 t /ha found in 100 % recommended phosphorus (P) fertilizer (T_1).

Project Code	GIN/CM/5.2	**Project Title**	Evaluation of Plant Growth Promoting Rhizobacteria, *Bacillus safensis* for zinc (Zn) solubilization potential in ginger
Centres	Chintapalle, Kalyani, Kammarpally, Kumarganj, Pasighat, Pottangi, Raigarh		

Date of start	2020-21	**Date of closure/ duration**	3 years
Experimental details		Treatments: T_1- 100% recommended zinc (Zn) fertilizer T_2- 50% zinc (Zn) fertilizer and *Bacillus safensis* T_3- 50% zinc (Zn) fertilizer alone T_3- *Bacillus safensis* alone T_3- control without Zn Crop variety: Popular improved variety of respective centre/area. • Experimental design: RBD • Treatments: 5 • Replication: 5 • Bed size: 3 x1m • Spacing: 15x30 cm; Total no. of beds: 25 • Methodology; Bacteria application as soil drench: At the time of planting, 30 days after planting (DAP), 60 days after planting (DAP) • Fertilizer application: As per the recommendation	
Observation Recorded		• Growth parameters (90 & 120 DAP) • Soil nutrients analysis –Available Zn & other major & minor nutrients (120DAP) • Nutrient uptake (harvest)- Leaf and rhizome • Yield and quality analysis • Economics	
Work done/achievements during 2023-24 (centre-wise)			
Chintapalli	It was observed that among different treatments in ginger, application of 50% (Zinc (Zn) fertilizer and Bacillus safensis recorded highest fresh weight of clump in grams (176.45 g), higher number of tillers per clump (8.65), fresh rhizome yield per hectare(13.03 t ha^{-1}), dry rhizome yield per hectare (3.04 t ha^{-1}).		
Kalyani	Result showed that T_2 (50% zinc (Zn) fertilizer and *Bacillus safensis)* is found the best combination followed by T_1 (100% recommended zinc (Zn) fertilizer) and T_3 (50% zinc (Zn) fertilizer alone). The experiment has been continuing in this year (2024-25) and the progress is satisfactory. Ginger has been planted after soil treatment as per scheduled programme.		
Kammarpally	Among treatments, T_2 (50% Zinc (Zn) fertilizer and *Bacillus safensis*) yielded the highest at 11.22 t ha^{-1}, followed by T_1 (100% recommended Zinc (Zn) fertilizer) with a yield of 9.8 t ha^{-1}. Both treatments significantly outperformed the control, which recorded a yield of only 6.21 t ha^{-1}.		
Kumarganj	In Evaluation of plant growth promoting rhizobacteria, *Bacillus safensis* for zinc (Zn) solubilizationpotentialin ginger, out of 5 different tested treatments, treatment T-2 (50 % Zn fertilizer and *Bacillus safensis*) gave highest yield (86.67 q ha^{-1}) followed by T-1 (100 % recommended zinc (Zn) fertilizer) 78.33 q ha^{-1}, T-3 (50% zinc (Zn) fertilizer alone) 72.67 q ha^{-1}, T-4 (*Bacillus safensis*alone) 66.333 q ha^{-1} and lowest yield found in treatment T-5 (Control without Zn) 62.47 q ha^{-1}.		
Pasighat	This experiment was conducted with Nadia variety and treatments were applied as per the technical programme. Among the treatments, the highest plant height (36.18 cm, 40.80 cm) at 90 and 120 days after planting, respectively, was		

	recorded in T_2 (50% P + *Bacillus safensis*) followed by T_1 (100% Zn) with a plant height of 32.86 cm and 37.44 cm at 90 & 120 DAP, respectively. Number of tillers/clump was maximum in T_2 with 2.6 & 3.44 tillers/clump at 90 and 120 DAP, respectively. Similarly, number of leaves was also found to be highest in T_2 with 9.56 & 12.12 number of leaves at 90 and 120 DAP, respectively. As far as yield parameters is concerned, highest yield/clump (123.08 g) was found in T_2 and the projected yield per hectare was also found to be highest in T_2 (12.51 t ha^{-1}) and the lowest yield in control (7.47 t ha^{-1}).
Pottangi	Application of Zn solubilization (16.7t ha^{-1}) gave 13.7% higher yield than control (14.7t ha^{-1}) in Suprabha .
Raigarh	Maximum plant height 50 DAS (26.56 cm) and 120 DAS (50.47) and maximum yield 14.38 t ha^{-1} in treatment 100% recommended zinc (Zn) fertilizer (T_1) 100 percent recommended zinc fertilizer @ 5 kg ha^{-1}.

TURMERIC

Project Code	TUR/CM/5.1	**Project Title**	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		
Date of start	2020-21	**Date of closure/ duration**	3 years
Experimental details	Treatments: T_1- 100% recommended phosphorus(P) fertilizer T_2- 75% phosphorus (P) fertilizer T_3- 75% phosphorus (P) fertilizer and *Bacillus safensis* T_3- 50% phosphorus (P) fertilizer T_3- 50% phosphorus (P) fertilizer and *Bacillus safensis* T_3- *Bacillus safensis* alone T_7- Control without P Crop variety: Popular improved variety of respective centre/area. • Experimental design: RBD • Treatments: 7 • Replications: 4 • Bed size: 3 x1m • Spacing: 15x30 cm; Total no. of beds: 28 Methodology: Bacteria application as soil drench: At the time of planting, 30 days after planting (DAP), 60 days after planting (DAP) • Fertilizer application: As per the recommendation except P which may be taken up as per the treatment		
Observation Recorded	• Growth parameters (90 & 120 DAP) • Soil nutrients analysis –Available P & other major &minor nutrients(120DAP) • Nutrient uptake (harvest)- Leaf and rhizome • Yield and quality analysis Economics		

Work done/achievements during 2023-24 (centre-wise)	
Chintapalli	It was observed that among different treatments in turmeric, application of 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 (26.42t ha^{-1}) and dry rhizome yield per hectare (7.12 t ha^{-1}).
Coimbatore	The trial was initiated with seven treatments including *Bacillus safensis* and Phosporus fertilizer alone and in combination. First dose of bacterial application was done by soil drenching at the time of planting. Among the seven treatments T_3 recorded (75% Phosphorus fertiliser + *Bacillius safensis*) more fresh weight per clump (299.5g) and fresh rhizome yield per hectare (24.95 t ha^{-1}) followed by T_3 (50% Phosphorus fertiliser + *Bacillius safensis*) 287.5g fresh weight per clump and fresh rhizome yield per hectare (23.25t ha^{-1})
Kahikuchi	Treatment T_3 (75% Phosphorus(P) fertilizer and Bacillus safensis) recorded the highest plant height (175.65 cm) followed by followed by 166.73 cm inT_3 (50% phosphorus (P) fertilizer and Bacillus safensis).Similarly T_3 (75% Phosphorus(P) fertilizer and Bacillus safensis) also recorded maximum number of shoots per plant (5.97 no.), petiole length (39.31 cm) and longest lamina length (80.63 cm) followed by T_3 (50% phosphorus (P) fertilizer and Bacillus safensis) 5.67 cm, 38.79 cm and 80.23 cm, respectively. However, number of leaves in main shoot was recorded highest (9.65 no.) in T_3 (50% phosphorus (P) fertilizer and Bacillus safensis). Fresh rhizome yield was recorded highest in T_3(27.49 t ha^{-1}) followed by T_3 (26.83 t ha^{-1}). Similarly, curcumin content was found highest in T_3 (5.63%). Leaf rhizome and soil analysis are on progress.
Kalyani	Result showed that T_3 (75% phosphorus(P) fertilizer and Bacillus safensis) is found the best combination followed by T_3 (50% phosphorus(P) fertilizer and Bacillus safensis*)* and T_1 (100% recommended phosphorus(P) fertilizer). The experiment is continuing in this year (2024-25). The health of the treated crop is satisfactory in the field.
Kammarpally	To evaluate solubilization of PGPRs in turmeric, different treatments (T_1-100% recommended phosphorus(P) fertilizer, T_2- 75% phosphorus (P) fertilizer, T_3- 75% phosphorus(P) fertilizer and Bacillus safensis, T_3- 50% phosphorus(P) fertilizer, T_3- 50% phosphorus (P) fertilizer and Bacillus safensis T_3-*Bacillus safensis* alone, T_7-Control without P) were tested, among them T_3- 75% phosphorus(P) fertilizer and *Bacillus safensis* (29.28 t ha^{-1}) followed by T_1-100% recommended phosphorus (P) fertilizer (28.53 t ha^{-1}) were found effective and recorded maximum yield when compare to control (18.25 t ha^{-1}).
Kozhikode	Among the treatments, the one with 75% P + *B. safensis* registered significantly ($P < 0.05$) higher rhizome yield and the increase was greater by 46.5% and 58.0 % compared to control (100% P) and absolute control. With regard to soil available P, the levels were significantly ($P < 0.05$) higher in all the treatments involving combined application of *B. safensis* with 50% or 75% or 100% P. Higher microbial activity in *B. safensis* treatment was confirmed with the observation on dehydrogenase, which registered marked greater levels in *B. safensis* + 75% P and corresponding increase in acid phosphatase activity was 26.5% higher compared to 100% P.

Pasighat	This experiment was conducted with NDH-98 variety and treatments were applied as per the technical programme. Among the treatments, the highest plant height (66.18 cm, 98.81 cm) at 90 and 120 days after planting, respectively, was recorded in T_3 (75% P + *Bacillus safensis*) followed by T_1 (100% P) with a plant height of 59.75 cm and 93.75 cm at 90 & 120 DAP, respectively. Number of tillers/clumps was maximum in T_3 with 2.50 & 3.65 tillers/clump at 90 and 120 DAP, respectively. Number of leaves was also found to be highest in T_3 with 6.20 & 6.90 number of leaves at 90 and 120 DAP, respectively. As far as yield parameters is concerned, highest yield/clump (199.02 g) was found in T_3 and the projected yield per hectare was also found to be highest in T_3 (18.22 t ha^{-1}) and the lowest yield in control (11.66 t ha^{-1})
Pottangi	Application of P solubilization (22.2t ha^{-1}) gave 13.8% higher yield than control (19.5t ha^{-1}) in Roma.
Pundibari	In this trial, effects of plant growth promoting Rhizobacteria, *Bacillus safensis* for phosphorus (P) solubilizing potential, seven (7) treatments were evaluated. Analysis of the data revealed that the maximum plant height (99.1 cm), highest number of tillers per plant (3.10) and fresh rhizome yield (28.37 t ha^{-1}) were recorded in T_3 (75% recommended phosphorus fertilizer and *Bacillus safensis*) followed by T_3 (50% recommended phosphorus fertilizer and *Bacillus safensis*) and T_1 (100% recommended phosphorus fertilizer). Whereas, all the parameters were found to be lowest in T_7 (Control *i.e.* without phosphorus fertilizer). Dry rhizome yield (5.17 t ha^{-1}) was also recoreded maximum in T_3 treatment.
Raigarh	Maximum Plant height 50 DAS (55.42cm) and 120 DAS (102.70cm) and maximum yield 24.85 t /ha found in treatment T_3.
Solan	Turmeric Variety *Palam Lalima* drenched with plant growth promoting rhizobacteria *Bacillus safensis* and application of 37.5 kg ha^{-1} P_2O_5 fertilizer gave the highest yield (277.93 q ha^{-1}) along with maximum net returns (₹ 4,20,754) and B:C ratio (1.54) under mid hill conditions of Himachal Pradesh.

Project Code	TUR/CM/5.2	**Project Title**	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		
Date of start	2020-21	**Date of closure/ duration**	3 years
Experimental details		Treatments: T_1- 100% recommended zinc (Zn) fertilizer T_2- 50% Zinc (Zn) fertilizer and Bacillus *safensis* T_3- 50% Zinc (Zn) fertilizer alone T_3- *Bacillus safensis* alone T_3- Control without Zn Crop variety: Popular improved variety of respective centre/area. • Experimental design: RBD • Treatments: 5 • Replication: 5 • Bed size: 3 x1m	

	• Spacing: 15x30 cm; Total no. of beds: 25 Methodology: Bacteria application as soil drench: At the time of planting, 30 days after planting (DAP), 60 days after planting (DAP) • Fertilizer application: - As per the recommendation
Observation Recorded	• Growth parameters (90 & 120 DAP) • Soil nutrients analysis –Available Zn & other major & minor nutrients (120DAP) • Nutrient uptake (harvest)- Leaf and rhizome • Yield and quality analysis • Economics
Work done/achievements during 2023-24 (centre-wise)	
Chintapalli	It was observed that among different treatments in turmeric, application of 50% Zinc fertilizer and Bacillus safensis recorded more number of tillers per clump (1.48), fresh weight of clump in grams (262.51 g), fresh rhizome yield per hectare(24.10 t ha^{-1}).
Coimbatore	The trial was initiated with seven treatments including *Bacillus safensis* and Zinc fertilizer alone and in combination. 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. Among the treatments, the treatment T_2 (50% Zinc fertilizer + *Bacillus safensis*) recorded more fresh weight per clump (229.58g) and fresh rhizome yield per hectare (23.08t ha^{-1})
Dholi	Among the treatments, highest significant turmeric (Var., Rajendra Sonali) yield of 51.24 t ha^{-1} was recorded in the treatment, T_2- 50% Zinc (Zn) fertilizer and *Bacillus safensis* over control (46.70 t ha^{-1}).
Kahikuchi	Treatment T_1 (100% recommended zinc fertilizer) recorded the highest plan height (167.59 cm), number of leaves at main shoot (8.63), maximum number of shoots (5.97 no.) per clump and longest lamina length (78.13 cm). However longest petiole length (37.54 cm) was recorded by T_2- 50% zinc (Zn) fertilizer and *Bacillus safensis treatments.* Fresh rhizome yield was recorded highest in T_2 (23.47 t ha^{-1}) followed by T_3 (22.41 t ha^{-1}). Similarly, Curcumin content was found highest in T_1 (5.45%) followed by T_2 (5.21%). Leaf rhizome and soil analysis are on progress.
Kalyani	Result showed that T_2 (50% zinc (Zn) fertilizer and *Bacillus safensis*) is found the best combination followed by T_1 (100% recommended zinc (Zn) fertilizer) and T_3 (50% zinc (Zn) fertilizer alone). The experiment has been continuing in this year (2024-25) and the progress is satisfactory. Turmeric has been planted after soil treatment as per scheduled programme.
Kammarpally	To evaluate PGPRs in ginger, different treatments (T_1-100% recommended Zinc (Zn) fertilizer, T_2- 50% Zinc (Zn) fertilizer and Bacillus safensis T_3- 50% Zinc (Zn) fertilizer alone, T_3- Bacillus safensis alone, T_3- control without Zn) were tested among them T_2- 50% Zinc (Zn) fertilizer and Bacillus safensis (39.52 t ha^{-1}) followed by T_1- 100% recommended Zinc (Zn) fertilizer (38.49 t ha^{-1}) were found effective and recorded maximum yield when compare to control (25.41 t ha^{-1})

Kumarganj	In Evaluation of plant growth promoting rhizobacteria, *Bacillus safensis*, for zinc (Zn) solubilization potential in turmeric, out of 5 different treatments tested in turmeric, treatment T-2 (50 % Zn fertilizer and *Bacillus safensis*) gave highest yield 327.33 q ha^{-1} hollowed by in decreasing order found yield in treatment T-1 (100 % recommended zinc (Zn) fertilizer) 310.67 q ha^{-1}, T-3 (50% zinc (Zn) fertilizer alone) 298.67 q ha^{-1} , T-4 (*Bacillus safensis* alone) 291.33 q ha^{-1} and in Treatment T-5 (Control without Zn) 275.33 q ha^{-1}.
Kanke	Fresh rhizome yield and its attributing characters of Turmeric were increased significantly by the application of Zn fertilizer and Zn solubilizing bacteria. Fresh rhizome yield was found maximum (36.484 t ha^{-1}) by application of 5 kg ha^{-1} Zinc sulfate (hydrated) as recommended dose which was at par with 50% Zinc (Zn) fertilizer and Bacillus safensis (T_2) and as 34.096 t ha^{-1} and use of Bacillus safensis alone (T_3) as 32.844 t ha^{-1}. Other parameters were in same line. However, Dry recovery was not affected significantly
Kozhikode	Among the treatments, combined application of *Bacillus safensis* with different levels of $ZnSO_4$ significantly increased the number of tillers, shoot length, number of leaves, dry root weight and shoot weight compared to application of 100% $ZnSO_4$ and absolute control. With regard to soil available Zn, the levels were significantly higher in all the treatments involving combined application of *B. safensis* with 50% or 75% or 100% $ZnSO_4$. *B. safensis* + 75% $ZnSO_4$ recorded significantly higher soil available Zn (6.36 ± 0.14 mg kg^{-1}). Among the treatments, application of 75% ZnSO4 + *B. safensis* registered significantly higher fresh rhizome yield and the increase was 147.97% and 93.28 % compared to control (100% $ZnSO_4$) and absolute control, respectively. Rhizome rot disease incidence was not observed in turmeric treated with combined application of *B. safensis* with 50% or 75% or 100% $ZnSO_4$, compared to treated control and absolute control.
Pasighat	This experiment was conducted with NDH-98 variety and treatments were applied as per the technical programme. Among the treatments, the highest plant height (63.27 cm, 86.70 cm) at 90 and 120 days after planting, respectively, was recorded in T_2 (50% P + *Bacillus safensis*) followed by T_1 (100% Zn) with a plant height of 59.85 cm and 83.43 cm at 90 & 120 DAP, respectively. Number of tillers/clump was maximum in T_2 with 2.52 & 3.20 tillers/clump at 90 and 120 DAP, respectively. Similarly, number of leaves was also found to be highest in T_2 with 6.24 & 8.02 number of leaves at 90 and 120 DAP, respectively. As far as yield parameters is concerned, tthe the highest yield/clump (168.62 g) was found in T_2 and the projected yield per hectare was also found to be highest in T_2 (16.32 t ha^{-1}) and the lowest yield in control (9.19 t ha^{-1})
Pottangi	Application of Zn solubilization (22.9t ha^{-1}) gave 19.7% higher yield than control (19.1t ha^{-1}) in Roma.
Pundibari	In this trial, effects of plant growth promoting rhizobacteria, *Bacillus safensis* for phosphorus (Zn) solubilizing potential, five (5) treatments were evaluated. Analysis of the data revealed that the maximum number of tillers per plant (3.12) and fresh rhizome yield (28.01 t ha^{-1}) were recorded in T_2 (50% recommended zinc fertilizer and *Bacillus safensis*)

	followed by T_1 (100% recommended zinc fertilizer). Whereas, all the parameters were found to be lowest in T_7 (Control without zinc fertilizer).
Raigarh	Maximum Plant height 50 DAS (56.42 cm) and 120 DAS (106.71cm) and maximum yield (25.31 t /ha) found in treatment T_1

TREE SPICES

Project Code	TSP/CM/5.1	**Project Title**	Site-Specific Nutrient Management in Nutmeg (*Myristica fragrans*)
Centres	Vellanikkara, Kozhikode, Dapoli and Coimbatore		
Date of start	2026	**Date of closure/ duration**	Three years
Experimental details	Treatments: 5 1. Site-specific soil test-based nutrient application 2. Site-specific soil test based 100% of their nutrient application through fertigation 3. Site-specific soil test based 75 % of their nutrient application through fertigation 4. Site-specific soil test based 50 % of their nutrient application through fertigation 5. Control		
Observations Recorded	1. Average height (cm) 2. Average girth (cm) 3. Number of branches 4. Average spread (m) 5. Fruit length (cm) 6. Fruit breadth (cm) 7. Fruit weight (fresh) (g) 8. Mace weight (fresh) (g) 9. Mace weight (dry) (g) 10. Nut weight (fresh) (g) 11. Nut weight (dry) (g) 12. Kernel weight (dry) (g) 13. Number of fruits per m^2 14. Number of fruits per tree 15. Fresh and dry nut yield per tree (kg) 16. Fresh and dry kernel yield per tree (kg) 17. Fresh and dry mace yield per tree (kg) 18. Kernel analysis: 19. Volatile oil (%) 20. Oleoresin (%) 21. Fixed oil (%) 22. Mace analysis: 23. Volatile oil (%) 24. Oleoresin (%)		
Work done/achievements during 2023-24 (centre-wise)			
All Centres	Centres have finallised the site of experiment. Ready to start the experiment		

CORIANDER

<table>
<tr><td>Project Code</td><td>COR/CM/5.1</td><td>Project Title</td><td>Growth and yield of Coriander as influenced by AMF (Arbuscular Mycorrhizal Fungi)</td></tr>
<tr><td>Centres</td><td colspan="3">Ajmer, Coimbatore, Dholi, Guntur, Jabalpur, Kota</td></tr>
<tr><td>Date of start</td><td>2022-23</td><td>Date of closure/ duration</td><td>Three years</td></tr>
<tr><td colspan="2">Experimental details</td><td colspan="2">• Experimental design: Factorial RBD; Replication: 3
<u>Treatment combinations: 9 + 1 control (absolute control)</u>
T_1: 100% RDP with Seed treatment
T_2: 75% RDP with Seed treatment
T_3: 50% RDP with Seed treatment
T_3: 100% RDP with Soil application (20 DAS @ 5 kg acre^{-1})
T_3: 75% RDP with Soil application (20 DAS @ 5 kg acre^{-1})
T_3: 50% RDP with Soil application (20 DAS @ 5 kg acre^{-1})
T_7: 100% RDP with Seed treatment (@ 100g per kg of seed) at the time of sowing, and Soil application (20 DAS @ 5 kg acre^{-1})
T_8: 75% RDP with Seed treatment with Seed treatment (@ 100g per kg of seed) at the time of sowing, and Soil application (20 DAS @ 5 kg acre^{-1})
T_9: 50% RDP with Seed treatment (@ 100g per kg of seed) at the time of sowing, and Soil application (20 DAS @ 5 kg acre^{-1})
C- Control (water spray)
• Crop variety: Popular improved variety of respective centre/area.
• Plot size & Crop spacing: 4 x 2.4 m, Spacing- 30 x 10 cm</td></tr>
<tr><td colspan="2">Observations Recorded</td><td colspan="2">1. Vigour (Plant height in cm)
2. No. of days to 50% flowering
3. No. of primary branches/plant
4. No. of secondary branches/plant
5. No. of umbels/plant
6. No. of umbellets/umbel
7. No. of seeds/umbel
8. Duration (No. of days to maturity)
9. Yield (q ha^{-1})
10. Essential oil (%)
11. Soil and plant P uptake
12. Economics and B:C ratio.</td></tr>
<tr><td colspan="4">Work done/achievements during 2023-24 (centre-wise)</td></tr>
<tr><td>Ajmer</td><td colspan="3">The results show application of 50, 75 and 100 % recommended P gave 961.2, 1189.3 and 1399.8 kg ha^{-1} seed yield whereas among AMF application methods, seed treatment along with soil application gave 1155.1 kg ha^{-1} seed yield. Maximum seed yield of 1453.0 kg ha^{-1} 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.</td></tr>
<tr><td>Dholi</td><td colspan="3">Among ten treatments comprising of application of different phosphorus level and mode of application of VAM, maximum yield (1978.30 kgha^{-1}) was recorded</td></tr>
</table>

	in treatment, 100% RDF + seed treatment @25 g/ kg of seed and soil application – 20 days after sowing @ 12.5kg/ ha against control (1623.70 kgha^{-1}).
Guntur	During 2023-24, 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}).
Jabalpur	The experiment was conducted using a Factorial Randomized Block Design with two factors: Phosphorus level (100% RDP, 75% RDP, 50% RDP, and 0% RDP) and Mode of application (Seed treatment at 100 g/kg of seed, Soil application 20 days after sowing at 5 kg/acre, and Seed treatment + Soil application). The highest plant height (112.82 cm) was observed in the treatment T6 (75% RDP combined with seed treatment and soil application), followed by T4 (75% RDP and seed treatment). The highest seed yield (16.95 q/ha) and a harvest index of 30.28 were reported in Treatment T5 (75% RDP and soil application of VAM at 20 DAS).
Kota	Due to delayed receipt of AMF culture, this trial was sown in 1st week of January, 2023, therefore, growth parameters, yield attributes and yield of coriander was drastically affected.

Project Code	COR/CM/6.1	**Project Title**	Effect of growth regulators on yield and quality of Coriander
Centres	Coimbatore, Guntur, Hisar, Jabalpur, Jobner, Kota, Raigarh		
Date of start	2022-23	**Date of closure/ duration**	Three years
Experimental details	• Experimental design: RBD; Replication: 3 <u>Treatment combinations: 8</u> T_1: Salicylic acid @ 50 ppm T_2: Salicylic acid @ 100 ppm T_3: Jasmonic acid @ 50 ppm T_3: Jasmonic acid @ 100 ppm T_3: Benzyl adenine @ 10 ppm T_3: Benzyl adenine @ 20 ppm T_7: Brassinosteroid @ 0.50 ppm T_8: Brassinosteroid @ 1.00 ppm C: Control (water spray) • Crop variety: Popular improved variety of respective centre/area. • Plot size & Crop spacing: 4 x 2.4 m, Spacing- 30 x 10 cm		
Observation Recorded	1. Vigour (Plant height in cm) 2. No. of days to 50% flowering 3. No. of primary branches/plant 4. No. of secondary branches/plant 5. No. of umbels/plant 6. No. of umbellets/umbel 7. No. of seeds/umbel 8. Duration (No. of days to maturity) 9. Yield (q ha^{-1}) 10. Essential oil (%)		

	11. Economics and B:C ratio
Work done/achievements during 2023-24 (centre-wise)	
Hisar	The significant differences were obtained for all the treatments. Maximum Umbels per plant (53.2) and seed yield (1993.6 kg ha^{-1}) was recorded with the application of Benzyl adenine @ 20 ppm which is being at par with spray of Benzyl adenine @ 10 ppm (1966.3 kg ha^{-1}).
Guntur	During 2022-23, among the different growth regulators evaluated, Salicylic acid @ 50 ppm (1258.00 kg ha^{-1}) followed by Benzyl Adenine @ 10 ppm (1207.3 kg ha^{-1}), Salicylic acid @ 100 ppm (1204.30 kg ha^{-1}), Jasmonic acid @ 50 ppm (1165.70 kg ha^{-1}) and Jasmonic acid @ 50 ppm (1127.6 kg ha^{-1}) were on par with one another and significantly superior to the control (1000.3 kg ha^{-1}).
Jabalpur	Using four plant growth regulators viz., Salicylic acid, Jasmonic acid, Benzyl adenine, and Brassinosteroid, in different concentrations with water spray as the control, the experiment was laid out using Randomized Block Design with three replications. The spraying was done at 30 DAS and 60 DAS. 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. In Quality analysis, volatile oil increases in BA@ 20ppm and highest ascorbic acid is obtained in BR@ 0.5ppm. The highest B:C ratio was recorded in plant treated with BA@ 20ppm.
Jobner	The nine treatments consisted of spray of different growth regulators were evaluated in RBD with 3 replications in a plot size of 4.0 x 2.4 m^2 with crop geometry of 30 x 10 cm. The crop was sown on 05.11.2023. The crop variety was RCr-728. The results showed that different modern growth regulators viz., salicylic acid @ 50 ppm, salicylic acid @ 100 ppm, jasmonic acid @ 50 ppm, jasmonic acid @ 100 ppm, benzyl adenine @ 10 ppm, benzyl adenine @ 20 ppm, brassinosteroid @ 0.50 ppm, brassinosteroid @ 1.0 ppm significantly increased growth parameters, yield attributes, yield, economics and qualityof coriander over control.
Kota	The growth, yield attributes and yield of coriander was influenced by different growth regulators as compared to control (water spray). Among the different growth regulators, application of T_2 (Salicylic acid @ 100 ppm) gave the highest growth parameters, yield attributes and seed yield of coriander.
Raigarh	Among the different growth regulators, earliest flowering (50% & 100% flowering) was recorded at 40.25 and 49.5 DAS in treatment of Benzyl adenine @ 20 ppm as well as highest yield (2135.80 kg ha^{-1}) and test weight followed by T_1, T_2, T_7 in terms of flowering but as per yield T_8 (1759.26 kg ha^{-1}) was recorded after T_3.

FENUGREEK

Project Code	FGK/CM/5.1	**Project Title**	Growth and yield of fenugreek as influenced by AMF (Arbuscular Mycorrhizal Fungi)
Centres	Dholi, Guntur, Kota, Mandor, Jabalpur		
Date of start	2022-23	**Date of closure/ duration**	Three years
Experimental details	• Experimental design: Factorial RBD; Replication: 3 Treatment combinations: 9 + 1 control (absolute control) T_1: 100% RDP with Seed treatment T_2: 75% RDP with Seed treatment		

	T_3: 50% RDP with Seed treatment T_3: 100% RDP with Soil application (20 DAS @ 5 kg acre^{-1}) T_3: 75% RDP with Soil application (20 DAS @ 5 kg acre^{-1}) T_3: 50% RDP with Soil application (20 DAS @ 5 kg acre^{-1}) T_7: 100% RDP with Seed treatment (@ 100g per kg of seed) at the time of sowing, and Soil application (20 DAS @ 5 kg acre^{-1}) T_8: 75% RDP with Seed treatment with Seed treatment (@ 100g per kg of seed) at the time of sowing, and Soil application (20 DAS @ 5 kg acre^{-1}) T_9: 50% RDP with Seed treatment (@ 100g per kg of seed) at the time of sowing, and Soil application (20 DAS @ 5 kg acre^{-1}) C- Control (water spray) • Crop variety: Popular improved variety of respective centre/area. • Plot size & Crop spacing: 4 x 2.4 m, Spacing- 30 x 10 cm
Observations Recorded	1. Plant height (cm) 2. No. of days to 50% flowering 3. No. of pods/plant 4. Length of pod (cm) 5. No. of seeds/pod 6. Weight of 1000 seeds 7. Duration 8. Yield (q ha^{-1}) 9. Diosgenin content (mg 100-g) 10. Soil and plant P uptake 11. Economics and B:C ratio
Work done/achievements during 2023-24 (centre-wise)	
Dholi	Among ten treatments comprising of application of different phosphorus level and mode of application of VAM, maximum yield (1880.54 kgha^{-1}) was recorded in treatment, 100% RDF + seed treatment @25 g/ kg of seed and soil application – 20 days after sowing @ 12.5kg/ ha against control (1526.79 kgha^{-1}).
Kota	The maximum and significantly higher plant height, pods/plant, seeds/pod and seed yield of fenugreek was recorded in 100% RDP over 75% RDP and 50% RDP. While in case of mode of applications, the seed treatment + soil application recorded higher plant height and seed yield of fenugreek.
Mandor	The results of two years pooled analysis showed that 100% RDP significantly increased the pods/plant, plant height, branches/ plant, test weight, net returns and B:C ratio of fenugreek over 50% RDP and control, although, seed and biological yields, gross returns and seeds/pod were also significantly higher over 75% RDP. The different mode of application of mycorrhiza recorded significantly higher pods per plant, test weight, seed yield, biological yield, net returns and B:C ratio over control and were at par with each other.
Jabalpur	The experiment was conducted using a Factorial Randomized Block Design with two factors: Phosphorus level (100% RDP, 75% RDP, 50% RDP, and 0% RDP) and Mode of application (Seed treatment at 100g/kg of seed, Soil application 20 days after sowing at 5 kg/acre, and Seed treatment + Soil application). The highest values observed in the treatment of 75% RDP combined with seed treatment and soil application: plant height (95.33 cm), primary branches (8.06), and secondary branches at harvest (16.49). However, these factors do not

	significantly affect phenological characteristics such as days to flower initiation and days to 50% flowering. For yield parameters also, the best results were achieved with 75% RDP + seed treatment + soil application, yielding a test weight of 15.97g and seed yield of 16.97 q ha^{-1}.

Project Code	FGK/CM/6.1	**Project Title**	Effect of growth regulators on yield and quality of fenugreek
Centres	Ajmer, Dholi, Hisar, Jobner, Kota		
Date of start	2022-23	**Date of closure/ duration**	Three years
Experimental details	• Experimental design: RBD; Replication: 3 Treatment combinations: 8 T_1: Salicylic acid @ 50 ppm T_2: Salicylic acid @ 100 ppm T_3: Jasmonic acid @ 50 ppm T_3: Jasmonic acid @ 100 ppm T_3: Benzyl adenine @ 10 ppm T_3: Benzyl adenine @ 20 ppm T_7: Brassinosteroid @ 0.50 ppm T_8: Brassinosteroid @ 1.00 ppm C: Control (water spray) • Crop variety: Popular improved variety of respective centre/area. • Plot size & Crop spacing: 4 x 2.4 m, Spacing- 30 x 10 cm		
	1. Plant height (cm) 2. No. of days to 50% flowering 3. No. of pods/plant 4. Length of pod (cm) 5. No. of seeds/pod 6. Weight of 1000 seeds 7. Duration 8. Yield (q ha^{-1}) 9. Diosgenin content (mg 100-g) 10. Soil and plant P uptake 11. Economics and B:C ratio		
Work done/achievements during 2023-24 (centre-wise)			
Ajmer	The results showed that different modern growth regulators significantly increased growth parameters, yield attributes, yield over water spray (control). The results further revealed that the lower concentration of salicylic acid @ 50 ppm, jasmonic acid @ 50 ppm, benzyl adenine @ 10 ppm, brassinosteroid @ 0.50 ppm recorded significantly higher fenugreek seed yield i.e. 680.7, 723.0, 798.5, 754.1 kg ha^{-1} than water spray. Application of Jasmonic acid @100 ppm, Benzyl adenine @ 20 ppm, Brassinosteroid @ 1.00 ppm also gave significantly higher seed yield to of fenugreek the magnitude of 1504.7, 1299.7 and 1648.3 kg ha^{-1}, respectively.		
Dholi	Among nine treatments comprising of application of different growth regulators, maximum yield (1867.20 kgha^{-1}) was recorded in treatment, application of Brassinosteroid @1.00 ppm against control (1518.50 kgha^{-1}).		
Hisar	The significant differences were obtained for all the treatments. Maximum number of pods per plant (64.4) and seed yield (2384.4 kg ha^{-1}) 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^{-1}).
Jobner	The nine treatments consisted of spray of different growth regulators evaluated in RBD with 3 replications in a plot size of 4.0 x 2.4 m^2 with crop geometry of 30 x 10 cm. The crop was sown on 05.11.2023. The crop variety was RMt-354. The results showed that different modern growth regulators viz., salicylic acid @ 50 ppm, salicylic acid @ 100 ppm, jasmonic acid @ 50 ppm, jasmonic acid @ 100 ppm, benzyl adenine @ 10 ppm, benzyl adenine @ 20 ppm, brassinosteroid @ 0.50 ppm, brassinosteroid @ 1.0 ppm significantly increased growth parameters, yield attributes, yield and economics of fenugreek over control.
Kota	The maximum plant height pods/plant and seed yield of fenugreek was recorded in foliar application of jasmonic acid @100ppm over control being at par with foliar applications of higher doses.

TECHNICAL SESSION III

CROP PROTECTION & FOOD SAFETY

Project code	Title	Centres
	Black pepper	
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	Appangala, Panniyur, Sirsi
PEP/CP/7.1	Screening of insecticides for pollu beetle, *Lanka ramakrishnai* in black pepper	Appangala, Panniyur
	Cardamom	
CAR/CP/6.11	Evaluation of fungicides against rhizome rot in small cardamom	Appangala, Mudigere, Myladumpara, Pampadumpara
CAR/CP/6.12	Evaluation of fungicides against leaf blight in small cardamom	Appangala, Mudigere, Myladumpara, Pampadumpara
CAR/CP/6.13	Observational trial on the efficacy of *Trichoderma asperellum* and *Pochonia chlamydosporia* for the management of rhizome rot and nematode in small cardamom	Appangala, Myladumpara, Pampadumpara
	Ginger	
GIN/CP/6.15	Priming of rhizomes for enhanced germination, vigour and storage rot suppression in ginger	Ambalavayal, Barapani, Chintapalli, Dholi, Kalyani, Kammarpally, Kanke, Nagaland, Pasighat, Pottangi, Pundibari, Raigarh, Solan.
GIN/CP/7.1	Spray schedule optimization of effective insecticides for shoot borer (*Conogethes punctiferalis*) in ginger	Ambalavayal, Barapani, Kanke, Mizoram, Mudigere, Nagaland, Pasighat, Pottangi, Pundibari, Sirsi
GIN/CP/7.2	Observational trial on the efficacy of *Trichoderma asperellum* and *Pochonia chlamydosporia* for the management of rhizome rot and nematode in ginger	Barapani, Chintapalli, Kozhikode, Pottangi
	Turmeric	
TUR/CP/7.8	Priming of rhizomes for enhanced germination, vigour and storage rot suppression in turmeric	Ambalavayal, Chintapalli, Coimbatore, Dholi, Kammarpally, Kahikuchi, Kanke, Kumarganj, Mizoram, Pasighat, Pottangi, Pundibari, Raigarh, Solan
TUR/CP/7.9	Spray schedule optimization of effective insecticides for shoot borer (*Conogethes punctiferalis*) in turmeric	Ambalavayal, Barapani, Guntur, Kammarpally, Kanke, Mizoram, Mudigere, Pasighat, Pottangi, Pundibari, Sirsi

TUR/CP/7.10	Observational trial on the efficacy of *Trichoderma asperellum* and *Pochonia chlamydosporia* for the management of rhizome rot and nematode in turmeric	Barapani, Coimbatore, Guntur, Kozhikode.
Cumin		
CUM/CP/7.1	Eco-friendly management of cumin blight	Jaugdan, Jobner, Mandor
Fenugreek		
FGK/CP/7.1	Bio-efficacy of fungicides against powdery mildew of fenugreek.	Coimbatore, Hisar, Jabalpur, Jagudan, Jobner, Kota, Raigarh.
Nigella		
NGL/CP/7.1	Management of root rot of nigella	Dholi, Kumarganj, Raigarh
Seed spices		
SS/CP/7.1	Survey and monitoring of diseases and insect pests of seed spices for development of prediction models	Ajmer, Coimbatore, Dholi, Guntur, Jagudan, Jobner, Kammarpally, Kalyani, Kumarganj, Raigarh, Sanand.

PROGRESS REPORT OF THE PROJECTS

CROP PROTECTION & FOOD SAFETY

BLACK PEPPER

Project Code	PEP/CP/5.10	**Project Title**	Observational trial on efficacy of *Trichoderma asperellum* and *Pochonia* for the management of *Phytophthora* foot rot and nematodes in black pepper
Centres	Appangala, Panniyur, Sirsi		
Date of start	2021	**Date of closure/ duration**	3 years (2021-22 to 2023-24)
Experimental details		Treatments: T_1- Control T_2- *T. asperellum* talc formulation (Mass multiply in cow dung:neem cake mixture (9:1). Mix *T. asperellum* talc formulation @1-2 kg 100kg^{-1} mixture. Apply 2-5kg *T. asperellum* mass multiplied mixture /plant) T_3- *T. asperellum* biocapsule formulation (1biocapsule /100L water. Apply 2-3L solution /plant) T_3- Metalaxyl-mancozeb (Drench the fungicidal solution (0.125 %) T_3- *Pochonia chlamydosporia* liquid formulation (Drench @1ml L^{-1}) T_3- Recommended nematicide (Drench the nematicidal solution) Crop variety: Popular improved variety of respective centre/area. • Experimental design: RBD • Treatments : 6 • Replication: 4 • Total no. of vines: 24 **Date of application:** Apply 2 times- May-June and September-October	
Observation Recorded		• Growth parameters • Yield and its attributes • Disease incidence • Soil population of *Phytophthora*/*Pythium*/nematodes (soil samples can be sent to IISR for analysis. Samples has to be taken before imposing treatments & after imposing treatments @ July- August and Oct-Nov) • Economics- BCR, gross returns, net returns • Residue analysis	
Work done/achievements during 2023-24 (centre-wise)			
Appangala	The trial was conducted with IISR Panchami variety at CHES Chettali and the disease incidence and yield were recorded and it was observed that treatment T_3 and T_3 recorded lowest disease incidence (PDI) and control recorded highest incidence of disease.		

Sirsi	Among the different treatments against the foot rot, least percent disease intensity (17.51 %) was recorded in treatment T_3 (Drench metalaxyl + mancozeb @ 1.25g/L) 17.51% and found on par with T_1 (*Trichoderma asperellum* talc formulation mass multiplied in cow dung and neem cake mixture (9:1). *Trichoderma asperellum* talc formulation @ 1-2 kg /100kg above mixture. Apply 2-5 kg mixture/plant.) 17.81%. However, in control, the highest PDI of 33.33 per cent was recorded.
Panniyur	*Phytophthora* foot rot disease incidence was lowest for T_3 - Metalaxyl-mancozeb (drenching @ (0.125%) and T_3 - Recommended nematicide (drenching Carbosulfan 25 EC @ 1g/litre) which were on par with 7.44 and 7.61 % PDI respectively. T_2 - T. asperellum talc formulation (mass multiplied in cow dung:neem cake mixture (9:1) @1-2 kg /100kg mixture and application of 2-5kg T. asperellum mass multiplied mixture /plant) and T_3 - T. asperellum bio capsule formulation (1biocapsule /100 L water application of 2-3L solution /plant) and T_3- Pochoniachlamydosporia liquid formulation (Drench @1ml/L) were on par compared to T_1-Control with PDI 20.88%.

Project Code	PEP/CP/7.1	**Project Title**	Screening of insecticides for pollu beetle, *Lanka ramakrishnai* in black pepper
Centres	Appangala, Panniyur		
Date of start	2021-22	**Date of closure/ duration**	3 years (2023-24)
Experimental details		Treatments: T_1- Chlorantraniliprole @ 0.3 ml L^{-1} T_2- Chlorantraniliprole @ 0.5 ml L^{-1} T_3- Flubendiamide @ 0.3 ml L^{-1} T_3- Flubendiamide @ 0.5 ml L^{-1} T_3- Spinetoram @ 0.3 ml L^{-1} T_3- Spinetoram @ 0.5 ml L^{-1} T_7- Quinalphos @ 2 ml L^{-1} T_8- Control (water spray) Crop variety: Popular improved variety of respective centre/area. Experimental design: RBD; Replication: 4 Date of first spray: August; Subsequent sprays at monthly interval (limited to a total of 4 sprays)	
Observation Recorded		• Growth parameters • Yield and its attributes • % damage • Economics- BCR, gross returns, net returns • Residue analysis	
Work done/achievements during 2023-24 (centre-wise)			
Appangala	The treatments were imposed during 2022 and recorded percent infestation of berries. The average percent infestation ranged from 3.94 to 13.23% across all the treatments. The average number of berries per spike ranged between 25.2 to 67.0 and the average number of infested berries per spike was between 1.33 to 3.57. All the treatments proved effective in reducing the pollu beetle infestation compared to untreated check. Among them, the black pepper vines sprayed with Flubendiamide @ 0.5 ml recorded lowest percent infestation and on par with both the dosages of Spinetoram.		

Panniyur	Regarding the percentage of damage all treatments T_2 Chlorantraniliprole @ 0.5 ml showed the lowest percent damage (0.44). T_1 and T_3 (Chlorantraniliprole @ 0.3 ml /L-1and Flubendiamide @0.5ml/L) were on par with 0.53 and 1.23 percent damage. Remaining treatments were on par except the absolutecontrol with 13 percent damage. Dry berry yield was on par for T_1- Chlorantraniliprole @ 0.3 ml L-1and T_2 Chlorantraniliprole @0.5 ml with 0.87 kg vine^{-1}. Remaining treatments were on par except the absolute control with 0.53kg vine^{-1}.

CARDAMOM

Project Code	CAR/CP/6.11	**Project Title**	Evaluation of fungicides against rhizome rot in small cardamom
Centres	Appangala, Mudigere, Myladumpara, Pampadumpara		
Date of start	2020-21	**Date of closure/ duration**	Two years
Experimental details		Crop: existing plants of any variety; Plot size/spacing: 3 x 3 m, 12 plants /plot; Replications:4; Design: RBD Treatments T_1- Spray and drench Tebuconazole @1ml L^{-1} T_2-Spray and drench Fenamidone + Mancozeb @ 2g L^{-1} T_3-Spray and drench Metalaxyl- mancozeb @ 1.25 g L^{-1} T_3- Spray and drench copper oxy chloride @ 2g L^{-1} T_3 - Recommended package of practices	
Work done/achievements during 2023-24 (centre-wise)			
Appangala	Two rounds of application of fungicides completed, observations were recorded for rhizome rot during Jun, July and August – 2023. The result of the trial showed that the treatment T_2 (Spraying and drenching of tebuconazole @1mL /L) significantly reduces the disease severity of rhizome rot consecutively for third year, followed by T_3.		
Mudigere	The different fungicides were evaluated against rhizome rot of cardamom in ZAHRS, Mudigere. Among the treatments, fungicide Fenamidone + Mancozeb @ 2 g L^{-1} (0.42 PDI) showed lowest rhizome rot severity and which was statistically on par with Metalaxyl + Mancozeb @ 1.25 g L^{-1} (0.83 PDI) and Tebuconazole @ 1 ml L^{-1} (1.25 PDI). The untreated control showed maximum disease severity (10.00 PDI).		
Myladumpara	Pre-treatment observations on disease incidence were recorded during June 2023 and the first round of treatments was imposed in July 2023 after the notice of the disease. Subsequently the second and third rounds of treatments were also imposed at monthly intervals and the observations recorded. The yield data was also recorded. Highest reduction in rhizome rot incidence was observed in T_2-Spray and drench Fenamidone + Mancozeb @ 2 g/l (74.25%) followed by T_3- Spray and drench Metalaxyl-Mancozeb @ 1.25 g/l (63.93%) and T_1- Spray and drench Tebuconazole @ 1 ml/l (53.46%).		
Pampadumpara	Among five treatments evaluated, T_2 (Spray and drench of Fenamidone +Mancozeb, 2 g L^{-1}). But there is no significant difference among them. Biometric observations were also recorded.		

Project Code	CAR/CP/6.12	**Project Title**	Evaluation of fungicides against leaf blight in small cardamom
Centres	Appangala, Mudigere, Myladumpara, Pampadumpara		
Date of start	2020-21	**Date of closure/ duration**	Three years
Experimental details		Plot size/spacing: 3 x 3 m, 12 plants /plot; Replications:4; Design: RBD **Treatments** T_1-Spray Carbendazim + Mancozeb @ 2g L^{-1} T_2-Spray Hexaconazole @ 2ml L^{-1} T_3-Spray Mancozeb @ 2 g L^{-1} T_3 –Spray Carbendazim @ 2g L^{-1} T_3- Recommended package of practices	
Work done/achievements during 2023-24 (centre-wise)			
Appangala	Two rounds of application of fungicides completed, observations were recorded for leaf blight during September, October – 2023 and mean were calculated. The result of the trial showed that the treatment T_2 recorded lowest disease incidence followed by T_1.		
Mudigere	The different fungicides were evaluated against leaf blight of cardamom at ZAHRS, Mudigere. Among the treatments, fungicide Tebuconazole @ 1 ml L^{-1} (4.58 PDI) showed lowest leaf blight severity and which was statistically on par with Hexaconazole @ 2 ml L^{-1} (5.42 PDI) and Carbendazim + Mancozeb @ 2g L^{-1} (5.83 PDI). The untreated control showed maximum disease severity (19.58 PDI).		
Myladumpara	Pre-treatment observations disease incidence were recorded during September 2023 and the first round of treatments was imposed in October 2023 after the notice of the disease. Subsequently the second and third round of treatments were also imposed at monthly intervals and the observations recorded. The yield data was also recorded. Highest reduction in leaf blight incidence was observed in T_3- Spray Tebuconazole @ 1 ml/l (73.02%) followed by T_2- Spray Hexaconazole @ 2 ml/l (72.047%) though the difference was not significant		
Pampadumpara	Among the five treatments evaluated, T_2 (spray hexaconazole @ 2ml/L) and T_3 (spray carbendazim @ 2g/L) reported lesser percent disease incidence as well as severity.		

Project Code	CAR/CP/6.13	**Project Title**	Observational trial on the efficacy of *Trichoderma asperelleum* & *Pochonia chlamydosporia* for the management of rhizome rot and nematode in small cardamom
Centres	Appangala, Myladumpara, Pampadumpara		
Date of start	2021	**Date of closure/ duration**	2 years (2021-22 to 2022-23)
Experimental details		Treatments: T_1- Control T_2- *T. asperellum* talc formulation (Mass multiply in cowdung:neem cake mixture (9:1). Mix *T. asperellum* talc formulation @ 1-2 kg 100kg^{-1} mixture. Apply 2-5 kg *T. asperellum* mass multiplied mixture /plant) T_3- *T. asperellum* biocapsule formulation (1biocapsule /100L water. Apply 2-3L solution /plant)	

	T_3- Metalaxyl-mancozeb (Drench the fungicidal solution (0.125 %) T_3- *Pochonia chlamydosporia* liquid formulation (Drench @1ml L^{-1}) T_3- Recommended nematicide (Drench the nematicidal solution) Crop variety: Popular improved variety of respective centre/area • Experimental design: RBD • Treatments: 6 • Replication: 4 Plot size: 3m **Date of application:** Apply 2 times - May-June and September-October
Observation Recorded	• Growth parameters • Yield and its attributes • Disease incidence • Soil population of *Fusarium* /*Pythium*/nematodes (soil samples can be sent to IISR for analysis. Samples has to be taken before imposing treatments & after imposing treatments @ July- August and Oct-Nov) • Economics- BCR, gross returns, net returns • Residue analysis
Work done/achievements during 2023-24 (centre-wise)	
Appangala	Rhizome rot disease incidence was recorded during August and September, Minimum disease incidence was recorded in T_2 (*T. asperellum* talc formulation followed by T_3 (*T. asperellum* biocapsule formulation.
Myladumpara	Pre-treatment observations on disease incidence were recorded and the first round of treatments was imposed in June 2023. Subsequently the second round of treatment was also imposed after one month and the observations recorded. The yield data was also recorded. Highest reduction in rhizome rot incidence was observed in T_2 - 78.23% (*T. asperellum* talc formulation mass multiply in cowdung: neem cake mixture 9:1, mix *T. asperellum* talc formulation @ 1-2 kg/100 kg mixture. Apply 2-5 kg *T. asperellum* mass multiplied mixture/plant) followed by T_3 – 77.60% (Metalaxyl+Mancozeb, drench the fungicidal solution 0.125%) though the difference was not significant. Highest reduction in *Fusarium* infections was observed in T_3 - 79.65% (*T. asperellum* biocapsule formulation, 1 biocapsule /100 lit water, apply 2-3 lit solution /plant) followed by T_2 (69.76%) though the difference were not significant. Highest reduction in nematode infestations (leaf rosetting) was observed in T_3- 71.86% (*Pochonia chlamydosporia* liquid formulation, drench @ 1ml/lit) followed by T_3 (67.66%) though the difference was not significant.
Pampadumpara	Among the five treatments evaluated, T_2 (T. asperellum talc formulation) recorded lesser percent disease incidence followed by T_3 and T_3. But there is no significant difference among them. Biometric observations were also recorded.

GINGER

Project Code	GIN/CP/6.15	**Project Title**	Priming of rhizomes for enhanced germination, vigour and storage rot suppression in ginger
Centres	Ambalavayal, Barapani, Chintapalli, Dholi, Kalyani, Kammarpally, Kanke, Nagaland, Pasighat, Pottangi, Pundibari, Raigarh, Solan		
Date of start	2020-21	**Date of closure/ duration**	Three years
Experimental details	Variety: Disease free rhizomes of any variety; Bed size/spacing: 3 x 1m, 40 plants /bed; 25 kg of seed; Design: RBD; Replications:6 **Treatments:** T_1-Rhizome treatment with Trichoprime T_2-Rhizome treatment with Metalaxyl-mancozeb @ 1.25g L^{-1}+ Imidacloprid 0.5 ml L^{-1} for 30 minutes T_3-Rhizome treatment with Tebuconazole @ 1ml L^{-1} + Imidacloprid 0.5 ml L^{-1} for 30 minutes T_3- Recommended state package of practices		
Observation Recorded	• Sprouting (%) • Plant population at 50 DAS • Plant height (cm) • Number of tillers per clump • Fresh weight of clump (g) • Fresh rhizome yield ha^{-1} (t) • Dry rhizome yield ha^{-1} (t) • Dry recovery (%) • Storage rot (%) • PDI – 30DAP,60 DAP, 90DAP (Rhizome rot) • Boldness of rhizome • Fiber content • Oleoresin (%) • Essential oil (%) • Disease (bacterial wilt, rhizome rot) and pest (shoot borer) incidence, if any		
Work done/achievements during 2023-24 (centre-wise)			
Ambalavayal	The treatments were found to be non-significant in relation to rhizome rot, pest, and disease incidence. Additionally, there was no occurrence of storage rot in any of the treatments.		
Barapani	Four treatment combinations were given as per the technical programme to evaluate their effects on ginger (Var. Nadia). Among the treatments, the highest sprouting % (92.59) and plant population (42.33) were recorded in T_1 (Rhizome treated with trichoprime), while the highest plant height (66.55cm) was recorded in T_2 Rhizome treatment with metalaxyl-mancozeb @ 1.25g/L+ imidaclorpid 0.5 ml/L. followed by the treatment T_1 (Rhizome treated with trichoprime (62.30 cm). However, the fresh wt /clump and yield t ha^{-1} were maximum in T_3 (Rhizome treatment with tebuconazole @ 1 ml/L+ imidaclorpid @ 0.5 ml/L (340.6g) and (14.77 t). Likewise, dry matter content was also found highest in T_3 (21.07%) and Oleoresin in T_2 (4.52%). AT 60 Days highest rhizome rot incident was recorded in T_2 Rhizome treatment with metalaxyl-mancozeb @ 1.25g/L+ imidaclorpid 0.5 ml/L and lowest in T_3, while		

	at 90 days, T_3 recommended state package and practices recorded the highest. (20.59)
Chintapalli	There is no significant difference among the treatments for different vegetative and yield characters. No storage rot disease incidence was observed among the treatments.
Dholi	All the treatments were found to have significant effect on different parameters viz., sprouting (%), plant population at 50 DAS (%), plant height, number of tillers per clump, fresh rhizome yield**/,** and rhizome rot incidence at 60 & 90 DAP (%). Storage rot was observed in none of the treatment. Maximum sprouting (92.50%), plant height (40.43 cm), fresh rhizome yield (12.89 t ha^{-1}) and lowest rhizome rot incidence (17.10 %) was recorded in treatment T_3 where, recommended state package of practices (developed by University) was adopted.
Kalyani	During 2023-24, in respect to sprouting percentage, plant population, maximum plant height, dry yield per hectare, dry recovery percentage and oleoresin (%) the highest result was recorded in Rhizome treated with Trichome (T_1), whereas Maximum clump Fresh wt., Fresh yield (t ha^{-1}) was recorded in Rhizome treatment with metalaxyl-mancozeb @1.25g/l + Imidacloprid 0.5ml/l for 30 minutes (T_2) with lowest Rhizome rot (%).
Kammarpally	To manage the rhizome rot of turmeric , four chemicals (T_1-Rhizome treatment with Trichoprime, T_2-Rhizome treatment with metalaxyl-mancozeb + Imidacloprid,T_3-Rhizome treatment with tebuconazole + Imidacloprid, T_3-Control)were used, among the T_1- Trichoprime recorded maximum yield (8.27 t ha^{-1}) followed by T_2-Metalaxyl-mancozeb + Imidacloprid (8.17 t ha^{-1}) when compare to control. PDI of 60 and 90 DAP has reduced in T_1 followed by T_2
Kanke	Rhizome of Ginger which were treated with Trichoprime had significant effect on yield. Maximum yield observed under this treatment was 10.92 t/ Ha followed by rhizomes treated with 2g/L matalaxyl- mancozeb as recommended at local level (9.90 t ha^{-1}) which were found to be at par with each other. Ginger rhizomes treated with matalaxyl- mancozeb @1.25 g/L and Imidacloprid @ 0.5 ml/L yielded 8.01 t ha^{-1} which was also at par with rhizome yield (7.33 t ha^{-1}) treated with Tebuconazole @ 1ml/L and Imidacloprid 0.5 ml/L. Yield attributing characters were also in line with the results. Storage rot was also found minimum in case of rhizome treated with Trichoprime (3.67%) as compared with maximum (5.83%) in case of T_2 i.e Rhizome treated with metalaxyl-mancozeb @1.25 g/L and Imidacloprid 0.5 ml/L for 30 min. However, it was at par with T_3.
Nagaland	Priming treatments significantly reduced the disease incidence. According to the data, T_3 produced the highest fresh rhizome yield at 25.798 t ha^{-1}, though it also showed relatively higher levels of storage rot (12.97%) and rhizome rot PDI (39.54). T_3 followed with a yield of 24.55 t ha^{-1}, accompanied by moderate storage rot (10.74%) and rhizome rot PDI (28.50). T_1, while yielding slightly lower at 23.125 t ha^{-1}, demonstrated the lowest storage rot (7.54%) and rhizome rot PDI (15.32). T_2 had the lowest yield at 22.925 t ha^{-1}, but experienced the highest storage rot (13.06%) and significant rhizome rot PDI (35.43).
Pasighat	Four treatments were given as per the technical programme to evaluate their effects on ginger (*var*. *Nadia*). Among the treatments, the highest sprouting % (93.89) and maximum plant population at 50 DAS (28.17) was recorded in T_1 (Rhizome treated with trichoprime). Highest plant height (45.49 cm) as well as number of tillers/clump (3.60) was also found highest in T_1- Trichoprime,

	followed by T_2- (Rhizome treatment with metalaxyl-mancozeb @ 1.25g L^{-1}+ imidaclorprid 0.5 ml L^{-1}) with a plant height of 41.88 cm and 3.10 number of tillers/clumps. Yield/clump (130.24 g) was highest in T_1 (Rhizome treated with trichoprime) followed by T_2 (124.07 g) that is rhizome treatment with metalaxyl-mancozeb @ 1.25g L^{-1}+ imidaclorprid 0.5 ml L^{-1}). Similarly, the yield t ha^{-1} was also maximum in T_1 (11.55 t ha^{-1}) followed by T_2 (10.57 t ha^{-1}). Highest PDI% for rhizome rot (12.45 %) was observed in T_3-(Recommended state package and practices) followed by T_1 (6.52%) and lowest in T_2 (4.19%).
Pottangi	Rhizome treatment with Trichoprime (*T.harzianum*) is found to be best followed Rhizome treatment with Metalaxyl Mancozeb @1.25gm/l +Imidacloprid @0.5ml/l for 30 minutes in ginger .
Pundibari	Highest sprouting percentage (84.33) found for treatment 2. Highest plant stand (33.83) at 50 DAS, highest plant height (56.17 cm) recorded in case treatment 2. Highest tiller no. (8.67) found for treatment 4. Lowest rhizome rot and wilt percent (11.29%) recorded in treatment 2 followed by treatment 1 (14.40%). No *Phyllosticta* leaf spot recorded. Lowest storage rot recorded in treatment 1 (3.50%). Highest yield was recorded in treatment 2 (12.22 t ha^{-1}). Highest dry recovery was recorded in treatment 1 (20.83%).
Raigarh	Minimum rhizome rot incidence (%) 16.62, storage rot (%) 7.83 and maximum yield 14.15 t ha^{-1} was found in treatment (T_2) Rhizome treatment with metalaxyl + Mancozeb @ 1.25 gm liter
Solan	Rhizome treatment with tebuconazole @ 1ml L^{-1}+ Imidacloprid 0.5 ml L^{-1} for 30 minutes (T_3) resulted in the highest rhizome germination (90.75%), number of tillers per plant (6.25), plant height (73.00 cm), and yield (99.00 q ha^{-1}), with the lowest rhizome rot incidence (14.25%). Rhizome treatment with metalaxyl-mancozeb @ 1.25g L^{-1}+ imidacloprid (0.5 ml L^{-1} for 30 minutes) (T_2) gave the second-best result.

Project Code	GIN/CP/7.1	**Project Title**	Spray schedule optimization of effective insecticides for shoot borer (*Conogethes punctiferalis*) in ginger
Centres	Ambalavayal, Barapani, Kanke, Mizoram, Mudigere, Nagaland, Pasighat, Pottangi, Pundibari, Sirsi		
Date of start	2020-21	**Date of closure/ duration**	3 years (2023-24)
Experimental details		Treatments: T_1- Chlorantraniliprole @ 0.3 ml L^{-1} T_2- Chlorantraniliprole @ 0.5 ml L^{-1} T_3- Flubendiamide @ 0.3 ml L^{-1} T_3- Flubendiamide @ 0.5 ml L^{-1} T_3- Spinosad @ 0.3 ml L^{-1} T_3- Spinosad @ 0.5 ml L^{-1} T_7- Chlorantraniliprole + Spinosad @ 0.5 ml L^{-1} (alternatively) T_8- Control (water spray) Crop variety: Popular improved variety of respective centre/area. Experimental design: RBD; Treatments: 8; Replication: 4 Date of first sprays: 45 days after planting; Subsequent sprays**:** at fortnightly intervals (maximum no. of sprays limited to 7)	

Observation Recorded	• Growth parameters • Yield and its attributes • Pre-treatment count (no of shoots/clump and no of infested • shoots/clump) • Final count: 15-20 days after the last spray (no of shoots/clump • and no of infested shoots/clump) • Economics- BCR, gross returns, net returns • Residue analysis
Work done/achievements during 2023-24 (centre-wise)	
Ambalavayal	No residues were detected in any of the treatments, with all chemical levels below the quantification limit (BQL). The results indicate that the chemical treatments were equally effective in controlling shoot borer damage in ginger. Only the control treatment (T_8) showed higher pest incidence.
Barapani	This experiment was conducted with Nadia variety and treatments were applied as per the technical programme. Among the treatments, the highest plant height was found in T_1 Chlorantraniliprole @ 0.3 ml L-1 (72.80cm) followed byT_3 Flubendiamide @ 0.3 ml L-1(69.83cm). Likewise total number (21.5) and leaf length (24.00cm) were found highest in T_1 Chlorantraniliprole @ 0.3 ml L-1. However, the number of shoots /clump (3.5) was found highest in T_2 Chlorantraniliprole @ 0.5 ml L-1, while the number of infected shoots /clump was found to be maximum in T8 water spray (1.25), whereas there was no infected shoots in the other treatments .As far as yield parameters are concerned, T_3 Spinosad @ 0.3 ml L-1 recorded the highest fresh weight /clump (439.43g) and Yield t ha^{-1} (17.18t).
Kanke	Spray of insecticide affected significantly on Ginger Rhizome yield and yield attributing characters. Spray of Chlorantraniliprole + Spinosad @ 0.5 ml/Lit (alternatively) enhanced (T_7) the fresh rhizome yield from 8.55 t ha^{-1} (control) to 13.26 t ha^{-1} which was at par with T_3 , T_3, T_3 and T_3.. It concludes that insecticide should be sprayed to get higher and healthy yield.
Mizoram	During the study, the infestation of the shoot borer was not observed irrespective of treatment. The result from the experiment showed that application of chlorantraniliprole + spinosad @ 0.5 ml L^{-1} (alternately) at fortnightly intervals was found very effective that resulted in good ginger growth, higher yield attributes, and ultimately higher fresh rhizome yield (20.9 t ha^{-1}) as compared to other insecticide treatments.
Mudigere	Application of application of chlorantraniprole @ 0.5 ml/ litre found to be effective against shoot borer in ginger.
Nagaland	Among the eight treatment combinations, the sprouting percentage significantly varied from 27.62% in T_3 to 54.29% in T_7. Plant height was recorded highest in T_8 (40.07 cm), and lowest was recorded in T_1 (22.41 cm) treated plots. It was also recorded that number of tillers per clump infested highest in T_3 (4.00) followed by T_2 (3.40).Yield per clump was highest in T_8 (41.87 g) and lowest in T_2 (9.91 g). The projected yield was highest in T_7 (2.68 t ha^{-1}), followed by T_2 (2.41 t ha^{-1}). The highest BC Ratio was recorded in T_2 (3.48), with the lowest in T_3 (2.09). and no infestation noticed in T_1 and T_3 treated plants.
Pasighat	This experiment was conducted with Nadia variety and treatments were applied as per the technical programme. The results showed that there was no

	significant difference among the treatments, however, the highest plant height was found in T_1- Chlorantraniliprole @ 0.3 ml L^{-1} (44.2 cm) followed by T_3- Flubendiamide 0.3 ml L^{-1} (43.0 cm) and the lowest plant height was recorded in T_3 – Spinosad 0.3 ml L^{-1} (38.4 cm). Highest number of tillers/clump (3.50) was recorded in T_3- Flubendiamide 0.3 ml L^{-1} and highest number of leaves/plant (14.30) was recorded in T_2- Chlorantraniliprole 0.5 ml L^{-1}. Maximum infested shoots/clump (0.40) was recorded in T_8- control followed by T_1- Chlorantraniliprole 0.3 ml L^{-1} (0.35). As far as yield is concerned, highest yield/clump and yield per ha (121.7 g, 11.6 t ha^{-1}) was observed in T_3- Flubendiamide 0.5 ml L^{-1} followed by T_1- Chlorantraniliprole 0.3 ml L^{-1} (116.0 g, 11.2 t ha^{-1}), respectively.
Pottangi	Spaying of Chlorantraniliprole and Spinosad @ 0.5 ml L-1 (alternatively is found to be best followed by spaying with Chlorantraniliprole @ 0.5 ml L-1
Pundibari	Highest sprouting percentage (93.75%) were found for treatments 1. An average of 7.3to 9.8 tiller no found in the plant population. No infested shoot was found during 2023-24 before and after spray at Pundibari Centre. Highest plant height (65.75 cm) recorded in $T_1$and highest leaf length (22.80 cm) recorded in T_3. Highest yield (12.02 t ha^{-1}) recorded in treatment 7 which is closely followed by T_1 (11.93 t ha^{-1}.)
Sirsi	Among the different treatments, T_2 (Chlorantraniliprole) @ 0.05% recorded significantly least shoot borer incidence (13.33%) and it was found on par with T_7 (alternatively sprayed with Chlorantraniliprole and Spinosad) @ 0.05% with the incidence of 15.52 %, T_3 (Spinosad @ 0.03) (15.74%). T_3 (Flubendiamide) @ 0.05% (15.95%), T_3 (Spinosad) @ 0.05 (16.27%), T_1 (Chlorantraniliprole) @ 0.03% (16.62%). Next best treatments were T_3 (Flubendiamide) @ 0.03% (19.84%). However, the control T_8 (water spray) recorded highest shoot borer incidence (22.58%).

Project Code	GIN/CP/7.2	**Project Title**	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		
Date of start	2021-22	**Date of closure/ duration**	2 years (2021-22 to 2022-23)
Experimental details	Treatments: T_1- Control T_2- *T. asperellum* talc formulation (Mass multiply in cowdung: neem cake mixture (9:1). Mix *T. asperellum* talc formulation @1-2 kg 100kg^{-1} mixture. Apply 2-5kg *T. asperellum* mass multiplied mixture /bed) T_3- Metalaxyl-mancozeb (Drench the fungicidal solution (0.125 %) T_3- *Pochonia chlamydosporia* liquid formulation (Drench @1ml L^{-1}) T_3- Recommended nematicide (Drench the nematicidal solution) Crop variety: Popular improved variety of respective centre/area. • Experimental design: RBD		

	• Treatments: 5 • Replication: 4 • Bed size: 3 x1m • Spacing: 15x30 cm Total no. of beds: 20 Date of application: At the time of planting 30 days after planting (DAP) 60 days after planting (DAP)
Observation Recorded	• Growth parameters • Yield and its attributes • Disease incidence • Soil population of *Fusarium*/*Pythium*/nematodes (soil samples can be sent to IISR for analysis. Samples has to be taken before imposing treatments & after imposing • treatments @ July- August and Oct-Nov) • Economics- BCR, gross returns, net returns • Residue analysis
Work done/achievements during 2023-24 (centre-wise)	
Barapani	This experiment was conducted with Nadia variety and treatments were applied as per the technical programme. Among the treatments, the highest plant height, number of leaves, leaf length and leaf breadth were recorded in T_2- T. asperellum (66.4cm), (30.5), (25.90cm) and (2.5 cm) respectively. However, the fresh weight /clump and yield t ha^{-1} were found highest in T_3- Pochonia chlamydosporia (391.21 g) and 16.09 t ha^{-1} respectively. Highest rhizome rot incidence at 60 and 90 DAS were recorded in T_3- Recommended nematicide (19.12% and 15.27%), respectively, while minimum rhizome rot were recorded in T_2- T. asperellum (11.71% and 10.22%) respectively.
Chintapalle	Among the different treatments, more plant height (60.23 cm) fresh rhizome yield per plant (309.52 g) and yield per hectare (20.27 t) were recorded in application of *Pochonia* formulation. More number of tillers (10.78) was observed in application of *T. asperellum* talc. No nematodes incidence was recorded among the treatments.
Kozhikode	Treatments were imposed as per the schedule and population of fungal pathogens and nematodes were enumerated before and after imposing different treatments. Soil samples analyzed after imposing treatments recorded reduction in the viable colony units of *Phytophthora* and *Pythium* after the application biocontrol agents, Trichoderma asperellum and *Pochonia chlamydosporia.* Soft rot disease was observed in ginger 30 days after planting and maximum PDI was observed in treatments T_1 (control) and T_3 (*Pochonia chlamydosporia* liquid formulation) and it ranged 0-15 %. Whereas in treatments T_3 (*T. asperellum* talc formulation), T_3 (*T. asperellum* biocapsule formulation) and T_3 (Metalaxyl-mancozeb (0.125 %) the PDI ranged from 0-5%.
Pottangi	Rhizome treatment with T. asperellum talc formulation (Mass multiply in cowdung :neem cake mixture (9:1) is found to be best

TURMERIC

<table>
<tr><td>Project Code</td><td>TUR/CP/7.8</td><td>Project Title</td><td>Priming of rhizomes for enhanced germination, vigour and storage rot suppression in turmeric</td></tr>
<tr><td>Centres</td><td colspan="3">Ambalavayal, Chintapalli, Coimbatore, Dholi, Kammarpally, Kahikuchi, Kanke, Kumarganj, Mizoram, Pasighat, Pottangi, Pundibari, Raigarh, Solan</td></tr>
<tr><td>Date of start</td><td>2020</td><td>Date of closure/ duration</td><td>Three years (2023-24)</td></tr>
<tr><td colspan="2">Experimental details</td><td colspan="2">Variety: - Disease free rhizomes of any variety; Bed size/spacing: 3 x 1m, 40 plants /bed; 25 kg of seed; Design: RBD; Replications:6
Treatments:
T_1-Rhizome treatment with Trichoprime
T_2-Rhizome treatment with metalaxyl-mancozeb @ 1.25g L^{-1}+ Imidacloprid 0.5 ml L^{-1} for 30 minutes
T_3-Rhizome treatment with Tebuconazole @ 1ml L^{-1} + Imidacloprid 0.5 ml L^{-1} for 30 minutes
T_3- Recommended state package of practices</td></tr>
<tr><td colspan="2">Observation Recorded</td><td colspan="2">• Sprouting (%)
• Plant population at 50 DAS
• Plant height (cm)
• Number of tillers per clump
• Fresh weight of clump (g)
• Fresh rhizome yield ha^{-1} (t)
• Dry rhizome yield ha^{-1} (t)
• Dry recovery (%)
• Storage rot (%)
• PDI – 30 DAP,60 DAP, 90 DAP (Rhizome rot)
• Curcumin content (%)
• Oleoresin (%)
• Essential oil (%)
• Disease (rhizome rot) and pest (shoot borer) incidence, if any</td></tr>
<tr><td colspan="4">Work done/achievements during 2023-24 (centre-wise)</td></tr>
<tr><td>Ambalavayal</td><td colspan="3">In the priming treatment in turmeric, treatment differences were non-significant with respect to control of storage rot and rhizome rot. However, leaf blotch incidence at 150 days after planting (DAP) negatively impacted the overall turmeric yield</td></tr>
<tr><td>Chintapalli</td><td colspan="3">There is no significant difference among the treatments for different vegetative and yield characters. No storage rot and rhizome rot disease incidence was observed among the 4 treatments.</td></tr>
<tr><td>Coimbatore</td><td colspan="3">Results indicate the complete suppression of storage rot. Turmeric rhizomes treated with Trichoprime showed the highest fresh rhizome yield (28.69 t ha^{-1}). The Trichoprime treatment also significantly controlled the severity of foliar diseases viz., leaf spot (PDI 4.89) and leaf blotch (PDI 5.64) as compared to the recommended state package of practices (PDI: 15.17 and 12.19 PDI, respectively).</td></tr>
</table>

Dholi	Except yield**, a**ll the treatments were found to have non-significant effect on different parameters viz., sprouting (%), plant population at 50 DAS (%), plant height (cm) and number of tillers per clump. Highest fresh rhizome yield (45.05 t/ ha) was recorded in treatment T_3 where, recommended state package of practices (developed by University) was adopted. Neither storage rot nor rhizome rot incidence was recorded at either day of observation *i.e.*, 30, 60 & 90 DAS.
Kammarpally	Among the treatments used to manage rhizome rot in turmeric, T_1 (Rhizome treatment with Trichoprime) recorded the highest yield (31.57 t ha^{-1}), followed by T_3 (29.75 t ha^{-1}), compared to the control. Percent Disease Index (PDI) at 60 and 90 days after planting (DAP) was also reduced in T_1, followed by T_2.
Kahikuchi	Treatment T_3, (rhizome treatment with Tebuconazole + Imidacloprid), demonstrated remarkable superiority in various aspects. It exhibited the highest sprouting percentage (96.48%) and the lowest incidence of rhizome rot at 90 DAP (3.42%). Moreover, T_3 also yielded the best results in terms of storage rot reduction in stored rhizome up to fourth week of storage, fresh rhizome yield (21.87 t ha^{-1}), dry rhizome yield (4.32 t ha^{-1}), and curcumin content (5.77).
Kanke	Turmeric rhizome treated with *Trichoprime* had significant effect on yield. Maximum yield observed under this treatment was 33.023 t/ Ha followed by rhizomes treated with metalaxyl-mancozeb @ 2g/L (T_3) which is considered as recommended dose at local level (30.240 t ha^{-1}). Priming of Rhizome with matalaxyl- mancozeb @1.25 g/L and Imidacloprid @ 0.5 ml/L(T_2) yielded 27.958 t ha^{-1} which was also at par with the above both. rhizome treated with Tebuconazole @ 1ml/L and Imidacloprid @0.5 ml/L (T_3) yielded 26.955 t ha^{-1}. Yield attributing characters were also found in same line. Storage rot was found minimum (4%) in case of rhizome treated with T_3- Rhizome treatment with metalaxyl-mancozeb @ 2g/L for 30 min. which was at par with T_1 i.e Trichoprime treated Rhizomes (4.50%).
Kumarganj	In Priming of rhizomes for enhanced germination, vigour and storage rot suppression in turmeric four treatments were tested, among these treatment, T_1-Rhizome treated with *Trichoprime*recorded highest fresh rhizome yield (37.67 t ha^{-1}) followed by in T-2 treatment (yield 34.75 t ha^{-1})-Rhizome treated with metalaxyl-mancozeb @ 1.25g/L+ Imidacloprid 0.5 ml/L and in Treatment T_3-Rhizome treated with tebuconazole @ 1ml /L+ Imidacloprid 0.5 ml/L (yield 32.33 t ha^{-1}). The lowest yield was recorded in T-4 treatment- rhizome treated with Carbendazim-(30.59 t ha^{-1}).
Mizoram	The results indicate that rhizome priming enhances germination, vigor, and yield. Turmeric rhizomes primed with Trichoprime (T_1) recorded significantly higher sprouting percentage (94.33%), plant height (123.77 cm), fresh clump weight (278.90 g), fresh rhizome yield (27.08 t ha^{-1}), and dry rhizome yield (6.34 t ha^{-1}). T_2 recorded the highest tillers per plant (3.11) but lower clump weight (229.63 g) and the least in recommended state package of practices without priming (T_3).
Pasighat	Among the treatments, T_1 (Rhizome treated with Trichoprime) exhibited superior results with the highest sprouting percentage (92.78%), plant height (116.08 cm), number of tillers per clump (3.30), yield per clump (187.39 g), and yield per hectare (18.31 t ha^{-1}). In contrast, T_3 (Recommended state package and practices) had the highest rhizome rot incidence (10.64%), while T_2

	(Rhizome treatment with metalaxyl-mancozeb and imidacloprid) also performed well in terms of yield and plant characteristics.
Pottangi	Rhizome treatment with Trichoprime.(T.harzianum) is found to be best followed Rhizome treatment with Metalaxyl Mancozeb @1.25gm/l +Imidacloprid @0.5ml/l for 30 minutes in turmeric
Pundibari	For all the treatment 100 percent sprouting was noticed. Highest plant height (98.17 cm) and tiller no (2.83) was noticed for treatment 1. No rhizome rot and wilt and leaf blotch incidence recorded. Lowest leaf spot (PDI 2.96) recorded in treatment 3. Lowest storage rot percentage (1.11) recorded in treatment 1 followed by treatment 2 and 3 (1.67). Highest yield (26.38 t ha^{-1}) was recorded in treatment 3 followed by treatment 1 (25.95t ha^{-1}). Highest dry recovery (21.49%) recorded for treatment 1.
Raigarh	Maximum yield was obtained(24.23 t ha^{-1}) in rhizome treatment with Tebuconazole @ 1ml /litre+Imidachloprid 0.5 ml /litre for 30 minutes tretemnt T_3.
Solan	Rhizome treatment with tebuconazole @ 1ml L^{-1}+ Imidacloprid 0.5 ml L^{-1} (T_3) for 30 minutes resulted in highest rhizome germination (91.00%), number of tillers per plant (6.00), plant height (118.50cm) and yield (182.00 q ha^{-1}) with a minimum rhizome rot incidence (18.00%). This was followed by rhizome treatment with metalaxyl-mancozeb @ 1.25g L^{-1}+ imidacloprid (0.5 ml L^{-1} for 30 minutes) and giving the second-best increase in horticultural parameters.

Project Code	TUR/CP/7.9	**Project Title**	Spray schedule optimization of effective insecticides for shoot borer (*Conogethes punctiferalis*) in turmeric
Centres	Ambalavayal, Barapani, Guntur, Kammarpally, Kanke, Mizoram, Mudigere, Pasighat, Pottangi, Pundibari, Sirsi		
Date of start	2021-22	**Date of closure/ duration**	3 years (2023-24)
Experimental details	Treatments: T_1- Chlorantraniliprole @ 0.3 ml L^{-1} T_2- Chlorantraniliprole @ 0.5 ml L^{-1} T_3- Flubendiamide @ 0.3 ml L^{-1} T_3- Flubendiamide @ 0.5 ml L^{-1} T_3- Spinosad@ 0.3 ml L^{-1} T_3- Spinosad @ 0.5 ml L^{-1} T_7- Chlorantraniliprole + Spinosad @ 0.5 ml L^{-1} (alternatively) T_8- Control (water spray) Crop variety: Popular improved variety of respective centre/area. Experimental design: RBD; Treatments: 8; Replication: 4 Date of first spray: 45 days after planting; Subsequent sprays**:** at fortnightly intervals (maximum no of sprays limited to 7)		
Observation Recorded	• Growth parameters • Yield and its attributes • Pre-treatment count (no of shoots/clump and no of infested shoots/clump) • Final count: 15-20 days after the last spray (no of shoots/clump and no of infested shoots/clump) • Economics- BCR, gross returns, net returns		

	• Residue analysis
Work done/achievements during 2023-24 (centre-wise)	
Ambalavayal	The result indicates that chemical treatments were on par in controlling the shoot borer damage in turmeric. Only the control treatment had slightly more pest incidence. Comparatively shoot borer attack is less in turmeric
Barapani	This experiment was conducted with Megha Turmeric1 and treatments were applied as per the technical programme. Among the treatments, the highest plant height was found in T_3 Flubendiamide @ 0.5 ml L-1 (112.45cm) followed by T_3 Flubendiamide @ 0.3 ml L-1. (110.63 cm). Likewise total number of leaves (13.75) and leaf length (53.60 cm) were found highest in T_3 Spinosad @ 0.3 ml L-1. The number of shoots /clump was found highest in T_1 Chlorantraniliprole @ 0.3 ml L-1. (4.75). However, no infected shoots were found in other treatments. As far as yield parameters are concerned, T_1 Chlorantraniliprole @ 0.3 ml L-1recorded the highest fresh weight /clump (488.21g) and Yield t ha^{-1} (17.32t).
Guntur	During 2023-24, the final psuedostem damage after three sprays significantly lowered in all the insecticide treatments over control. Among the insecticides, Chlorantraniliprole + Spinosad @ 0.5 ml L^{-1} (alternatively) recorded significantly higher yield compared to the control and was on par with the treatments viz., T_2 (Chlorantraniliprole @ 0.5 ml L^{-1}), T_3 (Flubendiamide @ 0.5 ml L^{-1}) and T_3 (Spinosad @ 0.5 ml L^{-1}).
Kammarpally	To manage the shoot borer in turmeric, different treatments (T_1- Chlorantraniliprole @ 0.3 ml L-1, T_2- Chlorantraniliprole @ 0.5 ml L-1 , T_3- Flubendiamide @ 0.3 ml L-1 , T_3- Flubendiamide @ 0.5 ml L-1 , T_3- Spinosad@ 0.3 ml L-1 , T_3- Spinosad @ 0.5 ml L-1) T7- Chlorantraniliprole + Spinosad @ 0.5 ml L-1 (alternatively), T8- Control (water spray) were formulated, among the treatments maximum yield was observed from T_2- (36.46 t ha^{-1}) followed by T_3-(32.66 t ha^{-1}) when compare to control. Maximum reduction of pest infection was noticed in T_2 followed by T_3. The shoot infection was less in T_2 treatment (0.92%).
Kanke	Spray of insecticide affected significantly on Turmeric Rhizome yield and yield attributing characters. Spray of Chlorantraniliprole + Spinosad @ 0.5 ml/Lit (alternatively) enhanced (T7) the fresh rhizome yield from 24.35 t ha^{-1} (control) to 29.27 t ha^{-1} which was at par with all the treatments except control.. It concludes that insecticide should must be sprayed to get higher and healthy yield by getting minimum infestation of shoot borer.
Mizoram	During the study, infestation of shoot borer was not observed irrespective of treatment. Result showed that application of chlorantraniliprole + spinosad @ 0.5 ml L^{-1} (alternately) at fortnightly intervals found very effective that resulted in good turmeric growth, higher yield attributes and ultimately higher yield (13.13 t ha^{-1}) at par with flubendiamide @ 0.3 ml/L (12.93 t ha^{-1}).as compared to other insecticide treatments.
Mudigere	Application of application of chlorantraniprole @ 0.5 ml/ litre found to be effective against shoot borer in Turmeric.
Pasighat	This experiment was conducted with *Nadia* variety and treatments were applied as per the technical programme. The results showed that there was no significant difference among the treatments, however, the highest plant height was found in T_1- Chlorantraniliprole @ 0.3 ml L^{-1} (104.53 cm) followed by T_3- Flubendiamide 0.5 ml L^{-1} (100.23 cm) and the lowest plant height was recorded in T_3 – Spinosad 0.3 ml L^{-1} (95.23 cm). Highest number of tillers/clump (3.40)

	was recorded in T_1- Chlorantraniliprole @ 0.3 ml L^{-1}, whereas, highest number of leaves/plant (7.45) was recorded in T_3- Flubendiamide 0.3 ml L^{-1} and lowest in T_3 – Spinosad 0.5 ml L^{-1} (6.55). Maximum infested shoots/clump (0.55) was recorded in T_8- Control followed by T_3- Flubendiamide 0.3 ml L^{-1} (0.32). As far as yield is concerned, highest yield/clump and yield per ha (152.08 g, 15.04 t ha^{-1}) was recorded in T_1- Chlorantraniliprole @ 0.3 ml L^{-1} followed by T_3- Flubendiamide 0.5 ml L^{-1} (143.08 g, 13.83 t ha^{-1}), respectively.
Pottangi	Spaying of Chlorantraniliprole and Spinosad @ 0.5 ml L-1 (alternatively is found to be best followed by spaying with Chlorantraniliprole @ 0.5 ml L-1
Pundibari	Good sprouting percentage were found for all the treatments. An average of 3.63 to 4.02 no of shoot found before infestation of shoot borer. No infested shoot was found before the spray. No of shoot borer infested shoots found at Pundibari during 2023-24 after spray also. Highest plant growth recorded in case of treatment 1 in respect of plant height, leaf length and leaf width. Highest yield (21.59 t ha^{-1}) recorded in case of treatment 2 which is closely followed by T_1 and T7 (21.35t ha^{-1} and 21.07t ha^{-1} respectively.)
Sirsi	Among the different treatments, treatment T_2 (Chlorantraniliprole) @ 0.05% recorded significantly least shoot borer incidence of 10.09 per cent, and it was found on par with T_7 (alternatively sprayed with Chlorantraniliprole and Spinosad @ 0.05 %) (10.48 %) T_3 (Flubendiamide @ 0.05%) (10.78 %), T_3 (Spinosad @ 0.05) (11.10 %). However, the control T_8 (water spray) recorded highest shoot borer incidence (27.87 %).

Project Code	TUR/CP/7.10	**Project Title**	Observational trial on the efficacy of *Trichoderma asperellum* and *Pochonia chlamydosporia* for the management of rhizome rot and nematode in turmeric
Centres	Barapani, Coimbatore, Guntur, Kozhikode		
Date of start	2021-22	**Date of closure/ duration**	2 years (2021-22 to 2022-23)
Experimental details		Treatments: T_1- Control T_2- *T. asperellum* talc formulation (Mass multiply in cowdung: neem cake mixture (9:1). Mix *T. asperellum* talc formulation @1-2 kg per 100kg mixture. Apply 2-5kg *T. asperellum* mass multiplied mixture per bed) T_3- Metalaxyl-mancozeb (Drench the fungicidal solution (0.125 %) T_3- *Pochonia chlamydosporia* liquid formulation (Drench @1ml L^{-1}) T_3- Recommended nematicide (Drench the nematicidal solution) Crop variety: Popular improved variety of respective centre/area. • Experimental design: RBD • Treatments : 5 • Replication: 4 • Bed size: 3 x1m^2 ; 40 plants/bed • Spacing: 15x30 cm • Total no. of beds: 20 Time of application: At the time of planting	

	30 days after planting (DAP) 60 days after planting (DAP)
Observation Recorded	• Growth parameters • Yield and its attributes • Pre-treatment count (no of shoots/clump and no of infested shoots/clump) • Final count: 15-20 days after the last spray (no of shoots/clump and no of infested shoots/clump) • Economics- BCR, gross returns, net returns • Residue analysis
Work done/achievements during 2023-24 (centre-wise)	
Barapani	This experiment was conducted with Megha Turmeric 1 and treatments were applied as per the technical programme. Among the treatments, the highest plant height was recorded in T_2-T. Asperellum (107.6cm), while the number of leaves per plant in T_3- Pochonia chlamydosporia (13.93) followed by T_2 -T. Asperellum (11.88). T_2 also recorded the highest leaf length and breadth. (52.58 cm) and (15.73 cm) respectively. However, T_3- Pochonia chlamydosporia recorded the fresh wt/clump as well as yield t ha^{-1} (445.28g and 17.22 t) respectively. The highest rhizome rot incidence at 60 DAS was recorded in T_1 (10.17%), while minimum rhizome rot was recorded in T_3- Pochonia chlamydosporia (5.28%).
Coimbatore	The results showed that the different treatment combinations were able to improve the plant growth parameters of turmeric var. CO 2. Rhizome rot disease was completely absent in all the treated plots. Rhizome rot disease was completely absent in all the treated plots except in control with 10.80% rhizome rot incidence and 7.25% incidence in nematicide treatment. The treatment T_2 (application of Trichoderma asperellum talc formulation) recorded the highest fresh rhizome yield of 29.10 t ha^{-1}, followed by T_3 (soil drenching with metalaxyl-mancozeb @ 0.125%) with a fresh rhizome yield of 27.83 t ha^{-1}.
Guntur	All the treatments imposed showed non-significant results for the management of rhizome rot and nematodes in turmeric using *Trichoderma asperellum* & *Pochonia chlamydosporia.*
Kozhikode	Among treatments, T_2 (*T.asperellum* talc formulation) yielded the highest fresh yield at 18.35 t ha^{-1}, while T_1 (Control) had the lowest yield at 10.31 t ha^{-1}. The lowest disease incidence was also recorded in T_2 (2.67%), followed by T_3 (3.40%). T_1 (Control) had the highest disease incidence at 8.9%. T_2 and T_3 treatments were effective in reducing rhizome rot disease. At the initial stage, the nematode soil population was similar among all treatments. However, at the final stage, T_3 (Nematicide Drenching) had the lowest nematode soil population at 30.75 N/100cc soil, while T_3 (*P.chlamydosporia*) had the highest at 47.5 N/100cc soil. This suggests that T_3 & T_3 was effective in reducing the nematode population in the soil.

CUMIN

Project Code	CUM/CP/7.1	**Project Title**	Eco-friendly management of cumin blight
Centres	Jaugdan, Jobner, Mandor.		
Date of start	2022-23	**Date of closure/ duration**	3 years

Experimental details

- Experimental Design: RBD
- Replication: 3
- Variety: Gujarat Cumin 4 (GC 4)
- Plot Size and Spacing: 4m x 3.0 m(Gross), 3.0 m x 24 m (Net), 30 cm row spacing,
- Seed Rate: 10-12 kg ha^{-1}.
- Sowing time: October – November

Treatments: 11

T_1	Seed treatment	*Pseudomonas fluorescens* 1.15 WP ($1x10^8$ cfu g^{-1}) @ 10 g Kg^{-1} seed
	Precautionary sprays (4 sprays)	*Pseudomonas fluorescens* 1.15 WP ($1x10^8$ cfu g^{-1}) @ 50 g $10L^{-1}$ water
T_2	Seed treatment	*Pseudomonas fluorescens* 1.15 WP ($1x10^8$ cfu g^{-1}) @ 10 g Kg^{-1} seed + *Trichoderma harzianum* 1.15 WP ($2x10^6$ cfu g^{-1}) @ 10 g Kg^{-1} seed
	Precautionary sprays (4 sprays)	*Pseudomonas fluorescens* 1.15 WP ($1x10^8$ cfu g^{-1}) @ 50 g $10L^{-1}$ water + *Trichoderma harzianum* 1.15 WP ($2x10^6$ cfu g^{-1}) @ 50 g $10L^{-1}$ water
T_3	Seed treatment	*Pseudomonas fluorescens* 1.15 WP ($1x10^8$ cfu g^{-1}) @ 10 g Kg^{-1} seed + *Trichoderma viride* 1.15 WP ($2x10^6$ cfu g^{-1}) @ 10 g Kg^{-1} seed
	Precautionary sprays (4 sprays)	*Pseudomonas fluorescens* 1.15 WP ($1x10^8$ cfu g^{-1}) @ 50 g $10L^{-1}$ water + *Trichoderma viride* 1.15 WP ($2x10^6$ cfu g^{-1}) @ 50 g $10L^{-1}$ water
T_3	Seed treatment	*Trichoderma harzianum* 1.15 WP ($2x10^6$ cfu g^{-1}) @ 10 g Kg^{-1} seed
	Precautionary sprays (4 sprays)	*Trichoderma harzianum* 1.15 WP ($2x10^6$ cfu g^{-1}) @ 50 g $10L^{-1}$ water
T_3	Seed treatment	*Trichoderma viride* 1.15 WP ($2x10^6$ cfu g^{-1}) @ 10 g Kg^{-1} seed
	Precautionary sprays (4 sprays)	*Trichoderma viride* 1.15 WP ($2x10^6$ cfu g^{-1}) @ 50 g $10L^{-1}$ water
T_3	Seed treatment	*Bacillus subtilis* 1.15 WP ($1x10^8$ cfu g^{-1}) @ 10 g Kg^{-1} seed
	Precautionary sprays (4 sprays)	*Bacillus subtilis* 1.15 WP ($1x10^8$ cfu g^{-1}) @ 40 g $10L^{-1}$ water
T_7	Seed treatment	*Bacillus subtilis* 1.15 WP ($1x10^8$ cfu g^{-1}) @ 10 g Kg^{-1} seed + *Trichoderma harzianum* 1.15 WP ($2x10^6$ cfu g^{-1}) @ 10 g Kg^{-1} seed
	Precautionary sprays (4 sprays)	*Bacillus subtilis* 1.15 WP ($1x10^8$ cfu g^{-1}) @ 40 g $10L^{-1}$ water + *Trichoderma harzianum* 1.15 WP ($2x10^6$ cfu g^{-1}) @ 50 g $10L^{-1}$ water
T_8	Seed treatment	*Bacillus subtilis* 1.15 WP ($1x10^8$ cfu g^{-1}) @ 10 g Kg^{-1} seed + *Trichoderma viride* 1.15 WP ($2x10^6$ cfu g^{-1}) @ 10 g Kg^{-1} seed
	Precautionary sprays (4 sprays)	*Bacillus subtilis* 1.15 WP ($1x10^8$ cfu g^{-1}) @ 40 g $10L^{-1}$ water + *Trichoderma viride* 1.15 WP ($2x10^6$ cfu g^{-1}) @ 50 g $10L^{-1}$ water
T_9	Seed treatment	*Bacillus subtilis* 1.15 WP ($1x10^8$ cfu g^{-1}) @ 10 g Kg^{-1} seed + *Pseudomonas fluorescens* 1.15 WP ($1x10^8$ cfu g^{-1}) @ 10 g Kg^{-1} seed
	Precautionary sprays (4 sprays)	*Bacillus subtilis* 1.15 WP ($1x10^8$ cfu g^{-1}) @ 40 g $10L^{-1}$ water + *Pseudomonas fluorescens* 1.15 WP ($1x10^8$ cfu g^{-1}) @ 50 g $10L^{-1}$ water
T_{10}	Standard chemical Check (3 sprays)	Three sprays of kresoxim- methyl 44.3 SC @ 0.044 % (10 ml $10L^{-1}$ water) (First spray at 35 days after germination and subsequent two spays at 10 days interval after first spray)
T_{11}	Control	Water spray

Note: Common furrow application of neem cake @ 1 t ha^{-1} will be made at the time of sowing Standard package of practices should be followed.

Observation Recorded	• Percent disease intensity (PDI) after last spray • Seed yield (q ha^{-1}) • 1000 seed weight • Volatile oil (%) • Fungicide residue analysis, if requires • Economics and cost benefit ratio
Work done/achievements during 2023-24 (centre-wise)	
Jaugdan	There was a significant difference in the percent disease intensity of blight and yield of cumin during the experimentation. The minimum blight intensity of 25.25 % and the maximum yield (7.14 q ha^{-1}) were observed in T_{10} (three sprays of kresoxim methyl @ 0.044%) and closely followed by $T_{9.}$ A similar trend was recorded in the case of 1000 seed weight and volatile oil percent.
Jobner	The results revealed that among the treatments, three sprays of kresoxim- methyl 44.3 SC @ 0.044 % standard chemical check was recorded most effective in controlling cumin blight with lowest disease intensity(9.50%) followed by four spray of *Bacillus subtilis* 1.15 WP ($1x10^8$cfu/g) @ 40 g / 10 L water + *Pseudomonas fluorescens* 1.15 WP ($1x10^8$cfu/g) @ 50 g / 10 L water(19.08%), andfour spray *Pseudomonas fluorescens* 1.15 WP ($1x10^8$cfu/g) @ 50 g / 10 L water + *Trichoderma viride* 1.15 WP ($1x10^6$cfu/g) @ 50 g / 10 L water (22.92%)in comparison to untreated check (45.58%). Maximum yield (5.54 q ha^{-1}) was obtained by three sprayings of kresoxim- methyl 44.3 SC @ 0.044 % standard chemical Check followed by *Bacillus subtilis* 1.15 WP + *Pseudomonas fluorescens* 1.15 WP (4.72 q ha^{-1}) and *Pseudomonas fluorescens* 1.15 WP + *Trichoderma viride* 1.15 WP (4.37q ha^{-1}).
Mandor	The maximum seed yield was recorded in three sprays of three sprays of 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) (899 kg ha^{-1}) which was followed by Seed treatment of *Bacillus subtilis* 1.15 WP ($1x10^8$ cfu/g) @ 10 g / kg seed + *Pseudomonas fluorescens* 1.15 WP ($1x10^8$ cfu/g) @ 10 g / kg seed + Precautionary sprays (4 sprays) *Bacillus subtilis* 1.15 WP ($1x10^8$ cfu/g) @ 40 g / 10 L water + *Pseudomonas fluorescens* 1.15 WP (1x108 cfu/g) @ 50 g / 10 L water (13.33%) (805 kg ha^{-1}). However, in control maximum (40%) disease intensity of blight and minimum seed yield (367 kg ha-1) were recorded under the control.

FENUGREEK

Project Code	FGK/CP/7.1	**Project Title**	Bio-efficacy of fungicides against powdery mildew of fenugreek.
Centres	Coimbatore, Hisar, Jabalpur, Jagudan, Jobner, Kota.		
Date of start	2022-23	**Date of closure/ duration**	3 years
Experimental details	• Experimental Design: RBD • Replication: 3 • Plot Size and Spacing: 3 x 2.5 m; spacing: 30 x 10 cm • Sowing time: October – November <u>Treatments: 7</u> T_1 = Two foliar spray of Azoxystrobin 23 % EC @ 0.1% T_2 = Two foliar spray of Tebuconazole 25.9 % EC @ 0.1%		

	T_3 = Two foliar spray of Hexaconazole 5% SC @ 0.1% T_3 = Two foliar spray of Propiconazole 25% EC @ 0.1% T_3 = Two foliar spray of Myclobutanil 10% WP @ 0.05% T_3 = Package of respective SAUs (Standard check) T_7 = Control Note: The aforesaid treatments will be applied twice at 15-day intervals starting from the appearance of the disease.
Observation Recorded	• Percent disease intensity (PDI) (Powdery mildew) • Test weight 1000 seeds(g) • Seed yield (q ha^{-1}) • Residue analysis • Economics (ICBR Ratio)
Work done/achievements during 2023-24 (centre-wise)	
Coimbatore	The treatments were imposed two times *viz*., (i) at the time of symptom appearance, (ii) 15-days after the first spray. The results showed that the different treatments were able to manage the powdery mildew at different levels when compared to control. Two foliar sprays of propiconazole (0.1%) at 15 days interval was found most effective in controlling the intensity of powdery mildew disease with a mean PDI of 8.52 and a higher seed yield of 5.45 q ha^{-1} as compared to the control which recorded PDI of 29.63 and lowest yield (4.16 q ha^{-1}).
Hisar	The significant differences were obtained for all the treatments except branches per plant and pod length. Maximum number of pods per plant (72.1) and seed yield (2113.0 kg ha^{-1}) was recorded with the application of two foliar spray of Mycolbutanil 10%WP @ 0.05%. All the fungicides control the disease ranging from 50.0 to 68.94 per cent. Minimum disease intensity (21.8%) was found where two foliar spray of Mycolbutanil 10%WP @ 0.05% and per cent disease control was 68.94 per cent
Jabalpur	The experiment was designed using a Randomized Block Design with three replications to identify the most effective chemical control strategies for managing powdery mildew in fenugreek, prioritizing safety and appropriateness. Two foliar sprays of Azoxystrobin (23% EC @ 0.1%), Tebuconazole (25.9% EC @ 0.1%), Hexaconazole (5% SC @ 0.1%), Propiconazole (25% EC @ 0.1%), Myclobutanil (10% WP @ 0.05%), and a control were applied at 15-day intervals starting at the onset of the disease. Percent disease intensity was calculated before spraying and 10 days after each spray using the 0-5 scale as per the scale given by Rathi and Tripathi (1994). The treatment involving two foliar sprays of Tebuconazole 0.1% (T_2) was the most effective in disease management, followed by the application of Sulphur, Myclobutanil 0.05%, and Propiconazole 0.1%,with PDI values of 20.7, 22.0, 27.3 and 36.7 respectively, after the second spray. The highest seed yield (22.56 q ha^{-1}) was achieved with Tebuconazole 0.1% spray, representing a 27.83% increase over the control.
Jagudan	In the present study, all treatments demonstrated significantly lower powdery mildew intensity compared to the untreated control. The most effective treatments were T_3 (two foliar sprays of hexaconazole 5SC (0.1%)) achieving the lowest powdery mildew intensity at 12.55% and the highest seed yield of 14.78 q ha^{-1} closely followed by the package of practices (standard check) (T_3), This trend was also reflected in the 1000 seed weight.

Jobner	The seven treatments consisted of spray of different fungicides viz., Azoxystrobin 23%EC @ 0.10%, Tebuconazole 25.9%EC @ 0.10%, Hexaconazole 5% SC @ 0.10%, Propiconazole 25% EC @ 0.10%, Myclobutanil 10% WP @ 0.05%, Wettable Sulphur 80% WP (Standard Check) and Plain Water (Untreated Control) spray were evaluated in RBD with 3 replications. Result of 2023 revealed that two spray of Hexaconazole 5% SC at 15 days interval was found most effective in controlling powdery mildew disease of fenugreek with lowest disease intensity (7.90%) followed by Wettable Sulphur 80% WP (11.64%) and Propiconazole 25% EC (13.00%) in comparison to untreated check (45.23%). Maximum yield (21.30 q ha^{-1}.) was obtained by two sprayings of Hexaconazole 5% SC followed by Wettable Sulphur 80% WP (19.85 q ha^{-1}.) and Propiconazole 25% EC (17.96 q ha^{-1}.).
Kota	Results revealed that all the treatment significantly reduced powdery mildew intensity as compared to control. The minimum disease intensity (15.03%) and maximum disease control (83.7%) as well as maximum yield (1197 kg ha^{-1}) was recorded with two foliar sprays of Tebuconazole 25.9 % EC @ 0.1% at the initiation of powdery mildew.
Raigarh	Minimum disease intensity (6.9%) and maximum yield(q ha^{-1}) 14.31 found in treatment application of carbendazim 0.1% at the appearance of the disease and followed by 35 DAS after first spray Wettable sulphur 0.2 %. The next best treatment was Treatment Two Foliar spray of Tebuconazole 25.9% EC @ 0.1%(T_2).

NIGELLA

Project Code	NGL/CP/7.1	**Project Title**	Management of root rot of nigella.
Centres	Dholi, Kumarganj, Raigarh.		
Date of start	2022-23	**Date of closure/ duration**	3 years
Experimental details	• Experimental Design: RBD • Replication: 3 • Plot Size and Spacing: 3 x 1.0 m; spacing: 30 x 10 cm • Sowing time: October – November <u>Treatments: 7</u> T_1: Soil application with Talc-based *Trichoderma viride* @2.5kg multiplied in minimum 250kg FYM per ha. T_2: Soil application with Mustard oil cake @1 ton per ha. T_3: Soil application with Neem cake @1 ton per ha. T_3: Soil application with Castor oil cake @1 ton per ha. T_3: Soil drenching with Boscalid (25.2%) + Pyraclostrobin (12.8%) WG @0.2%. T_3: Soil drenching with Azoxystrobin (20%) + Difenoconazole (12.5%) SC @0.2%. T_7: Control. **Method of soil drenching:** 2.0g or 2.0ml of fungicides should be mixed per lit. of water. 3.0 lit. of thus prepared fungicidal solution should be applied per bed ($3m^2$) for soil drenching. **Schedule of soil drenching (3 times):** I^{st} - One week prior to sowing; 2^{nd} – 45 DAS & 3^{rd} – 60 DAS.		

Observation Recorded	• Date of observation of 1st disease incidence • Per cent disease incidence (PDI) • Yield (kg ha^{-1}) • Incremental Cost-Benefit Ratio (ICBR) • Fungicide Residue Analysis in seeds after harvest. Where, $Per\ cent\ disease\ incidence\ (PDI) = \frac{\text{No.of disease plants}}{Total\ no.of\ plants} x100$ • $Incremental\ Cost\ Benefit\ Ratio\ (ICBR) = \frac{\text{Income from yield increased over control/ha}}{Expenditure\ incured\ for\ sparying/ha} x100$
Work done/achievements during 2023-24 (centre-wise)	
Dholi	Among the treatments T_3, involving soil drenching with Boscalid (25.2%) + Pyraclotrobin (12.8%) WG @0.2%, exhibited the lowest disease incidence at 7.40%, in contrast to the control group which had a disease incidence of 18.16%).
Kumarganj	In Management of root rot of nigella, among the seven tested treatments minimum disease incidence (6.36%) and higher yield (8.89 q ha^{-1}) was recorded in the treatment T_3 followed by T_3 with disease incidence (6.87 %) and yield (8.11 q ha^{-1}) and in T_1- Soil application with Talc based *Trichodermaviridae* @ 2.5 kg- disease incidence (6.80 %) and yield (7.78 q ha^{-1}).
Raigarh	Minimum disease incidence found in treatment T_1(11.67%), T_3(10.26%) and T_3(7.16) and yield 6.50 q ha^{-1} ,6.8 and 7.2 q ha^{-1} respectively.

SEED SPICES

Project Code	SS/CP/7.1	Project Title	Survey and monitoring of diseases and insect pests of seed spices for development of prediction models
Centres	Coimbatore, Dholi, Guntur, Jagudan, Jobner, Kalyani, Kumarganj, Mandor, Raigarh, Sanand		
Date of start	Rabi 2020-21	Date of closure/ duration	5 years
Experimental details	A. Field survey of diseases and insect pests of seed spices (cumin, coriander, fenugreek, fennel, ajwain and nigella) Proposed areas of survey: • Cumin- Rajasthan and Gujarat • Coriander- Rajasthan, U.P., Chhattisgarh, Bihar, Tamil Nadu • Fenugreek- Rajasthan, U. P., Chhattisgarh, Bihar, Tamil Nadu • Fennel- Gujarat, Rajasthan, UP • Ajwain- Rajasthan, Gujrat, M.P., Telangana, Andhra Pradesh • Nigella- Rajasthan, M.P., Bihar, Telangana, Andhra Pradesh, Chhattisgarh, West Bengal B. Monitoring diseases and insect pests of seed spices on the Institute farm • Cumin: *Alternaria* blight, powdery mildew, aphids and thrips		

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Coriander: Stem gall, powdery mildew, aphids, seed wasps
Fenugreek: Powdery mildew, downy mildew, aphids, jassids
Fennel: Ramularia blight, powdery mildew, aphids, seed wasps
Ajwain: Root rot, aphids, lygus bug
Nigella: Root rot, termite, capsule borer

<u>Methodology to be adopted</u>

Survey will be conducted in farmers' fields of cumin, coriander, fenugreek, fennel, ajwain and nigella for the prevalence of various diseases and insect pests during the cropping season.
The local popular/ susceptible variety of cumin, coriander, fenugreek and fennel crops will be planted in experimental plots.
Plots (5m x 5m) will be kept 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 will be taken from crop germination to maturity at weekly interval.
Standard package of practices should be followed except plant protection measures.

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<tr><td colspan="2">Observation Recorded</td><td>• Disease score of root diseases and DI will be calculated.
• Disease score of foliar diseases and PDI will be calculated
• Number of insects /umbel/5cm twig/percentage seed /plant damage
• Meteorological data & mapping of disease hot spots
• Correlation between meteorological parameters and disease/ pest distribution/ incidence</td></tr>
<tr><td colspan="3">Work done/achievements during 2023-24 (centre-wise)</td></tr>
<tr><td>Dholi</td><td colspan="2">Field survey of diseases and insect pests of seed spices (coriander, fenugreek & nigella):
Surveyed area: Muzaffarpur district of state of Bihar.
Coriander: Coriander crop cultivated by farmer was found to be affected by stem gall disease caused by Protomyces macrosporus. Disease incidence was found in the range of 10 to 60% with mean disease incidence of 33%.
Fenugreek: No disease was observed in the crop.
Nigella: Crop was not found cultivated by farmers.

Monitoring diseases and insect pests of seed spices on the Institute farm:

Result (2023-24):
Coriander: Coriander crop grown in plot (5m x 5m) under natural condition without any plant protection measures was found to be affected by stem gall disease caused by Protomyces macrosporus. Disease incidence was found 45.00%. Average population of aphid /5 twigs was observed 26.80 during 3rd S.M.D.
Fenugreek: No disease was observed in the crop.
Average population of aphid /5 twigs was observed 28.60 during 3rd S.M.D.</td></tr>
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Guntur	No incidence of Root rot, aphids, Lygus bug was observed during the year. Occurrence of South East Asia thrips (*Thrips parvispinus* Karny) was observed in the research station.
Jagudan	Institute farm: The incidence of blight was moderate (34.50%) in cumin. The powdery mildew was recorded with lower intensity (16.90%) in cumin. The aphid population was recorded higher as 56.0/ umbel, whereas, thrips population was observed 5.8 per plant. In fennel, the maximum Ramularia blight of 26.50 per cent was recorded. The aphid population was recorded moderate (18.23). The incidence of seed wasp was not observed during the experimentation period. In coriander, the lower intensity of powdery mildew (11.80%) was recorded. The aphid population was observed as 14.46/umbel, whereas no seed wasp infestation was recorded during the experimentation period. In fenugreek, the powdery mildew intensity was recorded moderate (28.65%). The aphid population was recorded as 23.0/umbel, whereas leaf hopper was 2.9 per plant. In ajwain,, during the experimentation period the incidence of pest and diseases viz., root rot, aphids, Lygus bugs etc. was not observed. **Field survey:** the incidence of blight and powdery mildew in cumin was moderate to high at different locations. The aphid infestation was ranged from low to moderate in cumin. In fennel, the infestation of Ramularia blight and aphid was recorded lower. In ajwain, the incidence of any pests and disease was not recorded during the experimentation period.
Jobner	. Experiments were conducted during Rabi 2023-24 at Institute Research Farm for cumin, coriander, fenugreek, fennel, ajwian and nigella. Seed spices crops were sown in natural condition without any plant protection measures for any of the pests/disease on seed spices crops. Seed spices crops were evaluated in plot size of 5.0x5.0 sq.m.accommodating with crop geometry maintained by thinning at Institute Research Farm, SKNCOA, Jobner. Experimental site at Institute Research Farm as well as roving survey of different field was done in cumin, coriander, fenugreek, fennel and ajwian during the year 2023-24. **Cumin:** In cumin disease intensity of *Alternaria* blight, wilt and powdery mildew and aphid infestation were recorded in institute research farmand surveyed areas. **Coriander:** Disease intensity of stem gall was not observed in institute farm. Disease intensity of powdery mildew and aphid and seed wasps infestation were recorded in research farmand surveyed areas. **Fenugreek:** In fenugreek crop disease intensity of powdery mildew and downy mildew and aphid infestation were recorded in institute research farmand surveyed areas. **Fennel:** In fennel crop disease intensity of *Ramularia* blight and powdery mildew and aphid and seed wasps infestation were recorded and surveyed areas. **Ajwain:** In ajwain crop disease incidence of root rot and aphid, lygus bug infestations were recorded in institute farm. **Nigella:** In nigella crop very less pest infestation was recorded in institute farm.
Kalyani	A. Institute Farm Monitoring (2023-24): The seed spices are not very common and popular to the farmers of this area, except coriander for leaf purpose and nigella in the northern part of the state. In

	our BCKV farm coriander, fennel, fenugreek and black cumin were grown in Rabi season for experimental trial and seed purpose. No severe attack of disease/insect pest was noticed in the field. But sowing time is maintained strictly within 15 November. B. Off Farm Survey (2023-24): Since the last year a survey was conducted in 2 districts of West Bengal (North and South Dinajpur) where Nigella or Black cumin is cultivated moderately in the state to identify different diseases and pests occurring in those areas and to assess the severity of different diseases and pests of Nigella, if available. Nine well distributed locations within those 2 districts were selected for the survey. In each location the survey was done at 3 different places. No severe attack of pests was found. Eccept one disease i.e. wilt disease of Nigella caused by *Fusarium oxysporum* f. sp. *cumini* was evident in all the fields of all the places surveyed.
Mandor	Survey and monitoring of diseases (SS/CP/7.1) of cumin was conducted during rabi 2023-24 and found that the disease Alternaria blight was first appeared in the first fortnight of January at Mandor. During survey of major cumin growing area of Jodhpur region, percent disease intensity of Alternaria blight ranged from 15% to 54%, Fusarium wilt from 3% to 22% and powdery mildew from 0% to 4%.
Raigarh	The field survey revealed that among seed spices diseases, powdery mildew was most prevalent in coriander, with a disease intensity of 22.12%, followed by *Alternaria* leaf blight at 17.45% and root rot in fenugreek at 6.3%. At the institute farms, Coriander crops was affected with powdery mildew whereas aphids affected the fennel crop. Ajwain as well as fenugreek were not affected by any diseases or insects.

Research Programmes at a glance (Crop-wise)

Crop Names	GENETIC RESOURCES & CROP IMPROVEMENT		CROP MANAGEMENT		CROP PROTECTION & FOOD SAFETY		Total No. of Projects
	List of Projects	No.	List of Projects	No.	List of Projects	No.	
Black pepper	PEP/CI/1.1, PEP/CI/3.7	2		--	PEP/CP/5.10, PEP/CP/7.1	2	4
Cardamom	CAR/CI/1.1, CAR/CI/3.9, CAR/CI/4.4, CAR/CI/4.5	4	CAR/CM/5.5, CAR/CM/5.6	2	CAR/CP/6.11, CAR/CP/6.12, CAR/CP/6.13	3	9
Large cardamom	LCA/CI/1.1, LCA/CI/2.1	2	LCA/CM/5.1	1		--	3
Ginger	GIN/CI/1.1, GIN/CI/2.5, GIN/CI/2.6, GIN/CI/2.7, GIN/CI/4.3	5	GIN/CM/4.1, GIN/CM/5.1, GIN/CM/5.2	3	GIN/CP/6.15, GIN/CP/7.1, GIN/CP/7.2	3	11
Turmeric	TUR/CI/1.1, TUR/CI/2.8, TUR/CI/2.9, TUR/CI/2.11	4	TUR/CM/5.1, TUR/CM/5.2	2	TUR/CP/7.8, TUR/CP/7.9, TUR/CP/7.10	3	9
Tree spices	TSP/CI/1.1, TSP/CI/1.2, TSP/CI/2.1, TSP/CI/2.4	4	TSP/CM/5.1	1		--	5
Coriander	COR/CI/1.1, COR/CI/2.8, COR/CI/4.1	3	COR/CM/5.1, COR/CM/6.1	2		--	5
Cumin	CUM/CI/1.1, CUM/CI/2.5	2		--	CUM/CP/7.1	1	3
Fennel	FNL/CI/1.1, FNL/CI/2.8	2		--	FGK/CP/7.1	1	3
Fenugreek	FGK/CI/1.1, FGK/CI/2.5	2	FGK/CM/5.1, FGK/CM/6.1	2		--	4
Ajwain	AJN/CI/2.1	1		--		--	1
Nigella		--		--	NGL/CP/7.1	1	1
Seed spices		--		--	SS/CP/7.1	1	1
Saffron	Project mode	1		--			1
Kalazeera	Project mode	1		--			1