Table 4.15: Interaction effect between protected environment and irrigation methods on yield attributes and yield

Irrigation Methods / Protected cultivation	Umbels/plant			Seed Yield kg /ha		
	Low pressurized drip irrigation	Pressurized drip irrigation	Flood system	Low pressurized drip irrigation	Pressurized drip irrigation	Flood system
P_1.-Plastic walk in tunnel	119.67	112.00	108.33	1689	617.78	1497
P_2-.Insect proof net tunnel	109.33	106.33	104.67	1528	1545	624
P_3-.Shade net tunnel	109.33	90.00	50.67	338	326	275
P_4.Plastic low tunnel	45.00	29.67	19.00	282	171	101
P_5. Open conditions	99.67	90.00	85.67	703	699	612
SEm±	4.04			47.5		
CD (P=0.05)	11.91			141		

At CCPT Delhi

Coriander seed crop (var- ACr-1) was grown under four conditions viz., control (open field), plastic low tunnels, Insect proof net covered walk in tunnel and transparent plastic covered walk in tunnel at the Centre for Protected Cultivation Technology, IARI, New Delhi during year 2009-10 to find out the effect of different conditions on growth and seed yield of coriander. Plastic covered walk in tunnel grown coriander crop produced maximum seed yield (ie 634.0 kg/acre) followed by Insect proof net covered walk in tunnel grown crop (586.0 kg/acre) which is significantly higher over control crop (ie 446.0 kg/acre)

CPd-6: Standardization of seed spice based cropping system with fruit crops

The study was conducted in split plot design in which three treatments viz Ber, Aonla and open space were laid in main plot and seed spices viz fennel, coriander, cumin, ajowan and fenugreek were undertaken in sub plot. The highest seed, stover and biological yield of seed spices was obtained in open space followed by with Aonla association. This might be due to no competition of seed spices with fruit trees in open space. Due to less canopy of Aonla compared to ber, there was less competition with seed spices; hence the next highest yield of seed spices was achieved with Aonla association (Table 4.16).

Among the seed spices the fennel resulted significantly highest seed yield (1575.49kg/ha.), Stover yield (2665.28 kg/ha) and biological yield (4240.77 kg/ha) over other seed spices followed by Ajowan.

CPd-7: Standardization of agrotechniques for minor seed spices (nigella, anise and dill)

An experiment carried out to study the effect of sowing dates and crop geometry on growth and yield of nigella was laid out in split plot design. Date of sowing significantly affected growth and yield attributes as well as seed yield of nigella (Table 4.17). Sowing of nigella on 15th October exhibited the highest seed yield (558.73kg ha-1), 1000- seed weight, seed yield per plant, capsule weight, number of seeds per capsule, number of capsule per plant , number of branches per plant, plant height (cm) over rest of the sowing dates. Crop geometry of 25 cm X 10 cm row to row and plant to plant spacing significantly resulted the highest plant height at 40 and 90 DAS as well as at harvest. Similarly, number of capsule per plant, number of seeds per capsule, 1000- seed weight were also recorded the highest with crop geometry of 25 x 10 cm .

Table 4.16: Effect of intercropping of seed spices with fruit trees on yield of seed spice crops

Treatments	Seed yield kg/ha	Straw Yield kg/ha	Biological Yield kg /ha	Harvest Index (%)	Fennel equivalent yield (kg/ha)
Fruit trees					
With ber	879.97	1475.83	2355.80	37.20	733.57
With Aonla	1003.18	1673.06	2676.23	37.37	857.49
Open Space	1112.66	1916.11	3028.77	36.76	981.85
S.Em ±	17.67	28.80	47.51	0.47	15.71
CD (P0.05)	61.15	99.64	164.38	NS	54.37
Seed spice crop					
Cumin	450.46	773.15	1223.61	36.78	844.62
Fennel	1575.49	2665.28	4240.77	37.22	1575.49
Dill	1058.63	1781.48	2840.12	37.29	529.32
Ajwain	584.03	999.54	1583.56	36.92	511.02
Fenugreek	1324.39	2222.22	3546.61	37.33	827.74
S.Em ±	17.67	35.48	47.51	0.68	15.71
CD (P0.05)	61.15	136.43	164.38	NS	54.37

Table 4.17: Effect of sowing dates and crop geometry on growth parameters of nigella

Treatments	Plant Height (cm)	No. of Branches /Plant	No.of capsules /Plant	No.of seeds/ capsule	Capsule wt. (mg)	Test weight (g)	Seed yield kg /ha
Date of sowing							
October 1st	47.44	11.24	35.96	68.09	199.84	2.27	276.19
October 15th	62.65	14.58	49.15	83.11	302.44	2.88	558.73
October 30th	56.58	11.09	38.78	75.85	262.23	2.56	361.90
November 15th	36.73	8.14	11.64	58.62	161.82	1.80	200.00
November 30th	26.22	6.98	8.89	45.16	134.53	1.46	57.14
SEm ±	0.97	0.32	1.00	2.14	6.88	0.07	7.91
CD (P=0.05)	3.16	1.05	3.25	6.97	22.43	0.23	25.79
Crop geometry							
Row to Row (20x10 cm)	44.15	9.81	28.33	62.01	200.79	2.06	247.62
Row to Row (25x10 cm)	47.93	11.15	29.87	69.57	224.17	2.34	339.05
Row to Row (30x10 cm)	45.69	10.25	28.45	66.92	211.56	2.18	285.71
SEm ±	0.91	0.23	0.75	1.50	4.85	0.05	6.61
CD (P=0.05)	2.69	0.68	2.21	4.41	14.32	0.15	19.51

A field experiment was conducted to study the effect of sowing dates and crop geometry on growth and yield of dill. Sowing of dill on 15 th October exhibited the highest seed yield(16.41 q ha^{-1}), seed yield per plant, number of seeds per umbel, number of umbel per plant, number of umblets, number of branches per plant and plant height over rest of the sowing dates (Table 4.18). Crop geometry of 40 cm X 20 cm row to row and plant to plant spacing significantly resulted the highest plant height at 40 and 90 DAS as well as at harvest. Similarly, numbers of umbels per plant, number of seeds per umbel were also recorded the highest with crop geometry of 40 x 20 cm.

Table 4.18: Effect of sowing dates and crop geometry on yield attributes and yields of dill

Treatments	Plant Height (cm)	No. of Branches /Plant	No.of Umbels /Plant	No.of Umbellets/ Umbel	Seeds/ Umbellet	Test weight (g)	Seed yield kg /ha
Date of sowing							
October 1st	129.29	11.04	54.51	33.20	23.64	4.59	1441.27
October 15th	135.24	11.82	60.63	44.58	57.40	4.90	1641.27
October 30th	119.46	9.40	24.80	36.55	24.61	4.06	558.73
November 15th	51.18	7.18	18.02	19.07	22.14	4.54	193.65
November 30th	50.42	5.93	9.68	12.02	12.54	3.58	142.86
SEm ±	3.36	0.29	1.12	0.94	0.72	0.13	26.95
CD (P=0.05)	10.95	0.94	3.64	3.06	2.34	0.44	87.87
Crop geometry							
Row to Row (40x10 cm)	102.60	9.77	39.15	30.97	29.83	4.41	920.00
Row to Row (50x10 cm)	96.32	9.12	31.23	28.78	28.08	4.29	761.90
Row to Row (60x10 cm)	92.44	8.33	30.21	27.49	26.29	4.30	704.76
SEm ±	2.42	0.20	0.80	0.68	0.51	0.09	20.15
CD (P=0.05)	7.14	0.59	2.36	2.02	1.49	0.27	59.42

A field experiment was conducted to find out the effect of sowing dates and crop geometry on growth and yield of anise. Sowing of anise on 1st November exhibited the highest seed yield (9.20 q ha^{-1}) , seed yield per plant, number of seeds per umbel, number of umbels per plant , number of branches per plant , plant height (cm) at all the growth stages which were significantly higher over rest of the sowing dates. Crop geometry of 30 cm X 10 cm row to row and plant to plant spacing significantly resulted the highest plant height at 40 and 90 DAS as well as at harvest. Similarly, number of umbels per plant, number of seeds per umbel was also recorded the highest with crop geometry of 30 x 10 cm (Table 4.19).

CPd 8: Seed Spices Crop Residue Recycling through Vermi-composting for Nutritional and Carbon Budgeting

Influence of vermi-composts on growth and yield of fennel

Plant height of fennel increased with the application of vermi-composts (Fig.4.25). The increased plant hieght was in order of - coriander vermiocomposts, fennel vermicompost and mixed reside vermi-compost. There was no statisical variation observed in number of branched per

Table 4.19: Effect of sowing dates and crop geometry on yield attributes and yields of anise

Treatments	Plant Height (cm)	No. of Branches /Plant	No.of Umbels /Plant	No.of Umbellets/ Umbel	Seeds/ Umbellet	Test weight (g)	Seed yield kg /ha
Date of sowing							
October 15th	55.35	14.07	41.16	17.11	19.69	2.62	901.59
October 30th	51.36	13.71	37.31	15.58	18.78	2.61	704.76
November 15th	44.34	12.22	30.73	14.31	15.44	2.43	292.06
November 30th	42.02	11.31	20.04	13.33	15.38	2.05	282.54
December 15th	34.62	9.27	11.70	10.82	12.17	1.98	142.86
SEm ±	1.46	0.39	0.94	0.46	0.52	0.08	15.93
CD (P=0.05)	4.76	1.26	3.06	1.51	1.68	0.27	51.95
Crop geometry							
Row to Row (20x10 cm)	47.99	12.76	31.81	14.89	17.91	2.42	516.19
Row to Row (30x10 cm)	45.27	12.05	27.45	14.08	15.82	2.18	464.76
Row to Row (40x10 cm)	43.36	11.53	25.30	13.72	15.15	2.41	413.33
SEm ±	0.99	0.26	0.67	0.32	0.35	0.05	12.64
CD (P=0.05)	2.93	0.78	1.98	0.93	1.03	0.15	37.27

plant with various vermi-composts at the level of 5t/ha. However, at 10 t/ha of vermi-compost gave higher no of branches than 5t/ha.

No of umbells per plant increased with 5 and 10t vermi-composts as compared to control (Fig 4.26). However, there was no significant variation among various vermi-composts at the level of 5t/ha. Moreover, 10 t application of various VC increased no of umbell per plant in order of coriander vermi-compost, fennel vermi-composts and mixed residue vermicomposts.

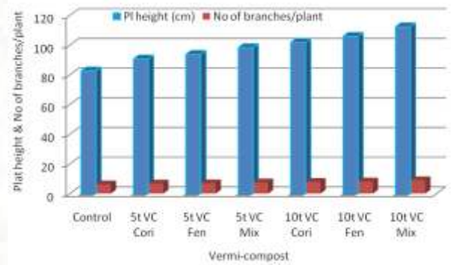


Fig. 4.25: Plant height and No of branches/plant in fennel with vermi-composts

Yield of fennel increased with the application 5 and 10t/ha vermicomposts of various crop residues (Fig 4.27). Seed yield of fennel increased 14% and 16% with the application of 5t each of fennel and mixed residue vermi-composts, respectively over the control. However, yield was 21% and 35% higher with 10 tonnes each of fennel and mixed residue vermicompost, respectively as compared to control. The seed yield with fennel VC and mixed VC were at par either applied 5 or 10 t/ha. However, seed and

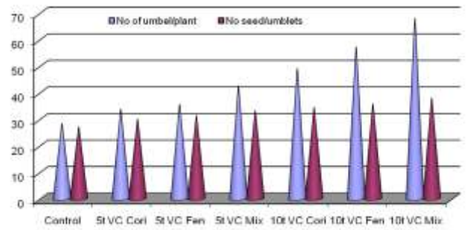


Fig. 4.26: No of umbel/plant and No of seed/ umbel in fennel with vermi-composts

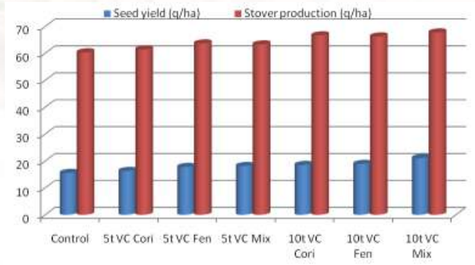


Fig. 4.27: Yield of fennel with vermi-composts

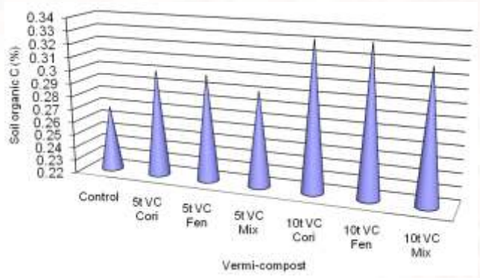


Fig. 4.28: Soil organic carbon (%) with vermi-composts

straw yield was always superior with mixed vermi compost than with coriander and fennel residue vermi compost. Stover yield was also higher with that level of vermi composts.

Soil organic carbon (SOC) after fennel crop was varied from 0.26 to 0.33%. Application of vermi compost either 5 or 10 t/ha increased the SOC (Fig 4.28). However, SOC was always lower where the mixed vermin compost was applied as compared to coriander or fennel VC.

CPd-10: Evaluation of irrigation methods in fennel under various configuration of crop geometry

An experiment conducted to study the effect of irrigation methods at varying crop configuration on growth, yield and water productivity. Drip irrigation system with low and high pressure exhibited higher growth, yield attributes and yield of fennel over furrow and conventional method. Low pressure drip irrigation

Table 4.20 : Effect of different irrigation methods at varying crop configuration on yield and water productivity in fennel

Treatments	Seed yield kg/ha	Straw yield kg/ha	Biological yield kg/ha	Irrigation water (mm)	Consumptive water use	WUE	WEE
(A) Irrigation methods							
Conventional	1084	1805	2685	400.00	345.00	3.14	2.71
All furrow	1310	2281	3592	320.00	243.00	5.39	4.09
Alternate furrow	904	1651	2555	250.00	230.00	3.93	3.62
Alt to Alt Furrow	909	1626	2535	250.00	235.00	3.87	3.64
Conventional drip	1522	2719	4241	280.00	272.00	5.60	5.44
High Pressure drip	1548	2814	4361	280.00	266.00	5.82	5.53
S.Em	31	54	84	-	-	-	-
CD (P=0.05)	93	164	253	-	-	-	-
(B) Crop configuration							
Norm,al row arrangement	1289	2324	3571	298.00	268.00	4.81	4.32
Paired row arrangement	1137	1974	3085	295.00	262.00	4.34	3.85
S.Em	17	31	48	-	-	-	-
CD(P=0.05)	51	94	143	-	-	-	-

resulted highest seed and straw yield of 1547 and 2813 kg /ha which is 42 and 55 per cent higher over conventional method of irrigation. All furrow method of irrigation yielded 21 per cent higher grain yield over conventional irrigation. Low pressure drip irrigation resulted highest water productivity in term of water use efficiency (5.82 kg /ha/mm).Though there was not much higher difference in growth and yield of fennel with respect to crop configuration. However, normal crop configuration resulted higher growth and yield of fennel over paired row system (Table 4.20)

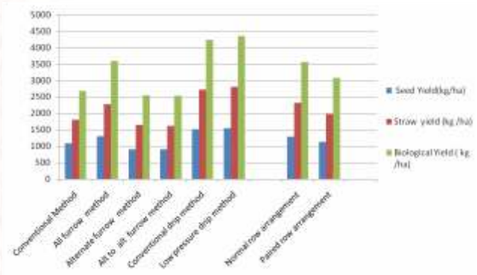


Fig.4.29: Effect of different irrigation methods at varying crop configuration on yield of fennel

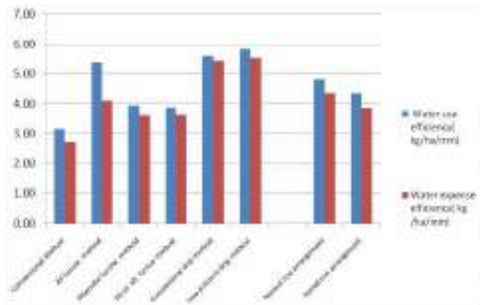


Fig.4.30: Effect of different irrigation methods at varying crop configuration on water productivity in fennel

CPd-11: Standardization of package for organic seed spice production (coriander and cumin)

Supply of 100% N and P through vermi-compost and enriched VC resulted higher growth parameter of coriander and cumin followed by 75% N&P through VC and enriched VC in combination with *Azotobactor* and 50% N and P through VC and enriched VC in combination with *Azotobactor* and PSB over rest of the treatments. Application of 100 percent N and P through vermi-compost and enriched VC resulted umbel/plant (20.33), umbellate /umbel (5.24), seed /umbellate (5.25) and seed yield (151.00 kg /ha).

CPd-12- Evaluation and identification of efficient cropping sequences for semi-arid spice growing area

The execution of field experiment on identification of efficient cropping sequences for seed spice growing area was started from May,2010. During summer season soil solarisation was done as per treatments. Summer season green manure crop were sown during summer.

CPd-13. Standardization of non monitory agro-techniques for seed spices under different agro-climatic conditions.

In order to standardize agro-techniques in various agro-climatic situations an inter-institutional project was started from September 2009. In the first phase of the programme the treatments on varying date of sowing with different crop geometry was taken at NRCSS, Ajmer, IARI, Vegetable Research Station and Centre for Temperate Horticultutre Research Institute, Srinagar (J& K). At NRCSS, five seed spices namely fennel, fenugreek, coriander, ajwain and nigella were sown and indicative results are as under. The highest umbel/plant (19.75), umbellate/umbel (30.75), seeds/umbellate (33.80), test weight (6.98 g) and seed yield (1957 kg /ha) were recorded with

Table 4.21: Effect of various sources of organic nutrition on growth and yield parameters in coriander

Treatments	Plant height (cm)			Umbel /plant	Umbellate /umbel	Seed / umbellate	Seed yield (kg/ha)
	40 DAS	80 DAS	Harvest				
100% N &P with VC & En VC	15.25	42.25	60.14	20.33	5.24	5.25	151.00
100% N &P with SM & En VC	12.14	39.24	55.75	15.67	4.62	4.02	121.20
100% N &P with PM & En VC	11.49	38.15	54.25	14.25	4.25	3.93	115.32
75% N &P with VC & En VC+Azot.	14.14	41.42	58.24	18.25	5.15	4.82	135.00
75% N &P with SM & En VC+Azot.	11.58	38.24	54.12	13.33	4.24	3.65	106.63
75% N &P with PM & En VC+Azo.	11.24	37.16	53.24	12.67	4.15	3.25	102.25
50% N &P with VC & En VC+Azot+ PSB	13.82	40.15	56.85	16.25	5.05	4.25	126.00
50% N &P with SM & En VC+Azot+PSB	10.45	37.45	52.18	11.25	4.12	3.15	95.25
50% N &P with PM & En VC+Azo+PSB	10.25	36.25	52.14	10.14	4.02	3.12	91.40
Absolute control	8.75	34.12	49.15	8.25	4.00	3.00	85.25
S.Em	0.25	0.76	1.15	0.52	0.16	0.14	4.11
CD (P=0.05)	0.74	2.25	3.42	1.55	0.48	0.42	12.21

VC - Vermicompost, SM- Sheep manure, PM- Poultry manure, En VC- Enriched vermi compost, PSB- Phosphorus Solublising Bacteria

sowing of fennel on 10th October. A row to row and plant to plant spacing of 45x45 cm was found better in fennel in which highest seed yield of 1672 kg /ha. Sowing of fenugreek on 20th October resulted highest yield of 1970 kg ha and crop geometry of 25 x10 cm crop produced seed yield 1930 kg /ha.

Sowing of coriander on 10th October exhibited the highest seed yield of 1055 kg /ha and crop geometry of 25 x 20 cm was found better in which the higher seed yield of 931 kg /ha was obtained. Sowing of Ajwain on 10th October gave the highest seed yield of 368 kg /ha and sowing of the crop at 50 x 30 cm row to row and plant to plant spacing is better which resulted higher seed yield of 262 kg/ha. Sowing of Nigella on 10th Oct resulted the highest seed yield of 382 kg /ha and 30 x10 cm crop geometry was found better which yielded 337 kg /ha nigella seed.

Table 4.22: Effect of date of sowing and crop geometry on yield attribute and yield of fennel

Treatment	Umbel /plant	Umbellate /umbel	Seeds /umbellate	Test weight (g)	Yield kg /ha
Date of sowing					
10 Oct	19.75	30.75	33.80	6.98	1957.49
20 Oct	15.68	27.25	31.93	6.30	1745.95
30 Oct	14.55	27.28	30.60	6.10	893.98
SEm ±	0.36	0.57	0.64	0.13	34.53
CD (P=0.05)	1.23	1.97	2.20	0.45	119.46
Crop Geometry					
60x30cm	16.10	27.52	31.75	6.33	1391.98
45x45cm	17.22	29.33	32.47	6.59	1672.97
SEm ±	0.23	0.42	0.64	0.23	21.48
CD (P=0.05)	0.75	1.34	1.54	0.31	68.71

Table 4.23: Effect of date of sowing and crop geometry on yield attribute and yield of fenugreek

Treatment	Pod/plant	Pod length (cm)	Seeds /pod	Yield kg /ha
Date of sowing				
10 Oct	24.88	13.44	17.80	1970.49
20 Oct	26.50	13.41	17.98	1958.91
30 Oct	22.33	11.98	17.93	1391.78
SEm	0.45	0.35	0.32	35.39
CD (P=0.05)	1.56	1.20	1.12	122.45
Crop Geometry				
20 x10cm	23.58	12.43	17.12	1633.87
25 x 10cm	25.55	13.46	18.68	1913.58
SEm	0.38	0.20	0.28	26.28
CD (P=0.05)	1.21	0.63	0.89	84.05

Table 4.24: Effect of date of sowing and crop geometry on yield attribute and yield of coriander

Treatment	Umbel /plant	Umbellate /umbel	Seeds /umbellate	Test weight (g)	Yield kg /ha
Date of sowing					
10 Oct	69.73	6.78	8.30	7.66	1055.53
20 Oct	52.75	6.45	7.88	7.33	1047.89
30 Oct	29.88	6.05	6.00	7.21	596.18
SEm	1.32	0.12	0.15	0.14	19.59
CD (P=0.05)	4.55	0.43	0.53	0.49	67.76
Crop Geometry					
30x15 cm	47.78	6.20	3.59	7.03	868.67
25x20 cm	53.78	6.65	3.80	7.77	931.06
SEm	1.62	0.10	0.11	0.28	13.13
CD (P=0.05)	5.19	0.31	0.34	0.88	42.00

Table 4.25: Effect of date of sowing and crop geometry on yield attribute and yield of ajwain

Treatment	Umbel /plant	Umbellate /umbel	Seeds /umbellate	Test weight (g)	Yield kg /ha
Date of sowing					
10 Oct	277.55	16.38	23.50	1.10	367.71
20 Oct	158.58	14.82	22.58	0.95	208.33
30 Oct	115.35	13.58	20.90	1.04	136.11
SEm	5.63	0.32	0.46	0.02	7.54
CD (P=0.05)	19.48	1.11	1.60	0.07	26.09
Crop Geometry					
50x30 cm	196.08	15.46	23.22	1.06	262.50
40x20 cm	171.57	14.38	21.43	1.00	212.27
SEm	2.14	0.22	0.34	0.04	2.75
CD (P=0.05)	6.85	0.70	1.07	0.12	8.80

NRCSS Annual Report 2010-11

Table 4.26: Effect of date of sowing and crop geometry on yield attribute and yield of nigella

Treatment	Umbel /plant	Umbellate /umbel	Seeds /umbellate	Test weight (g)	Yield kg /ha
Date of sowing					
10 Oct	34.58	71.98	6.52	2.73	382.29
20 Oct	28.60	71.55	4.16	2.50	291.90
30 Oct	26.88	67.20	3.92	2.25	285.65
SEm	0.62	1.33	0.12	0.05	6.82
CD (P=0.05)	2.13	4.59	0.41	0.16	23.58
Crop Geometry					
20x10 cm	28.37	68.97	4.46	2.29	302.85
30x10 cm	31.67	71.52	5.27	2.69	337.04
SEm	0.43	1.07	0.06	0.09	4.45
CD (P=0.05)	1.37	3.42	0.28	0.29	14.24

4.3 Crop Protection

Plant Pathology

CPt 1: Survey and surveillance of diseases of seed spices

On farm survey:

Field Surveys were conducted during rabi 2009-10 in Ajmer, Nagour, Barmer, Jalore, Kota, Baran and Sirohi districts of Rajasthan, Banaskantha district of Gujarat and Faizabad district of U.P. for the prevalence and occurrence of cumin, coriander, fenugreek and fennel diseases. It has been observed that blight (0-70%), wilt (0-28%) and powdery mildew (20-54%) in cumin; stem gall (10-62%) and powdery mildew (0-75%) in coriander; powdery mildew (0-96%) in fenugreek and gummosis and powdery mildew (22-95%) diseases in fennel were prevalent in major growing areas surveyed in Rajasthan, U.P. and Gujarat. The phanorogamic plants i.e. *Orobanche sp.* and *Cuscutta sp.* were also observed in cumin fields in Nagaur district (Table 4.27 to 4.32).

Table 4.27: Distribution of cumin diseases in different districts of Rajasthan and Gujarat surveyed during 2009-10 *rabi* season

State/District	Cultivars grown	Diseases identified
Rajasthan Ajmer	GC 4, RZ 19, Own seed,	Wilt, Blight, Powdery mildew
Nagaur	RZ 19, Own seed, Avani – III, Dinkar, Chamatkar,	Wilt, Blight, Powdery mildew, *Orobanche*
Barmer	GC 4, Western seed, Own seed	Wilt, Blight, Phyllody
Jalore	Western seed, Own seed	Wilt, Blight, Phyllody
Tonk	-	Blight
Gujarat Banaskantha	GC 4	Blight, Powdery mildew

Table 4.28: Prevalence of major cumin diseases in different districts of Rajasthan and Gujarat

District	Villages/ location	Fields	Wilt		Blight		Powdery mildew	
			Mean	Range	Mean	Range	Mean	Range
Rajasthan Nagaur	10	12	8.0	0-8	19.1	2.2-70	-	-
Barmer	6	13	-	-	25.8	0-36	-	-
Jalore	5	12	18.0	8-28	36.0	8-54	-	-
Tonk	2	2	-	-	10.0	8-12		
Gujarat Banaskantha	5	5	-	-	24.2	14-34	37.0	20-54

Table 4.29: Distribution of coriander diseases in different districts of Rajasthan , Gujarat and Uttar Pradesh surveyed during 2009-10

State/District	Cultivars grown	Disease Identified
Rajasthan Naguar	Own seed	Nil
Kota	Own seed	Blight
Baran	Own seed	Stem gall
Gujarat Banaskantha	Own seed	Blight, Powdery Mildew
U.P. Faizabad	Locally purchased	Powdery mildew, Stem gall
Lucknow	Locally purchased	Stem gall

Table 4.30: Prevalence of major coriander diseases in different districts of Rajasthan , Gujarat and Uttar Pradesh

District	Villages	Fields	Stem gall		Blight		Powdery mildew	
			Mean	Range	Mean	Range	Mean	Range
Naguar	1	1	-	-	-	-	-	-
Kota	4	7	-	-	traces		-	-
Baran	2	3	34.7	27-50	-	-	-	-
Banaskantha	1	1			30	0-30	34	0-34
Faizabad	7	9	45.0	10-62.5		-	45.3	5-75
Lucknow	3	5	38.9	31.3-60.0	-	-	-	-

Table 4.31: Distribution of fennel and fenugreek diseases in different districts of Rajasthan, Gujarat & Uttar Pradesh

State/ District	Cultivars grown	Disease Identified
Fennel		
Tonk	Own seed	Nil
Sirohi	Own seed	Gummosis
Banaskantha	Own seed	Gummosis
Faizabad	NDF-5, Locally collected	Powdery mildew
Fenugreek		
Naguar	Own seed	Powdery Mildew
Faizabad	NDM-20, Not known	Powdery mildew

Table 4.32: Prevalence of major fennel and fenugreek diseases during the *rabi* season of 2009-10

District	Villages	Fields	Powdery mildew	
			Mean	Range
Fennel				
Faizabad	5	5	68.5	22.5-95
Fenugreek				
Naguar	2	7	24.3	0-45
Faizabad	7	7	47.5	2.5-96.3

Plate 4.4: Cumin blight symptoms on farmers field

Plate 4.5: *Orobanche* in cumin field

New disease symptoms

During survey new disease symptoms were observed on the Institute farm. Symptoms observed were root rot of anise (Plate 4.6), powdery mildew of anise (Plate 4.7). leaf spot of anise (Plate 4.8), powdery mildew of caraway (Plate 4.9), powdery mildew of dill (plate 4.10), blight of dill (Plate 4.11), root rot of nigella (Plate 4.12). Isolations for causal organisims were made on PDA and purified from roots and foliage of anise and nigella.

Plate 4.6: Root rot of anise

Plate 4.7: Powdery mildew of anise

Plate 4.8: Leaf spot of anise

Plate 4.9: Powdery mildew of caraway

Plate 4.10: Powdery mildew of dill

Plate 4.11: Blight of dill

Plate 4.12: Root rot of nigella

NRCSS Annual Report 2010-11

Monitoring on the Institute farm:

- Two varieties each of cumin, coriander and fenugreek crops were planted in four different dates of sowing during *rabi* 2009-10 at NRCSS farm to monitor the appearance and spread of diseases. In cumin, wilt disease was observed from early crop stage. The other diseases observed were blight and powdery mildew. Blight was appeared during the month of January at pre flowering to flowering stage, where as powdery mildew was appeared late in the season at the maturity stage of the crop. In fenugreek powdery mildew disease was observed in the month of February and the disease was spread within the field up to maturity stage of the crop (mean disease index 42-51%). The root rot of Fenugreek was observed in early growth stage of crop. In coriander, powdery mildew symptoms were observed during late in the season and spread within a week after initiation. Mean disease index was 59-87% in different dates of planting.

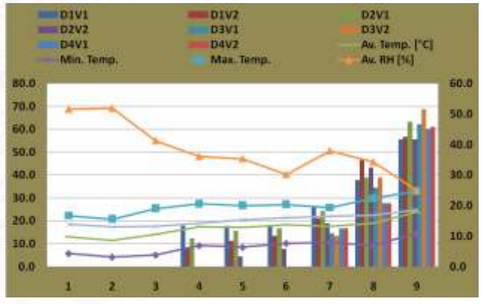


Fig. 4.31: Appearance and spread of fenugreek powdery mildew

Table 4.33: Simple correlation coefficient of fenugreek powdery mildew and meteorological factors

Treatment	Air temperature [°C]			RH [%]	Soil temp [°C]
	Mean	Max	Min		
D1V1	0.952	0.910	0.926	-0.827	0.956
D1V2	0.875	0.866	0.818	-0.730	0.919
D2V1	0.933	0.894	0.901	-0.794	0.951
D2V2	0.819	0.811	0.765	-0.653	0.887
D3V1	0.798	0.788	0.753	-0.607	0.837
D3V2	0.795	0.791	0.743	-0.606	0.829
D4V1	0.804	0.775	0.776	-0.609	0.844
D4V2	0.804	0.775	0.776	-0.610	0.843

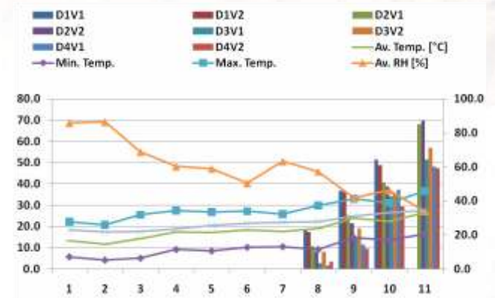


Fig 4.32: Appearance and spread of coriander powdery mildew

Table 4.34: Simple correlation coefficient of coriander powdery mildew and meteorological factors

Treatment	Air temperature [°C]			RH [%]	Soil temp [°C]
	Mean	Max	Min		
D1V1	0.792	0.758	0.769	-0.641	0.874
D1V2	0.796	0.763	0.772	-0.644	0.874
D2V1	0.848	0.820	0.847	-0.729	0.879
D2V2	0.828	0.801	0.829	-0.712	0.859
D3V1	0.811	0.793	0.800	-0.698	0.857
D3V2	0.836	0.810	0.835	-0.720	0.873
D4V1	0.782	0.769	0.765	-0.673	0.846
D4V2	0.787	0.766	0.784	-0.677	0.836

CPt 5: Eco-friendly approaches for the management of soil borne pathogens of seed spices

A. Comparative efficacy of bioagents against wilt of cumin

A field experiment was conducted at NRCSS, Ajmer to know the comparative efficacy of bio agents and organic amendments for the management of cumin wilt disease using seed treatment and soil application during *rabi* season of 2009-10. The data revealed that all bio agents reduced the wilt incidence as compared to untreated control. However, variation in disease incidence was observed from 18.5-37.7%. The maximum reduction in the disease was observed with the application of *T. viride* (18.5%). Maximun seed yield was also observed in the same treatments (Fig. 4.33).

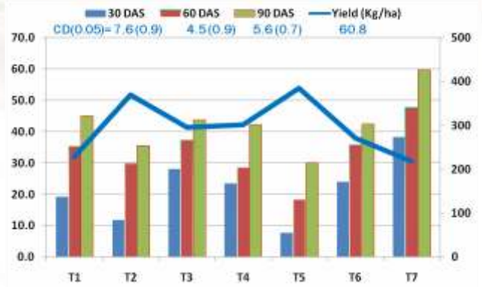


Fig. 4.33: Comparative evaluation of bioagents for the management of cumin wilt and yield of cumin

B. Isolation and bioefficacy of native bioagents:

Nine rhizosperes soil samples of cumin were collected from the Institute field and 16 different *Trichoderma* isolates were isolated at NABII and tested against *Fusarium oxysporium* f.sp. *cumini* in dual culture. The isolates showed variation in growth inhibition of *F. oxysporium* f.sp. *cumini*, however, maximum reduction in growth was observed with isolate Cu 7-01 (Plate 4.13 and Fig. 4.33A)

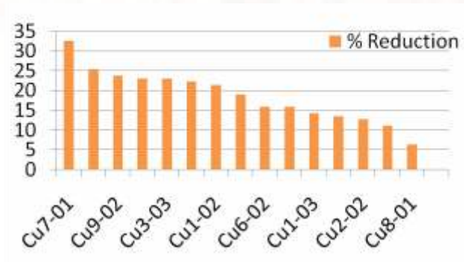


Fig 4.33 A: Bioefficacy of native *Trichoderma* isolates against *Fusarium oxysporium* f.sp. *cumini*

C. Effect of organic amendments on wilt of cumin:

Among soil amendments maximum reduction in wilt disease incidence and increase in seed yield was observed with the application of mustard residue + mustard cake + neem cake (Fig. 4.34 & 4.35) followed by mustard residue + mustard cake+poultry manure (32.7%). However, all organic amendments reduced the wilt incidence as compared to untreated control (61.1%).

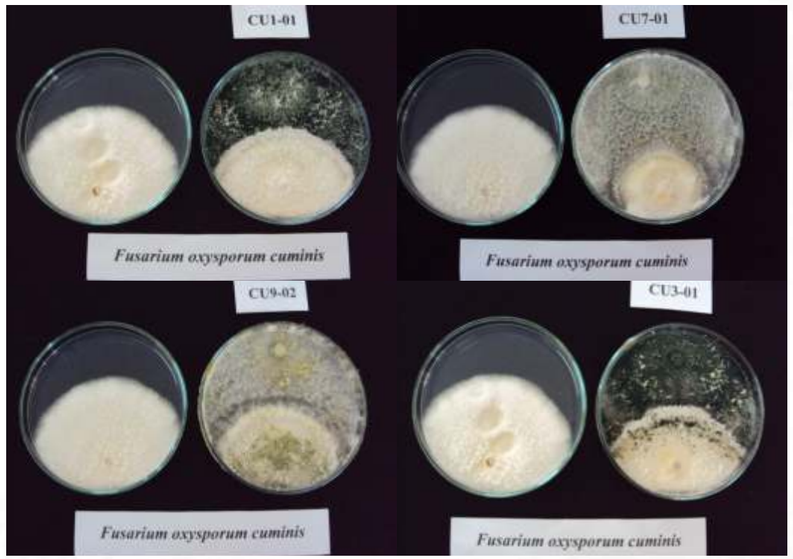


Plate 4.13: Growth inhibition of Fusarium oxysprium f.sp. *cumin* against *Trichoderma* isolates.

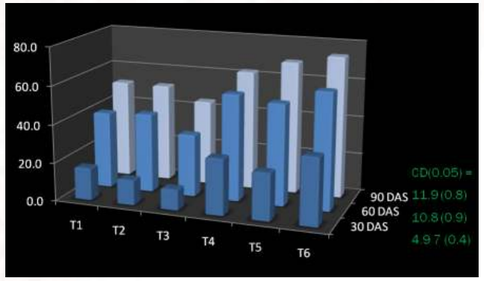


Fig. 4.34: Effect of organic amendments on wilt of cumin

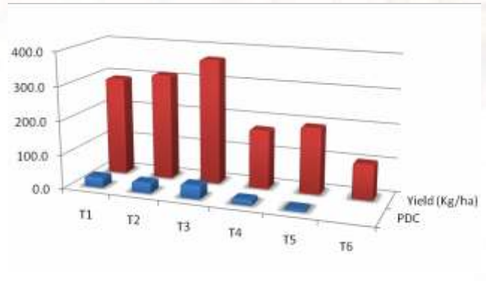


Fig. 4.35: Effect of amendments on cumin seed yield

CPt-7: Development of plant protection schedule for cumin cultivation

Four different application schedules of chemical, organic fungicides and insecticides were tested against different diseases and insects of cumin during *rabi* 2009-10. Results revealed that all four application schedules reduced the powdery mildew, blight PDI and aphid population as compared to untreated control. However, maximum disease and pest reduction and increase in yield was observed with application schedule S_2 & S_3 (Soil application of neem cake + mustard cake, seed treatment with tebucanazole, soil drenching with metalaxyl, foliar spray with mancozeb, propiconazole, karathane, acetamiprid and imidachlorpid (Fig. 4.36 and table 4.35, 4.36).

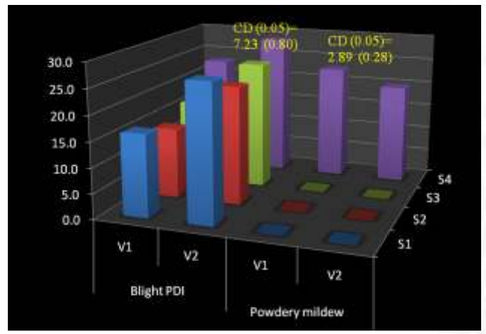


Fig.4.36: Effect of varieties and application schedule on blight and powdery mildew of cumin

Table 4.35: Effect of varieties and application schedule on aphid population in cumin

Variety / Schedule	Aphid Population					
	V_1			V_2		
	0	3	7	0	3	7
1st spray						
S1	25.8	5.0	6.3	16.9	1.3	3.0
S2	12.9	0.0	1.0	9.6	2.0	1.2
S3	16.3	2.3	3.6	25.6	1.0	2.1
S4	29.9	2.4	4.1	25.9	3.6	5.0
S0	33.9	38.0	42.2	35.1	35.6	36.3
2nd spray						
S1	21.2	8.6	8.3	11.6	7.3	6.9
S2	8.9	0.6	3.0	6.3	2.1	3.0
S3	24.3	2.6	3.3	16.6	1.3	2.1
S4	10.0	4.3	4.0	17.6	8.3	6.3
S0	32.6	22.6	19.0	42.3	27.3	18.4
3rd spray						
S1	5.3	1.3	0.33	3.0	1.2	0.11
S2	4.1	0.6	0.0	2.3	0.3	0.0
S3	6.5	1.0	0.6	10.0	1.3	0.0
S4	7.3	1.7	0.6	9.1	3.3	0.1
S0	10.2	7.0	1.3	9.3	9.0	1.5

Table. 4.36: Effect of varieties and application schedule on yield and yield attributing characters of cumin

Variety /Schedule	Plant height		Branches/Plant		Yield/Plot(g)		Yield Kg/ha	
	VI	V2	VI	V2	VI	V2	VI	V2
SI	27.11	35.00	5.0	6.3	558.3	425.0	465.3	354.2
S2	37.56	34.11	6.1	6.0	658.3	811.7	548.6	676.4
S3	33.22	28.11	5.8	5.9	625.0	608.3	520.8	506.9
S4	32.25	28.83	5.8	5.6	358.3	491.6	298.6	409.7
S0	25.33	30.78	5.2	5.7	308.3	316.7	256.9	263.9
CD(P=0.05)	4.56		0.62		86.46		59.56	

Entomology :

CPt-2. Management of seed spice midge *Systole albipennis* (Walker) in coriander

Integrated pest management of seed midge (*Systole albipennis* Walker) using cultural method, i.e. effect of date of sowing, botanicals like neem (*Azadirachta indica*) and Karanj (*Pongamia spp.*) based formulation and synthetic organic insecticides. Adult insect population dynamics on coriander crop by sweep net monitoring methods showed that there were three peak activities of adult population on the crop. Among application of botanicals, spraying of neem oil at 1.0 and 2.0 % level gave maximum protection and higher seed yield against pest and were only 3.5 and 3.9 % infestation, respectively as compared 13.1% infestation to control (Fig 4.37). In case of insecticide application imdacloprid (4.4% infestation) and thiomethoxam (4.7 % infestation) gave maximum protection and seed yield of coriander i.e. 13.4 and 13.7q/ha, respectively (Fig. 4.30). Different dates of sowing of crop showed that late sown crop suffered less from the attack but yield was recorded lower.

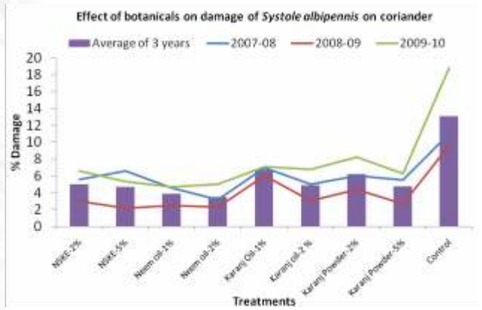


Fig .4.37: Effect of botanicals on damage of *Systole albipennis* on coriander

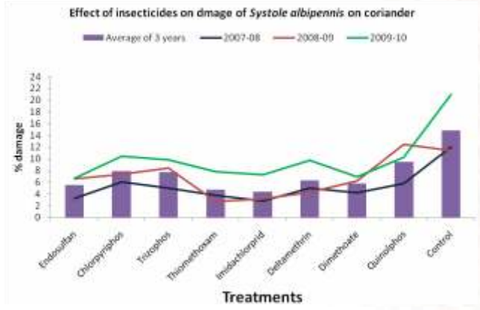


Fig .4.38: Effect of insecticides on damage of *Systole albipennis* on coriander

CPt-3: Survey and Surveillance for study on occurrence of insect pests of seed spices

Sucking pests complex was found major pests of all seed spices crops (Table 4.37). Important sucking pests recorded on these crops are aphids (*Aphis gossypii, Myzus persicae*, *Aphis craccivora* and *Hyadaphis coriandri*), thrips, white fly (*Bemisia tabaci*), jassids (*Empoasca* spp.), cletus bug and nysus bug. Beside this seed midge (*Systole albipennis*) was found as major pests of coriander and fennel. Defoliators like *Helicoverpa armigera* and *Spodoptera litura* occure at full vegetative stages for the short period on all the crops. Cut worm (*Agrotis ipsilon*) infestation at lower level was also noticed at early growth stages in cumin, fennel and fenugreek crops. Among natural enemies complex predators coccinellids, syrphid fly and *Chrysoperla carnea* and parasitoides *Aphidius* spp. commonly found during full vegetative stages to crop maturation stages (Table 4.38).

Table 4.37: Major Insect pests of Coriander, Cumin Fennel, and Fenugreek

S. No.	Insects	Scientific Name	Crop
1	Cut worm	*Agrotis ipsilon*	Cumin,Fennel
2	Aphids	*Hyadaphis coriandri*	Coriander
		Hyadaphis coriandri	Fennel
		Aphis gossypii	Cumin
		Myzus persicae	Cumin
		Aphis craccivora	fenugreek
3	Thrips	*Thrips tabaci , Caliothrips indicus, Scirtothrips dorsalis, Frankliniell schultzei, Aeolothrips collaris, Haplothrips Spp.*	Coriander,Cumin,Fennel, Fenugreek
4	Seed Midge	*Systole albipennis*	Coriander & Fennel
5	White Fly	*Bemisia tabici*	Coriander, Cumin & Fenugreek
6	Leaf Minor	*Lyromiza spp.*	fenugreek
7	Jassids	*Empoasca spp.*	Fenugreek & Cumin
8	Leaf/Fruit eating caterpillar	*Helicoverpa armigera*	Coriander, Cumin & Fenugreek
		Spodoptera litura	Coriander, Cumin & Fenugreek
9	Seed bug	*Nysius spp.*	Fennel, Ajwain
		Cletus spp.	Fennel, Ajwain

Table 4.38: Major Natural Enemies complex of Coriander, Cumin Fennel, and Fenugreek

S. No.	Insects	Scientific Name
1	Coccinella	*Coccinella septumpunctata*
		Hippodamia variegata
		Brumoides Suturalis
		Cheilomenes sexmaculata
		Scymnus sp.
2.	Syrphid fly	*Episyrphus balteatus*
		Ischiodon scutellaris
3	Chrysoperla	*Chrysoperla carneaa*
4	Aphids Parasitoides	*Aphidius sp.*

CPt-4: Studies on bio ecology of storage pests in seed spices

- Seed spice crop at storage is attacked by five species of stored pest namely cigarette beetle (*Lasioderma serricorne* F,), drug store beetle (*Stegobium panicum* L.), seed spices midge (*Systole albipennis* walker), red rust flour beetle (T*ribolium castenium* H.) and warehouse beetle (*Trogoderma* spp.).
- Cumin, coriander, fennel and ajowan was found most affected at storage condition.

dill and nigella found low infestation and fenugreek was found free from any insect infestation at storage level.

- More than 80 per cent of damage of all seed spices at storage was due to cigarette beetle (*Lasioderma serricorne*).
- Coriander, cumin, fennel and ajowan got more physically deterioted after infestation at storage condition. In laboratory studies annual losses due to cigarette beetle was 58.0% in fennel, 49.58 % in coriander, 51.02% in cumin, 47.755 in ajowan and 39.0 5 in dill seed was observed.
- Average development period of immature stages cigarette beetle on cumin, coriander, fennel and ajowan was 35.8 days (5.9 days egg period, 24.7 larval period and 5.2 days papal period) and adult longevity was 25.0 days.

Plate 4.14: Cumin seed infested with *Lasioderma serricorne*

CPt-6: Biorational Management of aphids in cumin and fennel crops

- In cumin crop application of application of neem oil and *Verticillium lacanii* prove effective in control of aphids (*Myzus persicae* and *Aphis gossypii*) and also gives higher yield after insecticides check.
- In fennel crop application of *Beauveria bassiana and* Allyl iso thio cynate extracted from mustard seed gives maximum protection and yield after insecticides check.

Plate 4.15: Development of fungal mycelium on aphid body

4.4 Basic Science

BS-1 :Effect of some chemicals on low temperature tolerance in cumin and coriander

Two important varieties of each cumin and coriander were grown. Spray of selected chemicals (ABA, ASA, Betain hydrochloride and proline)was made at two stages. Various morphological parameters have been evaluated and correlated with yield potential. Low temperature injury was assessed using cell membrane injury analysis. Concentration of some chemicals on growth and yield of cumin and coriander was significant. Membrane integrity was found to be affected by spraying these chemicals.

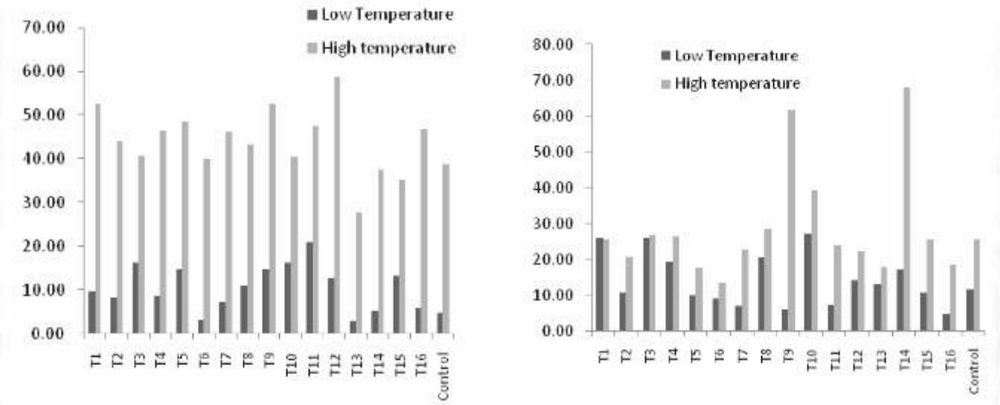


Fig. 4.39: Effect of selected chemicals on membrane injury (%) in coriander (RCr 41, I & IInd spray)

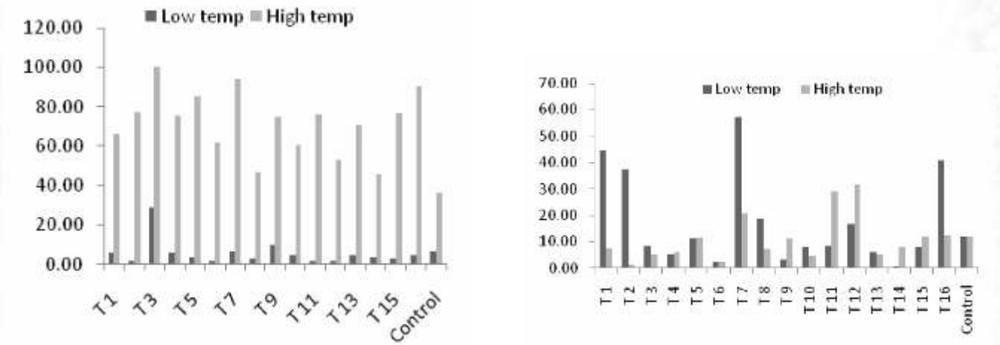


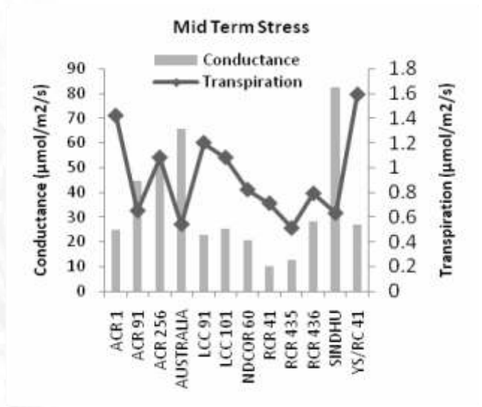
Fig. 4.40: Effect of selected chemicals on membrane injury (%) in cumin (GC 4, I & IInd spray):

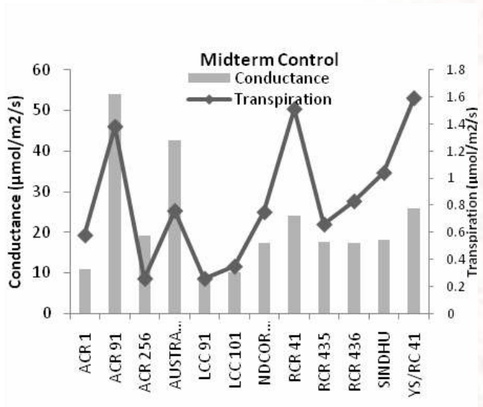
BS-2: Physiological parameters and their relation to seed yield in seed spices crops

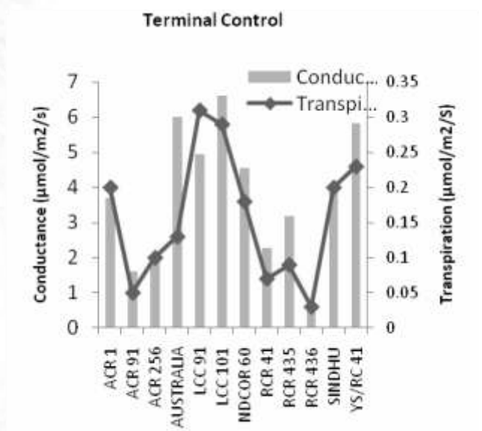
Study was conducted on two genotypes of cumin, coriander, fennel and fenugreek.

- Rate of photosynthesis in two genotypes in all seed spices varies significantly at all growth stages.
- Variation in leaf temperature between two genotypes were non significant except in cumin at 45 DAS.
- Difference between leaf to air temperature was significant in all crops at all stages.

- Except fenugreek and cumin, transpiration rate was at par in all genotypes of other crops
- Stomatal conductance also varies with the genotypes in all crops.
- PAR was highly variable at different stages which have direct relation with rate of photosynthesis.
- Growth parameters viz. shoot weight, Root weight, Shoot length, Root length, Number of branches showed a definite growth pattern in all crops i.e. increase with age of the plant except shoot and root weight which decrease at maturity.
- A high ratio of SW/RW and FW/DW Coriander and cumin resulted in to higher yield
- This relation is not reflected in fenugreek and fennel







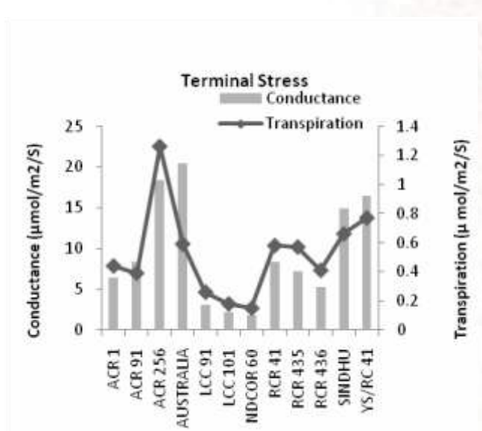


Fig. 4.41: Effect of water stress on photosynthetic parameters parameters

BS-3: Effect of water stress on water relation, photosynthetic parameters and membrane integrity of coriander genotypes

Twelve coriander (*Coriandrum sativum* L.) accessions comprising of released varieties, advance breeding material, regional and exotic collections were evaluated at National Research Centre on Seed Spices, Ajmer for effect of water stress on morpho-physiological and seed quality parameters including total oil, essential oil, test weight and seed size. All recorded parameters showed significant genotypic variation as well as significant interaction of genotype with environment. Midterm water stress does not have adverse effect on studied quality parameters while terminal water stresses exhibit reduction in most of the accessions.

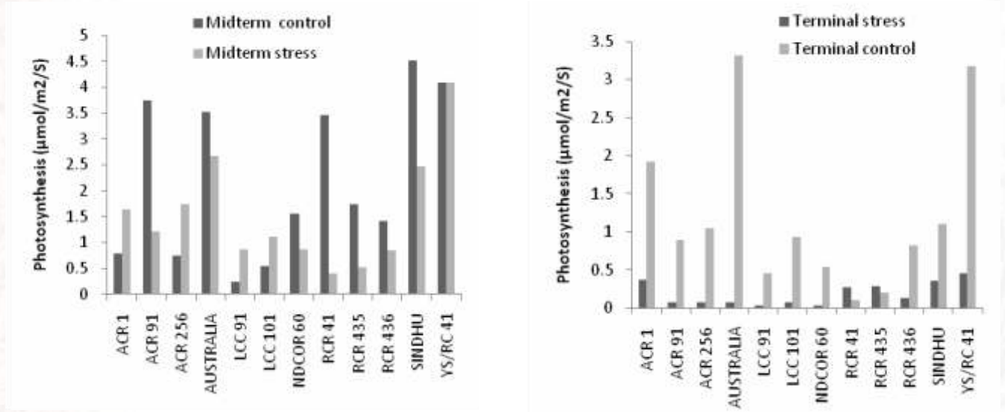


Fig. 4.42: Effect of water stress on photosynthesis

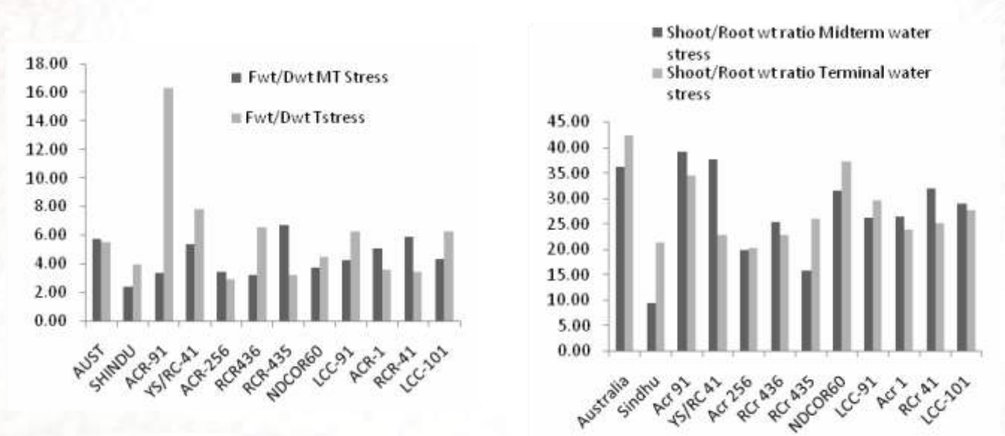


Fig. 4.43: Effect of water stress on morphological parameters

Table 4.39: Effect of water stress on total oil and essential oil content in different coriander accessions

Accessions	Total oil (%)				Essential oil (%)			
	Non Stress/ Control	Mid-term water stress	Terminal water stress	Mean	Non Stress/ Control	Mid-term water stress	Terminal water stress	Mean
ACr 1	13.25	14.93	13.08	13.75	0.19	0.23	0.22	0.21
ACr 91	16.59	16.55	9.90	14.35	0.21	0.19	0.19	0.20
ACr256	10.59	7.80	9.24	9.21	0.09	0.21	0.09	0.13
Australlia	15.98	15.81	12.48	14.76	0.15	0.21	0.20	0.19
LCC 101	15.43	21.14	10.74	15.77	0.51	0.26	0.41	0.39
LCC 91	14.26	14.20	11.06	13.17	0.39	0.23	0.33	0.32
NDCOR 60	15.24	18.11	12.25	15.20	0.32	0.25	0.43	0.33
RCr 41	16.27	15.15	14.38	15.27	0.02	0.14	0.19	0.12
RCr 435	13.44	12.29	12.09	12.61	0.30	0.29	0.27	0.29
RCr 436	16.17	16.74	14.85	15.92	0.19	0.17	0.16	0.14
Sindhu	13.95	11.30	11.30	12.18	0.11	0.19	0.15	0.15
YS/RC 41	9.25	8.80	14.23	10.76	0.01	0.11	0.13	0.08
SEm (±)	0.59	0.59	0.52	1.15	0.01	0.01	0.01	0.03
CD (0.05)	1.72	1.74	1.51	3.335	0.03	0.02	2.11	0.101

Table 4.40: Effect of water stress on test weight and seed size in different coriander accessions

Accessions	Test Weight (g)				Seed size (mm)			
	Non Stress/ Control	Mid-term water stress	Terminal water stress	Mean	Non Stress/ Control	Mid-term water stress	Terminal water stress	Mean
ACr 1	9.45	14.11	10.18	11.24	3.11	3.23	3.06	3.13
ACr 91	16.18	14.49	14.01	14.89	3.24	3.87	3.35	3.49
ACr256	9.68	13.88	11.47	11.68	3.14	3.33	3.30	3.26
Australlia	16.82	18.42	15.85	17.03	3.47	3.36	3.95	3.59
LCC 101	23.48	23.35	20.84	22.56	4.38	4.37	4.61	4.45
LCC 91	21.83	21.71	22.67	22.07	4.25	4.20	4.08	4.18
NDCOR 60	22.33	23.23	21.14	22.23	4.34	4.19	3.94	4.16
RCr 41	15.68	13.66	12.01	13.78	3.24	3.21	3.30	3.25
RCr 435	15.09	13.69	13.28	14.02	3.35	4.59	3.51	3.82
RCr 436	16.59	23.13	17.19	18.97	3.33	3.40	3.94	3.56
Sindhu	16.67	14.67	16.00	15.78	3.44	3.30	3.16	3.30
YS/RC 41	15.68	9.23	9.61	11.50	3.60	3.46	3.14	3.40
SEm (±)	0.71	0.72	0.67	0.98	0.15	0.15	0.15	0.14
CD (0.05)	1.51	0.03	1.95	2.83	0.44	0.45	0.44	0.420

BS-4: Developing varieties resistant to fungal pathogen in cumin through gene tranmsformation

Wilt, blight and Powdery mildew incited by *Fusarium oxysporum* f.sp.*cumini*, *Alternaria burnsii* and *Erysiphe polygoni*, respectively are the major threat to cumin cultivation in arid and semi arid areas. All these three diseases cause serious losses in seed yield. Development of transgenic harboring genes that are directly involved in fungal development and survival may provide a solution for wide range of fungal diseases. Such (Chitinase, and β1-3 glucanase) genes have been well characterized and have been found effective against various diseases and crops at laboratory and green house conditions. Proposed project is a collaborative effort of NRCSS, Ajmer and Biotechnology division IIHR, Bangalore. Regeneration protocol and field testing of transgenic plants will be carried out by NRCSS while genetic transformation work will be done by IIHR, Bangalore.

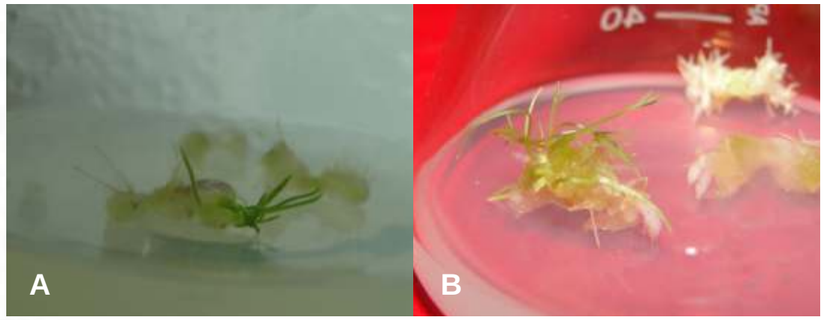


Plate 4.16: Shoot organogenesis from hypocotyl callus of var. GC 4 on (A) Gamborg's medium supplemented with TDZ 1.0 mg L-1 and NAA 0.5 mg L-1 and on (B) MS medium supplemented with TDZ 0.5 mg L-1 and NAA 1.0 mg L-1

Plate 4.17 : (A) Apical shoot tip explant developed in to complete plant on MS medium without growth regulators. (B & C) Shoot multiplication on MS medium supplemented with kinetin 1.0 mg L-1 and NAA 0.1 mg L-1

4.5 Social Science

SS-1: Awareness and adoption of seed spices production technology

This is inter-institutional project running with the collaboration of Krishi Vigyan Kendra, Ajmer and ADG(Ag. Extn.), KAB-I, Pusa New Dlehi. In this project we have given demonstrations and training to the selected farmer's of Ajmer and Jodhpur district for cumin and in Baran district for coriander crop.

- By giving seed and fertilizers to 18 per cent selected famers in each village demonstration of Cumin and Coriander in Ajmer, Jodhpur and Baran districts has been completed.

- Training programme to selected farm families in Ajmer, Jodhpur and Baran district has been done successfully.

Trainings

Details of trainings and beneficieris of these trainings district wise is presented in Table 4.41.

Demonstrations

Total 432 demonstrations were conducted in three districts and total area under demonstration is 72 ha (Table 4.42). Results of the demonstrations were presented in table 4.43.

Table 4.41: District wise trainings conducted and participants

District	Number of training	Number of participant
Ajmer	7	432
Jodhpur	6	331
Baran	3	472
Total	**16**	**1235**

Table 4.42: District wise demonstrations conducted during rabi 2009-10

District	Crop	Number of Demonstrations	Area/ha
Ajmer	Cumin	144	24
Jodhpur	Cumin	126	21
Baran	Coriander	162	27
Total		**432**	**72**

Table 4.43: Results of Demonstrations

Crop	Variety	No. of Farmers	Area (ha)	Demonstration yield (q/ha)				Increase yield (%)	B:C ratio
				Highest	Lowest	Average	Local-check		
Cumin (at Ajmer)	RZ-209	144	24	12.6	6.00	8.30	5.10	62.73	3.60
Cumin (at Jodhpur)	RZ-209	126	21	9.48	5.10	7.56	4.56	65.78	3.20
Coriander (at Baran)	Rcr-435	162	27	19.8	9.30	13.9	11.80	17.79	2.79

Project SS-2: Development of expert system on seed spices

Variety and insect-pests disease module have been developed for ten seed spices crops and data of ten spices crops uploaded in computer.

Project SS-3: Development of traders/ exporters/ industrialist information on seed spices.

The information regarding exporters, traders and industrialists have been collected from different sources. In MS-access programme tables have been developed and interlinked with each other. State wise list have been prepared for 200 seed spices traders/ industrialists and exporters. To incorporate search query module for accessing state wise information from data base and uploaded on our centre's website.

4.6 Seed Production

Mega Seed Project on Seed Production of Agricultural Crops and Fisheries

The project was started in year 2006 with the assistance from ICAR, which is coordinated by DSR, Mau (UP). Seven seed spices crops namely coriander, cumin, fennel, fenugreek, ajowain , dill and nigella have been taken for seed multiplication on an area about 16 acres of land at NRCSS Farm. The variety wise production details are given in table 4.44.

Table 4.44: crop and variety wise seed production during 2009-10

S. No.	Crop and variety	Production (Kg)
1.	**Fenugreek**	
	A. Fg.-1 (AM-1)	155.0
	AFg.-2 (AM-2)	243.0
	RMt-1	156.0
	RMt-305	116.0
2.	**Fennel**	
	AF-1	262.0
3.	**Coriander**	
	ACr-1	101.0
4.	**Nigella**	
	AN-1	20.5
5.	**Dill**	
	AD-2	4.5
6.	**Ajowan**	
	AA-1	5.0
	AA-2	65.0
7.	**Cumin**	
	GC-4	42.0
	RZ-209	55.0
Total		1225.0

5. TRANSFER OF TECHNOLOGY

NRCSS is involved in various activities like training programmes for farmers and training for state department's employees on seed spices crops. The problem regarding seed spices production are attended at the centre and provided published literature to the farmers and visitors on production technology on seed spices crops. Field visits, demonstrations and farmers training programmes and kisan mela are organized with the collaboration of KVK, State departments and other extension agencies and NGO's for disseminating of latest technology.

5.1 National Horticulture Mission

In this scheme we have selected a District in each states i.e. Jaisalmer (Rajasthan), Jhansi (U.P.) and Hyderabad (Andhra Pradesh) for giving training to the farmers on seed spices crops. Under this scheme we have organized 2 days training programme to 100 farmers and delivered lectures through experts on seed spices so that farmers get benefitted to seed spices production technology which is developed by the scientists.

5.2 Crop Museum

In rabi season all our mandate crops with released varieties (11 nos.) i.e. Coriander, Cumin, Fennel, Fenugreek, Ajwain, Dill, Anise, Nigella, Celery, and Caraway were sown. The main aim to develop crop museum was to disseminate the knowledge about the innovative seed spices production technology and popularize the same amongst the farmers, researchers and visitors of the country.

5.3 Visit of farmers at centre's farm:

Various groups of farmers, students and researchers have visited and see the activities of NRCSS. Most of the farmers get benefitted and get solution to their problem. During 20010-11 about 2500 farmers, students from different states of the country mainly from Rajasthan, Haryana, U.P., M.P., Himachal Pradesh and Maharashtra visited the centre under training and visit programme of respective states. The lectures delivered through scientists and technical officers of the centre and suggested solutions to their problems and educate them by exhibiting the new technology in the field.

5.4 Visits of farmer's field

Many farmers come at our centre with their problems occurred in their fields. To overcome their problems many visits were made to farmer's field by our experts. The farmer's were also guided through telephonic talk to solve their problems with respect to seed spices crops.

5.5 Kisan Mela

National Masala Kisan Mela and Kisan Goshthi-2011 was organized by NRCSS, Tabiji Ajmer on 22nd March, 2011. About 500 Male and female farmers including other officials were participated and benefitted by different lectures and also get solutions to their problems during Kisan Goshthi. The Mela cum exhibition was inaugurated by Dr. M.M. Anwer. On this occasion Smarika-2011 were released which contains the production technology of seed spices. The Smarika-2011 was distributed among all the participants free of cost for the benefit of the farmers. Many stalls were arranged by different centres of ICAR and Department of Agriculture, Govt. of Rajasthan, Banks and NGO's.

5.6 Training Programme:

1. **Farmers training programme under NHM during 17th -19th October, 2010 at KVK Jaisalmer**

NRCSS, Ajmer organized a farmers training programme for Seed spice growing farmers of Jaisalmer & Barmer districts of Rajasthan during 17–19 October, 2010 under NHM project entitled "Technology dissemination & transfer of technology of seed spices" sponsored by Directorate of Arecanut & Spice Development, Calicut. The venue of the training was KVK, Jaisalmer. In all fifty farmers attended the training programme. The inaugural session was presided over by Dr. M. M. Anwer, Director, NRCSS and Sh. Homey Cheriyan Deputy Director (DASD) was the Chief guest of the inaugural function. There were 10 technical lectures on various aspects of Production of Seed spices. Dr. Gopal Lal, Dr. S.S. Meena, Sh. M. A. Khan, Sh. G. K. Tripathi of this

institute attended the training programme and delivered lectures on various aspects of Seed spices. Apart from the resource personnel from Ajmer, scientist of ARS Jaisalmer and KVK Jaisalmer also delivered lectures on the aspects of seed spices.

2. **Farmers training programme under NHM during 15th -16th November, 2010 at KVK, CRIDA**

NRCSS, Ajmer organized a farmers training programme for Seed spice growing farmers districts of Hyderabad during 15–16 November, 2010 was conducted under NHM project entitled "Technology dissemination & transfer of technology of seed spices" sponsored by Directorate of Arecanut & Spice Development, Calicut. The venue of the training was KVK, CRIDA. In all fifty farmers attended the training programme. P.I of this programme was Dr. G. Lal and the Coordinator were Dr. R.S. Mehta and Sh. M.A. Khan from NRCSS, Ajmer. The inaugural session was presided over by Dr. M. M. Anwer, Director, NRCSS and Sh. B.L. Meena Assistant Director (DASD) was the Chief guest of the inaugural function. The technical bulletin on seed spice production was printed in Multilanguage first time for the farmers. There were 14 technical lectures on various aspects of Production of Seed spices. Dr. Gopal Lal, Dr. R.S. Mehta, Sh. M. A. Khan, of this institute attended the training programme and delivered lectures on various aspects of Seed spices. Apart from the resource personnel from Ajmer, scientist of KVK CRIDA and CRIDA also delivered some lectures on the aspects of seed spices.

3. **Training programme for Women**

One Month Women Training Programme on processing of seed spices is heldfrom 22.11.2010 to 21.12.2010 in NRCSS premises. NRCSS have supported logistic and other facilities to the beneficiaries. The programme is inaugurated by Dr. G. Lal as an in-charge Director in the presence of I/c Social Science, Mr. M.A. Khan and programme organizer Mr. J. Chaturvedi. All type of training has given to women like package of practices, processing, grading, packing and grinding of seed spice. Women were also tought about bank formalities like how to open account in the bank and to apply loan for small scale industries etc.

4. **Training programme on "Commercial Production of Seed Spices"**

A training programme on "Commercial Production of Seed Spices" was organized by HRD unit of NRCSS during 1st December to 10th December 2010. The participants of programme were Agriculture Officers of Bodoland Territorial Council, Assam, India. The programme includes 30 in house lectures covering all aspects of seed spices cultivation. The resources persons were the faculty from NRCSS. Project Coordinator of AICRP on spices Dr. M. Anand Raj, eminent spice breeder from RAU Bikaner, Dr. EVD Sastri, Chief Scientist, KVK Ajmer, Dr. G. N. Mathur and Dr. Sajiv Anand were among the invited speakers. The participants also visited seed spice growing areas of Jodhpur and Jaisalmer. Course Director Dr. M. M. Anwer delivered lecture on ongoing seed spices research at NRCSS and future perspectives.

5. Seminar on New Dimensions of Enhancing Production & Productivity of Seed Spices in Dry land Areas of Andhra Pradesh" from November 11-12, 2010 at CRIDA, Hyderabad

National Research Centre on Seed Spices, Ajmer organized "Seminar on New Dimensions of Enhancing Production & Productivity of Seed Spices in Dry land Areas of Andhra Pradesh" from November 11-12, 2010 at CRIDA, Hyderabad" in collaboration with Agri-Horticultural Society, Hyderabad. The seminar was sponsored by Directorate of Arecanut and Spices Development, Calicut. Dr. M. M. Anwer, Director, NRCSS, Ajmer was the Organizing Chairman of the seminar and Dr. Y. K. Sharma, Sr. Scientist was Organizing Secretary of the seminar. One hundred participants including Officers from Department of Horticulture and Agriculture Govt. of Andhra Pradesh, scientists & technical's of ICAR and University, and farmers attended the seminar. Dr M. Tamil Selven, Director, Directorate of Arecanut and Spices Development, Calicut inaugurated the seminar. The scientists were represented by experts from pioneer institutes in seed spices research such as National Research Center on Seed Spices Ajmer, Central Research Institute for Dry land Agriculture, Hyderabad, Agricultural Research Institute (Andhra Pradesh Horticultural University), Hyderabad & Guntur. The purpose of organizing the seminar was to make the efforts to enhance the production and productivity of seed spices in Andhra Pradesh particularly dry land areas. This event was organized to provide an ideal platform to the Horticulture & Agriculture officers, scientists, seed spice growers to come together for meaningful deliberations on issues on different aspects like crop production, crop improvement, crop protection, crganic cultivation and general aspects related to enhance the production and productivity of seed spices.

In two days seminar there were deliberations of invited lectures on different aspects. Ten lectures on important aspects including present status and future prospects were delivered and discussed in detail.

6. Training to progressive farmers of Mewat

A three days training programme on seed spices production technology was organized by HRD unit of NRCSS for progressive farmers of Mewat Development Agency, Nuh, Mewat (Haryana) during 21-23rd December 2010. Farmers were trained on cultivation technologies of cumin, coriander, fennel and fenugreek crops. Farmers were told about value addition in seed spices crops. They visited all seed spices crops at NRCSS farm and told about different types of experiments.

7. Field day cum training programme on ajwain production

A Field day cum training programme on ajwain production in dry land area of Andhra Pradesh was organized on 28th Feb, 2011 at Kohir village of Medak district of Andhra Pradesh. On the occasion of field day sixty progressive seed spice growers from Medak district participated. Scientists from National Research Centre on seed Spices Ajmer imparted training to farmers on various aspects of ajwain Production. Team of scientists also visited ajwain field. On the site of field, interaction with farmers was made and queries of farmers in respect to ajwain production were addressed. The performance of Ajwain on farmer's field under dry land condition was also very good.

8. Field day cum training programme on nigella production

A Field day cum training programme on nigella production in dry land area of Andhra Pradesh was organized on 1st March, 2011 at Kohir village of Medak district of Andhra Pradesh. On the occasion of field day fifty progressive seed spice growers from Medak district participated. Scientists from National Research Centre on seed Spices, Ajmer imparted training to farmers on various aspects of ajwain production. Team of scientists also visited ajwain field. On the site of field, interaction with farmers was made and queries of farmers in respect to ajwain production were addressed. The performance of nigella on farmer's field under dry land condition was also very good.

9. State level Seminar on "Increase in area, production and productivity of seed spices in Orissa" from March 10th -11th, 2011 at Directorate of Research on Women in Agriculture, Bhubaneswar

The Centre had organized a state level seminar entitled "Increase in area,production and productivity of seed spices in Orissa" during 10th – 11th march. This was conducted under NHM project entitled "Dissemination of seed spices production technology through trainings & front line demonstrations, workshops and seminars." sponsored by Directorate of Arecanut & Spice Development, Calicut. The venue of the training was Directorate of Research on women in agriculture, Bhubaneswar. In all 100 stakeholders like, farmers, agricultural officers scientists and lectures of Orissa state attended the seminar. In two days seminar there were deliberations of invited lectures on different aspects namely Crop Production, Crop Improvement, Crop Protection, Organic cultivation and general aspects related to enhance the production and productivity of seed spices.. Ten lectures on important aspects including present status and future prospects were delivered and discussed in detail.

10. Two days training conducted at National Research Centre for Agroforestry, Jhansi

NRCSS, Ajmer organized a farmers training programme entitled "Measures to increase the production and productivity of seed spices in Bundelkhand area" during 19th – 20th February, 2011. The venue of the training was NRC on Agroforestry, Jhansi. In all fifty farmers from Jhansi and near by area attended the training. The training was provided on various aspects of seed spice production. The resources person from National Research Centre on Seed Spices, and NRC on Agroforestry, Jhansi delivered lectures. Farmers were made aware of value of seed spices both medically as well as income generation and improved production technology of seed spices particularly for Bundelkhand area.

6. HUMAN RESOURCE DEVELOPMENT

Teaching Programmes

Number of masters degree students: Four

1. "Organogenesis in Anise (*Pimpinella anisum*)." Submitted by Ishan Ullah Khan from Mahatma Gandhi Institute of Applied Sciences, Jaipur (University of Rajasthan). Under guidance of Dr. S.N. Saxena.
2. "Analysis of medicinal properties of cumin (*Cuminum cyminum* L) and ajowain (*Trachyspermum ammi* L) seed extracts and shoot callus" Submitted by Dolly Aggrawal from Mahatma Gandhi Institute of Applied Sciences, Jaipur (University of Rajasthan). Under guidance of Dr. S.N. Saxena.
3. "Analysis of medicinal properties of Anise (*Pimpinella anisum*) and Nigella (*Nigella sativa* L.) seed extract and shoot callus" Submitted by Megha Verma from Mahatma Gandhi Institute of Applied Sciences, Jaipur (University of Rajasthan). Under guidance of Dr. R.K. Kakani.
4. "Assessment of genotypic variation in medicinally important compounds in coriander (*Coriandrum sativum L.*) genotypes" Submitted by Sumit Saini from Mahatma Gandhi Institute of Applied Sciences, Jaipur (University of Rajasthan). Under guidance of Dr. S.N. Saxena

Programmes Organized

1. XXI Workshop of AICRP on Spices

XXI workshop of AICRP (Spices) was held at NRC on Seed Spices during 5th – 6th July, 2010. It was organised by Project Coordinator AICRP (Spices) situated at Indian Institute of Spices Research, Calicut. Dr. H. P. Singh DDG (Hort.) was the chief guest and Dr. G. B. Raturi was the guest of Honour. Dr. M. M. Anwer welcomed all the dignitaries. There were five technical sessions namely on genetic resources, crop improvement, crop management, crop protection and transfer of technology and in each session the work done by each AICRP centres was presented. New programmes for the coming season were also discussed.

2. National Consultation on "Seed Spices Biodiversity and Production for Export- Perspective, Potential, Threats and their solutions".

National Research Centre on Seed Spices, Ajmer, in collaboration with Indian Society of Seed Spices organised National Consultation on "Seed Spices Biodiversity and Production for Export- Perspective, Potential, Threats and their Solutions" in commemoration of celebration of a decade of NRCSS, on 7th July, 2010 at Auditorium of DAV College, Ajmer. It was sponsored by Indian Council of Agricultural Research, New Delhi, National Bank for Agriculture and Rural Development, Science Palace, Ajmer, Directorate of Arecanut and Spices Development, Calicut and Krishak Vikas Sansthan, Ajmer.

The Inaugural session was presided by Dr. S. P. Tiwari, Vice Chancellor, SKRAU, Bikaner and Dr. B. S. Chundawat, Ex. Vice Chancellor, SDAU, Sardarkrushinagar, Gujarat was the chief guest. Dr. Umesh Srivastava, ADG (H-II), ICAR, New Delhi, Dr. M. Tamil Selvan, Director, DASD, Calicut, Kerala, Dr. B.B. Vashishtha, Ex Director NRCSS and Dr. Rajesh Sharma, Principal DAV College, Ajmer were the guests of honour. Dr. M.M.Anwer, Director NRCSS and Organizing Chairman welcome all the dignitaries and gave a clear picture about the research work being carried out at NRCSS. Dr. Gopal Lal, Principal Scientist (Hort.) and Organizing Secretary presented a vote of thanks. There were six technical sessions with around 15 lead speakers. Concurrently a poster session was also conducted in which around 104 posters were presented. 13 posters were selected as best posters. The plenary session was presided by Dr. J.S. Chouhan, Director, Directorate of Rapeseed and Mustard Bharatpur and Mrs. Naseem Aktar Insaf, MLA Pushkar, Ajmer was the chief guest. Dr. Umesh Srivastava, ADG (H-II), ICAR, New Delhi. The recommendations of respective sessions were discussed, modified and approved by the house.

Symposia / Seminars: Twenty in-house seminars have been organized

NRCSS Annual Report 2010-11

Other Training Programme Attended

S. No	Name of the participant	Name of training	Duration
1.	Dr. R. K. Kakani	Three months training on Marker Assisted Selection in Horticulture with Prof. Muralee Dharan Nair at Michigan State University, East Lansing, Michigan, USA under NAIP (ICAR).	18 March to 14 June 2010
2.	Dr. R.S. Meena	Breeding of chickpea and lentil" at ICARDA, Aleppo, Syria organized	25 to 7 May 2010

Seminar/ Symposia / Training / Meetings attended

S. No.	Name of the participant	Seminar/ Symposia / Training / Meetings
1.	Dr. G. Lal	• National conference on production of quality seeds and planting material-Health management in horticultural crops." jointly organized by Society for promotion of Horticulture, Indian institute of Horticultural Research and Confederation of Horticultural Association of India held on 11-14th March,2010 at New Delhi. • National Conference on Horticultural Biodiversity for Livelihood, Economic Development and Health Care. Organised by Lt. Amit Singh Memorial Foundation at Bangalore during 29-31 May, 2010 • National Group Meeting of Research Workers (XXI Workshop) of All India Coordinated Research Project on Spices, Organised by PC Unit of AICRPS, Calicut and NRCSS, Ajmer during July 5-6, 2010 at NRCSS, Ajmer. • National consultation on "Seed spices biodiversity and production for export- perspective, potential, threats and their solutions", organised by NRCSS and ISSS, Ajmer on July 7, 2010 at Auditorium of DAV College, Ajmer. • Two day workshop on women friendly farm tools and equipment during 4th- 5th October, 2010 at Bhubaneshwar, Orissa. • National seminar on engineering agriculture for evergreen revolution. Organized by Indian society of Agricultural Engineers, AP chapter in association with Acharya N.G. Ranga Agricultural University, Hyderabad and Central Research Institute for Dryland Agriculture, Hyderabad, September 24-25, 2010. • 4th Indian Horticulture Congress, 2010. Organized by Horticultural Society of India, New Delhi and Skills Foundation of India Gurgaon November 18-21, 2010, New Delhi. • National Seminar on Precision Farming in Horticulture, 2010. Organized by Department of Fruit Science College of Horticulture & Forestry, Maharana Pratap University of Agriculture & Technology, Udaipur Campus: Jhalarapatan, Jhalawar December 28-29, 2010.

S. No.	Name of the participant	Seminar/ Symposia / Training / Meetings
2.	Dr. O. P. Aishwath	• Carbon sequestration in urban ecosystem, OSU, USA held on 14. April, 2010. • National group meeting of research workers (XXI Workshop) of AICRP- ICAR held on 5-6 July 2010. • National Consultation on Seed Spices Biodiversity and Production for Export-Perspective, Potential, Threats and their Solutions, held on July 7 2010 at NRCSS, Ajmer, Rajasthan, India. • International conference on climate change and Environment held on 22-24 September, 2010 at Kochi, Kerala. • National Seminar on Issues in Land Resource Management: Land degradation, Climate Change and Land use Diversification held on 08-10 October, 2010 at Nagpur, (MH). • 75th Annual convention of Indian Society of Soil Science on Development in Soil Science-2010 held on 14-17 November 2010 at IISS, Bhopal (MP). • Short course on 'Geostatistical Analysis of Environmental Data' from 21 to 25 February 2011at International Crop Research Institute for Semi-Arid Tropics, Hyderabad.
3.	Dr. S. N. Saxena	• National Group Meeting of Research Workers (XXI Workshop) of All India Coordinated Research Project on Spices" at NRCSS, Ajmer, 5-6, July, 2010. • National Consultation on Seed Spices Biodiversity and Production for Export-Perspective, Potential, threats and Their Solutions, held at NRCSS, Ajmer on July 7, 2010. • ICAR-Industry meet held at NASC, Delhi during 27-28, August, 2010 • 3rd CIC/CAC meeting of NAIP project "Studies on Cryogenic Grinding for Retention of Flavour and Medicinal Properties of Some Important Indian Spices" held at New Delhi on 29-30th August 2010. • 4th CIC meeting of NAIP project "Studies on Cryogenic Grinding for Retention of Flavour and Medicinal Properties of Some Important Indian Spices" held at CIPHET, Ludhiana on 30th January 2011. • One day workshop on Bioinformatics at NBPGR, New Delhi • 4th Indian Horticulture Congress2010 at New Delhi from 18th -21st Nov., 2010. • National seminar on Plant Physiology held at SKNCOA, Jobner on 25th February, 2011.

S. No.	Name of the participant	Seminar/ Symposia / Training / Meetings
4.	Dr. Y. K. Sharma	• Training Programme on "Microbial Agents of Major Insect Pests and Diseases of Crops" from 1-8 March, 2011 at Directorate of Oil seed Research, Hyderabad. • Participated in National Symposium on Crop Health Management for Sustainable Agri-horticultural Cropping System", 17 -19 February, 2011 at CARI, Port Blair. • Participated in National Consultation on Seed Spices Biodiversity and Production for Export-Perspective, Potential, Threats and their Solutions, July 7, 2010. • Participated in "Annual Workshop & Group Meeting of AICRPS Workers, July 5-6, 2010 at NRCSS, Ajmer.
5.	Dr. R. K. Kakani	• National Group Meeting of Research Workers (XXI Workshop) of All India Coordinated Research Project on Spices" at NRCSS, Ajmer, 5-6, July, 2010. • National Consultation on Seed Spices Biodiversity and Production for Export-Perspective, Potential, threats and Their Solutions, held at NRCSS, Ajmer on July 7, 2010. • One day workshop on Bioinformatics at NBPGR, New Delhi • ICAR-Industry meet held at NASC, Delhi during 27-28, August, 2010 • National Training programme on IPR and Technology Licensing in Agriculture at NAARM, Hyderabad during March 2 to 11, 2011. • ICAR Zonal technology management and Business Planning and Development Meeting cum workshop (North Zone) at IARI, New Delhi during March 17-18, 2011.
6.	Dr. Krishna Kant	• Participated in National Symposium on Crop Health Management for Sustainable Agri-horticultural Cropping System", 17 -19 February, 2011 at CARI, Port Blair. • Participated in National Consultation on Seed Spices Biodiversity and Production for Export-Perspective, Potential, Threats and their Solutions, July 7, 2010. • Participated in "Annual Workshop & Group Meeting of AICRPS Workers, July 5-6, 2010 at NRCSS, Ajmer.
6.	Dr. S. S. Meena	• National Conference on "Horticultural Biodiversity for Livelihood, Economic Development and Health Care" 29-31 May, 2010 at UHS Campus, Bangalore. • National Group Meeting of Research Workers (XXI Workshop) of All India Coordinated Research Project on Spices" at NRCSS, Ajmer, 5-6, July, 2010.