In this experiment, five coriander cultivars (JSS-R-50, JBT-38/94, Ajmer Green, IC-771744 and ACr 1 were sown on 28.03.2014 under green shade net (50%) considering ACr-1 as check variety. Results revealed that performance of cultivar Ajmer Green Coriander was best among all the tested lines. Ajmer Green cultivar exhibited longest first leaf (15.13 cm), second leaf (14.33 cm) with maximum number of basal leaves per plant (12.25), longest basal leaf (17.04 cm) and number of leaf lets per plant (7.03). This cultivar took minimum time *i.e.*, 7-11 days for germination with maximum plant height (21.68 cm) at harvest. Flower initiation was very late (55.75 DAS) in Ajmer Green cultivar, which is a most desirable character for leafy type cultivars, however JBT-38/94 flowered in only 37 DAS and ACr 1 (check) flowered only in 43.25 DAS. Similarly, 50% flowering was also recorded after 65.75 DAS in Ajmer Green as compared to JBT-38/94 (46.75 DAS) and ACr 1 (53.50 DAS). The crop was harvested twice for green leaf yield (first on 05.06.2014 *i.e.*, at 68 DAS and second on 20.06.2014 *i.e.*, at 83 DAS), however Ajmer Green coriander was harvested after 71 DAS for first cut and after 89 DAS for second cut due to late in 50% flowering. It is further stated that Ajmer Green coriander exhibited maximum yield (2960.47 kg/ha) of green leaves. Minimum PDI (8.33%) with respect to powdery mildew was recorded in Ajmer Green cultivar as compared to maximum PDI (60.835) in ACr 1 (check).

Performance of fenugreek lines for green leaf under summer season

Five fenugreek lines (AFg 3, AFg 4, AFg 5, AFg 6 and Hisar Sonali) under green shade nets (50%) were sown on 30.03.2014 to evaluate the performance in off season for green leaf considering Hisar Sonali as check. Among all the lines tested, performance of AFg 5 was recorded best. In AFg-5, the seed germination was initiated after 2.50 DAS and completed after 4.25 DAS which was at par with Hisar Sonali (Check). Maximum plant height of AFg 5 at harvest was 30.58 cm as compared to minimum (25.58 cm) in AFg 4. AFg 5 is a late flowering genotype, bolting initiated at 35.75 DAS and 50% flowering was recorded at 45.75 DAS as compared to earliest bolting initiation (28 DAS) and 50% flowering (33.75 DAS) in AFg 3. Check Hisar Sonali exhibited bolting at 33.75 DAS and 50% flowering at 40.50 DAS. The crop was harvested twice for green leaf yield, however AFg 5 was harvested after 45 DAS for first cut and after 81 DAS for second cut due late in 50% flowering. Highest green leaf yield (3633.02 kg/ha) with maximum number of branches (5.68/ plant) and minimum number of flowers (3.83/plant) were recorded in AFg 5 cultivar. Minimum insect infestation was recorded on AFg 5 cultivar with minimum aphids (13.55/ plant), jassids (2.0/ plant) and leaf eating caterpillar (1.73/ plant) as compared to AFg 3 (aphids 37.09/plant) and AFg 6 (jassids 7.32/ plant and leaf eating caterpillars 2.33/ plant).

CPd/13.7.1: Standardization of economical intercropping system of seed spices with vegetables (2013-15)

(R.S. Mehta, S.S. Meena, R. Singh, J.K. Ranjan, Harisha C. B., S.P. Maheria)

Two field experiments on intercropping of fennel and dill with five vegetables (cabbage, knolkhol, lettuce, french-bean and fenugreek with fennel; cabbage, knolkhol, beetroot, french-bean and fenugreek with dill) in three intercropping ratio viz., 1:1, 1:2 and 2:2 were conducted under low pressure drip irrigation system. Two crops of knolkhol were taken within 80 days after sowing of base crop but only one crop cycle of other vegetables could be taken. Intercropping of fennel with knolkhol in all the three ratio resulted at par with fennel equivalent yield, however, 1:2 fennel with knolkhol in 1:2 intercropping ratio exhibited the highest fennel equivalent yield (1712 kg/ha), net return (Rs.1,26, 000/ha) and BCR (2.85) followed by 2:2 intercropping ratio. Similarly, the highest dill equivalent yield (1936kg /ha), net return (Rs.1,13, 265 / ha) and BCR (2.72) was obtained in intercropping of dill and knolkhol in 1:2 ratio which was at par with 1:1 inter-cropping ratio of dill +cabbage). Dill + knolkhol in 1:2 ratio and dill + cabbage in 1:1 ratio produced 146 and 142 percent higher DEY respectively over sole crop of dill (Table 5.19).

Intercropping of dill with knolkhol in 1:1 and 1:2 ratio

Intercropping of fennel with lettuce (1:1)

Intercropping of fennel with cabbage (1:1)

Table 5.19 Effect of fennel based intercropping systems on yield of fennel, vegetables and fennel equivalent yield, returns and BCR

Treatment	Fennel yield (kg/ha)	Vegetable yield (kg/ha)	Fennel yield (kg/ha)	Cost of cultivation (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	BCR
Sole Fennel	889.58	0	889.58	35000	88958	53958	1.54
Sole cabbage	-	13883.33	1388.33	42250	138833	96583	2.29
Sole Knolkhol	-	9895.83	1484.38	41240	148438	107198	2.60
Sole Lettuce	-	4386.67	1096.67	40240	109667	69427	1.73
Sole French-bean	-	1032.50	619.50	32230	61950	29720	0.92
Sole fenugreek	-	7395.83	369.79	27250	36979	9729	0.36
Fennel+Cabbage (1:1)	659.94	9375.00	1597.44	45750	159744	113994	2.49
Fennel+Cabbage (2:2)	673.15	7645.83	1437.73	45750	143773	98023	2.14
Fennel+Cabbage (1:2)	522.06	8583.33	1380.40	45750	138040	92290	2.02
Fennel+Knolkhol(1:1)	675.19	6479.17	1647.06	44250	164706	120456	2.72
Fennel+Knolkhol(2:2)	787.50	6100.00	1702.50	44250	170250	126000	2.85
Fennel+Knolkhol(1:2)	587.50	7500.00	1712.50	44250	171250	127000	2.87
Fennel+Lettuce (1:1)	586.63	3126.67	1368.29	42350	136829	94479	2.23
Fennel+Lettuce(2:2)	670.83	2555.00	1309.58	42350	130958	88608	2.09
Fennel+Letttuce (1:2)	550.21	2636.67	1209.38	42350	120938	78588	1.86
fennel+French-bean (1:1)	838.96	603.33	1200.96	41350	120096	78746	1.90
Fennel+French-bean (2:2)	666.93	540.42	991.18	41350	99118	57768	1.40
Fennel+French-bean(1:2)	776.04	887.50	1308.54	41350	130854	89504	2.16
Fennel+Fenugreek (1:1)	781.88	5500.00	1056.88	40240	105688	65448	1.63
Fennel+Fenugreek (2:2)	641.67	4875.00	885.42	40240	88542	48302	1.20
Fennel+fenugreek (1:2)	692.34	6434.00	1014.04	40240	101404	61164	1.52
SEm 26.80	242.35	53.93					
CD(P=0.05)	77.41	693.83	154.13				
CV % 6.75	7.67	7.64					

CPd/13.8.1: Development of value added products from seed spices (2014-17)

(G.Lal, B.K. Mishra, Neelima Garg)

Different value added products from seed spices namely Fennel-aonla squash & RTS, Dill-aonla squash & RTS, Coriander aonla squash & RTS, Probiotic drink of seed spices, Dill-aonla capsules as functional food, Dill Parag, Dill Prash, Methica Tea were prepared during the reporting period with the help of PHT Lab, ICAR-CISH, Lucknow and Anti diabetic Fenugreek-QPM biscuits were developed at ICAR-NRCSS, Ajmer itself. Six applications for grant of patents with respect to different products of seed spices filed during 2014 at Indian Patent Office, New Delhi.

CPd/13.10.1: Effect of non-edible oil cakes on coriander and cumin growth and yield (2013-15)

(R.S. Mehta, G.Lal, R. Singh, O.P. Aishwath, B.K. Mishra, S.S. Meena, S.S. Rathore, R.D. Meena, Honappa Asangi)

Field experiments on effect of non-edible cake on yield, quality and disease incidence in cumin and coriander comprising of twelve treatments were conducted with three replications in randomized block design. Due to severe damage by hail storm, yield attributes and yield could not be recorded. Application of 100% RDN through castor, neem, and jatropha cake and RDF resulted at par plant height at 45 and 75 DAS in cumin which is significantly higher over application of 75% RDN through these cakes + bio-fertilizer, control and absolute control. Maximum number of leaves per plant, branches per plant was recorded with the application of recommended doses of fertilizer which is at par with application of 100% RDN through castor cake + Castor cake ash. Maximum wilt disease was recorded in the in absolute control whereas minimum was reported with supply of 100% RDN through neem cake. In coriander application of 100% RDN through castor cake with castor cake ash and RDF resulted significantly higher plant height at 45 and 75 DAS, number of leaves /plant at 45 DAS and number of branches /plant at 75 DAS over rest of the treatments (Fig 17).

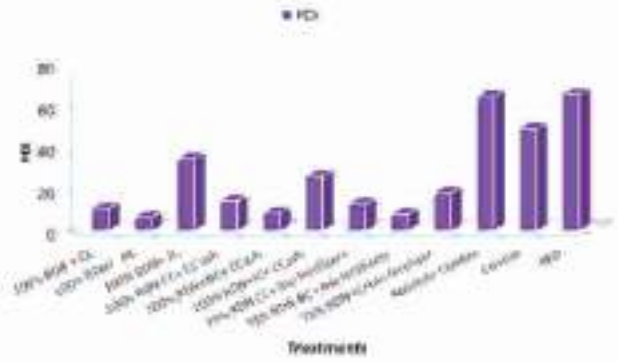


Fig.17 Cumin wilt disease PDI

Project 4 (CPt): Development and refinement of efficient crop protection technologies for production of safe seed spices

CPt-1: Survey and surveillance of existing and emerging diseases of seed spices (2012-15)

(R.D. Meena, Y.K. Sharma, R.S. Meena and N.K. Meena)

Cumin field at Jodhpur region

Coriander field in Kota region

Survey of various seed spices growing regions was conducted and samples from major crops were collected. In *cumin Alternaria* blight, wilt and yellowing affected plants, in fennel plants showing gummosis, in fenugreek samples of leaf spot, powdery mildew, downey mildew and in coriander stem gall affected plants were collected for advance studies. The plants with yellowing symptoms were tested at advance laboratory to find out the etiology associated. The causal agent of the same was detected which belongs to member of family Potyviridae and the further studies in this aspect is in progress.

During survey from different seed spices growing areas three cumin *Alternaria* blight isolates were collected and maintained in plant pathology lab. Data with respect to disease incidence has been complied and analyzed and depicted in table 5.20.

Table 5.20 Survey of seed spices diseases on farmers fields

S.No.	Area/ rergion	Seed spice crop	Major disease	Disease intensity
1	Sirohi	Fenugreek	DM, PM	Moderate
		Cumin	Blight, wilt	Moderate
2	Barmer	Fenugreek	PM	Moderate
		Cumin	Blight, wilt	Moderate
3	Kota	Coriander	Stemgall	Severe
		Fenugreek	PM	Moderate to severe
4	Ajmer	Cumin	Blight	Severe
		Coriander	PM	Nil
		Fenugreek	PM	Moderate
		Fennel	*Ramularia* blight	Nil
5	Nagaur	Cumin	Blight, wilt	Severe
		Fenugreek	PM	Moderate to severe
		Coriander	PM	Low
6	Jodhpur	Cumin	Blight, wilt	Severe
		Fenugreek	PM	Moderate to severe
7	Sawai Madhopur	Fenugreek	PM, DM	Moderate to severe
8	Jaisalmer	Cumin	wilt	Moderate

DM - Downy mildew
PM - Powdery mildew

Four seed spices crops (cumin, coriander, fennel and fenugreek) were planted at Institute farm and monitored for appearance and spread of diseases. Observations were also taken on temperature, relative humidity, rainfall etc. during the cropping season. During the year cumin blight appeared in severe form and recorded up to 92% PDI. Powdery mildew of fenugreek was in moderate to severe form while *Ramulria* blight on fennel was not observed. Powdery mildew on coriander found in low intensity. The symptoms appeared first approximately on fenugreek for powdery mildew (62 DAS); Fenugreek downy mildew (65 DAS); fenugreek blight (106 DAS); cumin blight (89 DAS) and on fennel root rot (3 DAS). Rainfall occurred during January seem to be a key component that helped in spread and development of *Alternaria* blight diseases in cumin.

CPt-3: Survey and surveillance of insect pests in seed spices (2012-15)

(Krishna Kant, N.K. Meena and S.R. Meena)

Population of insect pests, natural enemies and pollinators on seed spice crops were observed at Institute farm as well as in major seed spice crops growing areas. The survey revealed that sucking pests are the major pests responsible for significant yield loss in seed spice crops. Among sucking pests aphids and thrips contribute major population, beside it, white fly, jassids, nysus bug, cletus bug were also important pests recorded on these crops. Seed wasp (*Systole albipennis*) recorded in the coriander and fennel. Among natural enemies complex predators coccinellids, syrphid fly and *Chrysoperla carnea* develop at flowering/full vegetative growth of the plant and parasitoides *Aphidius* spp. occurred during February and March months. Honey bee *Apis florea* recorded as most important pollinators of all seed spice crops. Ber fruit plant and *Cenchrus ciliaris* commonly known as anjan grass recorded as alternate host of Nysius bug and thrips during off season. Root knot and lesion nematode population recorded on cumin crop.

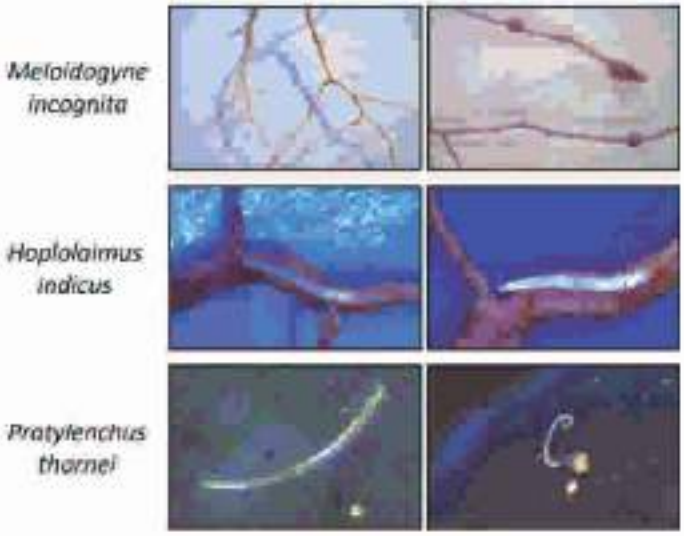
New record of nematodes infestation in cumin crop

Nematodes are serious pest of many agricultural crops. Nematodes are reported from all important agricultural, horticultural crops as important host and are responsible for significant loss of productivity of crop produces. On survey of insect pest of seed spices, nematodes complex of cumin crop observed in cumin root in crop sample collected from 18 village across 5 development block of Ajmer district. Cumin crops were observed suffering from nematodes infestation showed damaged, deformed and knot formation on primary and secondary roots. The infestation recorded at flowering stage of the crop. In early stages plant showed stubby rood symptoms and on later stage plant roots epidermis showed shrinked and dry in highly infested plants. There was three different species of nematodes associated with cumin root namely *Pratylenchus thornei*, *Hoplolaimus indicus* and *Meloidogyne incognita*. The nematode species *P. Thornei* and *H. indicus* were found for first time in cumin field causing damage to the root of the plant. The affected plants all around the field showed wilted symptom and leaves turned dry and straw colour. The nematode population was identified at Department of Nematology, MPUAT Udaipur (Table 5.21).

Table 5.21 Nematode species identified from cumin sample

S. No.	Sample No.	Nematode Associated	No. of Galls / 5 gm roots	No.of Nematodes / 10 ml. suspension
1.	NRCSS - 1	*Meloidogyne incognita*	6	5
		Hoplolaimus indicus	-	2
		Pratylenchus thornei	-	1
2.	NRCSS - 2	*Meloidogyne incognita*	3	4
		Hoplolaimus indicus	-	2
		Pratylenchus thornei	-	1
3.	NRCSS - 3	*Meloidogyne incognita*	7	11
		Hoplolaimus indicus	-	3
4.	NRCSS - 4	*Meloidogyne indicus*	8	9
		Pratylenchus thornei	-	3
		Hoplolaimus indicus	-	1

Nematodes Population Identified from Cumin Root



CPt-9: Management of Fennel Seed Wasp (*Systole albipennis* Walker)

(K. Kant, S.R. Meena, R.S. Mehta and B.K. Mishra)

Management of seed wasp in fennel crop using agronomical manipulation, application of botanicals and insecticidal application as soil incorporation and foliar spray showed various level of protection from wasp. Sowing of fennel crop on 1st September and 15th September reduced maximum seed damage. Inter cropping of fennel with dill in ratio of 2:1 found most effective in reduction of seed wasp damage. Among Botanicals applications, Karanj meal 500 kg/ha.+ Spray of Karanj oil 2% was found superior followed by Neem meal+ Neem oil 2%. Application of insecticides as soil incorporation, Clothianidin 50 % @1.0 kg ai/ha at 60 DAS found highly effective against seed wasp and no residue detected in seed at harvest.

Table 5.22 Seed wasp management under different practices

S. No.	Treatments	% Damage	Yield (Q/ha.)
1	1st September Sowing.	2.4	19.4
2	Fennel, Dill intercropped (2:1)	4.4	10.48
3	Karanj Meal +Karanj Oil	2.87	16.12
4	Clothianidin 1.0 kg ai/ha, 60DAS	0.87	22.26

CPt-8: Management of storage insect pest and micro organism of seed spices through Modified Atmospheric Packaging and other non chemical methods

(K. Kant, B.K. Mishra, S.S. Rathore, M.K. Vishal and S.R. Meena)

Modified Atmospheric Packaging (MAP) using N_2, O_2, and CO_2 gases alone and in combination with and without vacuum packaging in aluminium foil for control of *Lasioderma serricorne* beetle in cumin and ajwain seeds have been carried out. All the treatments were found highly effective for control of beetle population as no insects were survived in any treatments. Among different tested non chemical method of control of beetle population using different salts and diatomeous earth showed diatomeous earth @ 0.2% most effective for *L. serricorne* management of both in cumin and ajwain seed as maximum mortality of beetle and lowest seed damage were observed. Similarly impregnation of own seed oil on cumin and ajwain seed showed that 1.0% w/v and stored in close container gave maximum protection against beetle population in both ajwain and cumin seeds. Quality of seeds during storage was found superior than control for total and essential oil content and total microbial load on seeds. Seed germination of ajwain and cumin seed showed that application of gases causes significant reduction of germination and in case of vacuumed pack, complete inhibition of germination was recorded. In other treatment of non chemical methods no significant difference in seed germination was observed.

Table 5.23: Effect of non chemical approaches for Cigarette beetle *L. serricorne* management

S. No.	Treatments	Crop	Storage	Packaging conditions	Damage (%)	Total Oil (%)	Essential Oil (%)	Total Fungal Count (CFU/g) x10^5	Total Bacterial Count (CFU/g) x10^7
1	Diatomeous earth (0.2%)	Ajwain	RT	Plastic closed container	3.9	7.9	3.4	0.47	1.3
2	Diatomeous earth (0.2%)	Ajwain	27± 10°C	Plastic closed container	4.5	7.6	3.3	14.4	17.3
3	Diatomeous earth (0.2%)	Cumin	RT	Plastic closed container	2.3	4.4	3.6	0.98	1.67
4	Diatomeous earth (0.2%)	Cumin	27± 10°C	Plastic closed container	2.9	4.0	2.3	88.4	15.0
5	Ajowain Oil (1.0 % w/v)	Ajwain	RT	Plastic closed container	0.4	8.9	4.5	4.3	1.03
6	Ajowain Oil (1.0 % w/v)	Ajwain	27± 10°C	Plastic closed container	0.6	9.0	4.6	4.2	1.2
7	Cumin Oil (0.50% w/v)	Cumin	RT	Poly Pack	1.4	6.7	3.2	17.1	4.57
8	Cumin Oil (1.0 % w/v)	Cumin	27± 10°C	Plastic closed container	1.6	7.9	4.8	11.1	1.3

CPt-10: Evaluation of *Trichoderma* isolates for the management of wilt (*Fusarium oxysporum* f.sp. *cumini*) disease of cumin

(Y.K. Sharma, R.D. Meena, B. K Mishra, S.S. Rathore)

Among 16 *Trichoderma* isolates evaluated, most effective four isolates (Cu 3-01, Cu 7-01, Cu 7-02 and Cu 9-02) were selected for further studies. All four isolates showed more than 40% growth inhibition of *Fusarium oxysporum* f.sp. *cumini* tested in dual culture and reduced the cumin wilt incidence as compared to untreated control. Comparatively, maximum reduction in wilt incidence was achieved with application of Cu 7-01 which was at par with 7-02, 3-01 and *T. viride* under pot condition. The four isolates showed variable reaction in culture on PDA. The colony growth on PDA ranged from 5.93 to 6.46 cm, comparatively Cu 7-01 was the fastest growing isolate and Cu 9-02 was the slowest in growth. The isolates showed yellow and off white pigmentation in culture and took 48-60 hours for abundant sporulation. Cultures of all isolates showed production of chlamydospores (Table 5.24).

The isolates showed variation in overgrowth over the test pathogen (competition for the space and nutrition), mycoparasitism and production of volatile and non-volatile compounds in culture indicated different mode of action for antagonistic activity against cumin wilt pathogen.

Table 5.24 Colony growth and morphological characters of

Isolates	Growth on PDA	Pigmentation	Appearance of green conidia	Chlamydospore formation
Cu 3-01	6.23	Off white	48-60 hrs	+
Cu 7-01	6.46	Yellow	48-60 hrs	+
Cu 7-02	6.03	Off white	48-60 hrs	+
Cu 9-02	5.93	Yellow	48-60 hrs	+

Based on the *in vitro* and *in vivo* antagonistic activity, the selected *Trichoderma* isolates were tested for antagonistic activity among them. None of the isolate showed antagonism between them. The mixture of *Trichoderma* isolates were tested in different combinations against wilt disease of cumin under pot and field conditions showed efficient reduction in wilt incidence and enhanced growth characters (Table 5.25). Comparatively, maximum reduction in wilt disease and higher vigour index was observed with the application of consortium of *Trichoderma* isolates followed by individual isolates under pot and field conditions.

Cu 7-01 & 7-02 Cu 7-01 & 9-02 Cu 7-01 & T.v.

Cu 7-02 & 9-02 Cu 7-02 & T.v. Cu 9-02 & T.v.

Compatibility of *Trichoderma* isolates

Table 5.25 Efficacy of *Trichoderma* isolates on growth attributes and wilt incidence of cumin

Treatments	Wilt incidence (%) Pot	Field	Root length (cm)	Shoot length (cm)	Seedling wt. (mg)	Vigour index
3-01+7-01	15.5 (4.1)	4.6 (2.4)	4.9	8.6	167.5	1260.5
3-01+7-02	14.0 (3.9)	4.4 (2.3)	4.9	8.3	174.4	1341.7
7-01+7-02	13.4 (3.8)	4.1 (2.2)	5.3	8.4	176.3	1341.3
Cu 3-01	18.6 (4.4)	6.3 (2.7)	4.2	7.4	147.0	1118.9
Cu 7-01	17.4 (4.3)	6.8 (2.8)	4.2	7.2	135.5	1177.1
Cu 7-02	17.9 (4.3)	6.3 (2.7)	4.2	7.6	144.9	1137.5
Control	36.9 (6.2)	13.7 (3.8)	3.9	6.5	117.6	949.1
CD (P=0.05)	2.86 (0.30)	1.02 (0.14)	0.6	1.04	20.35	163.1

CPt/13.13.1: Management studies on emerging problems in cumin and fenugreek (2013-16)

(Y.K. Sharma, R.D. Meena, R.K. Solanki and R.K. Kakani)

Symptomatology and management of fenugreek leaf blight (*Alternaria alternata*)

The pathogen associated with leaf blight of fenugreek was isolated from the blighted fenugreek leaves and compared with reisolated fungal pathogen. The symptomatology, pathogenicity and morphology confirmed the identity of pathogenic fungus as *Alternaria alternata*. The *in vitro* bioefficacy of plant extracts showed variable response for growth inhibition of *A. alternata*. Maximum growth inhibition was observed with application of neem oil and garlic extract (Table 5.26).

Fenugreek leaf blight symptoms

Table 5.26 Effect of plant extracts on growth inhibition of fenugreek leaf blight pathogen (*A. alternata*)

Treatment	Radial growth (cm) 10%	15%	Percent inhibition 10%	15%
Ajwain seed ext.	5.4	5.5	35.4 (6.0)	36.2 (6.1)
Neem Kernel ext.	4.9	5.0	41.4 (6.5)	42.3 (6.6)
Neem oil	1.5	1.5	82.0 (9.1)	82.4 (9.1)
Garlic ext.	1.0	1.0	88.4 (9.5)	88.1 (9.4)
Nigella seed ext.	7.4	6.8	12.5 (3.7)	21.5 (4.7)
Dill seed ext.	5.3	5.3	37.5 (6.2)	38.8 (6.3)
Cumin seed ext.	4.1	4.2	51.5 (7.2)	51.7 (7.3)
Zeeri root ext.	6.2	6.1	26.0 (5.2)	28.6 (5.4)
Zeeri floral buds ext.	4.8	4.9	43.2 (6.6)	43.2 (6.6)
Zeeri leaves ext.	6.1	5.9	27.5 (5.3)	31.4 (5.7)
Control	8.4	8.6	0.0 (1.0)	0.0 (1.0)
CD (P=0.05)	0.92	0.91	5.79 (0.45)	6.03 (0.46)

CPt/13.12.1 Sustainable management of insect pests in coriander and cumin (2013-16)

(N.K. Meena, K.Kant, G.Lal, S.N. Saxena, S. Choudhary and M.A. Khan)

Relative efficacy of botanicals and bio-pesticides against aphid on coriander

An experimental trial was conducted to evaluate the relative efficacy of wild botanical products i.e. leaf extract of *Capparis decidua, Withania somnifera, Pongamia pinnata, Datura stramonium, Parthenium hysterophorus, Lantana camera, Ricinus communis, Annona squamosal* and fruit juice of *Citrullus colocynthis, Allium sativum* and cow urine against aphid under open field conditions. All the treatments were found effective significantly against aphid as compared control. Maximum per cent reduction in aphid population (78.05%) was recorded in organic salt followed by ker extract (76.13%) and tumba fruit extract (75.40%).

Screening of different varieties of coriander against aphid under field conditions

A field experiment was conducted to screen out twelve varieties/entries of coriander *viz.*, Gujarat Coriander- 1, Gujarat Coriander-2, Sadhana (CS-4), ACr-1, Swathi, RCr-41, RCr-436, RCr-684, Hisar Sugandh, Pant Haritima, Sindhu (CS-2) and Rajendra Swati for their relative susceptibility against aphid. The data revealed that the minimum average aphid population (3.50 aphids/spike) was recorded on Rajasthan Coriander-684 followed by Ajmer coriander-1, and both varieties were statistically at par in their susceptibility. Rajasthan Coriander-41 was received highest aphid infestation (6.14) followed by Sadhana (CS-4).

CPt/13.17.1: Impact of pollinators on yield and quality of coriander, fennel, ajwain & dill (2013-17)

(N.K. Meena, K. Kant, R.D. Meena, R.K. Solanki, S.S. Rathore)

Impact of insect pollinators on yield and quality of coriander

An experiment was designed with cages (measuring 5x4x2.17 meters, length x width x height) covered with insect proof nylon nets 16 mesh for bee pollination as well as without pollination. Results revealed that, coriander flowers were visited by 24 insect species of different orders and families. Among these insect visitors, Hymenoptera (9 species), Diptera (6 species), Hemiptera (3 species), Coleoptera (2 species), Neuroptera (1 species) and Lepidoptera (3 species) were observed on coriander crop. Honeybees (*Apis florea, A. mellifera* and *A. dorsata*) were the most prominent pollinators of coriander during cropping season in semi-arid region of Rajasthan. The visit of these insect pollinators were started at 08.00 h in lesser number, then after its population increased gradually and reached to peak between 12.00 to 14.00 h. *Apis florea* was the most abundant floral visitor (21.60 bees m^2h-1) over time and space followed by *A. mellifera* (18.22), *A. dorsata* and *Episyrphus balteatus* (3.1). After that the population of honeybees declined gradually and perceived negligible at evening 18.00 h. Highest yield of coriander 1275.06 kg/ha was obtained in bee pollinated plots (caged), which was 125.4 percent higher than control (without bee pollination-caged) where 565.69 kg/ha yield received. The test weight of bee pollinated seed was 9.89g, whereas, 8.88g was recorded in control plots.

Impact of insect pollinators on yield and quality of fennel

Similar experiment was conducted on fennel crop. Fennel flowers were visited by 23 insect species of different orders and families. Among these insect visitors, Hymenoptera (6 species), Diptera (6 species), Hemiptera (3 species), Coleoptera (3 species), Neuroptera (1 species) and Lepidoptera (4 species) were noticed on the crop. Like coriander, honeybee's species *Apis mellifera, A. florea,* and *A. dorsata* were the most prominent pollinators of this crop during cropping season in semi-arid region of Rajasthan. Other pollinators viz., *Episyrphus balteatus (Episyrphidae: Diptera); Eristalis sp. (Syrphidae: Diptera), and Musca sp.-1 (unidentified)* were also noticed as prominent pollinators in the crop. Activity of these insect pollinators started from 08.00 h meagrely, which gradually increased with the advancement of the temperature and light and reached to peak by 12.00 to 14.00 h for most of the pollinators. A total of 1592.63 kg/ha yield of fennel was obtained in bee pollinated plots (caged) as compared to 268.25 kg/ha in control plot (without bee pollination-caged). Large variation in yield is also due to hail storm damage to the crop.

Project 5 (BS): Development and refinement of post-harvest handling, processing and value addition techniques in seed spices

BS-6: Quality profiling of coriander and fenugreek germplasm (2011-15)

(S.S. Rathore, S.N. Saxena and R.K. Kakani)

Fifteen genotypes of coriander and 19 genotypes of fenugreek were evaluated for quality attributes and medicinal properties. Total phenolic content (TPC), Total flavonoid content (TFC) total antioxidant content were evaluated in both seed spices (coriander and fenugreek). In coriander genotypes, FAME analysis has been done and palmitic aicd, elaidic acid and stearic acid were also analyzed using GC-MS. Chemical constituents of fixed oil viz., peroxide value and free fatty acid value have been evaluated in both seed spices. Fatty acid methyl esters of coriander oil showed large genotypic variation. In fenugreek free amino acids and 4-hydroxyisoleucine have been analyzed and a rapid screening method for 4-hydroxyisoleucine has also been developed (Table 5.27-5.31).

Table-5.27 Total phenolic flavonoid and antioxidant content in coriander genotypes.

	Total Phenolic Content (mg/g GAE/crude extract)	Total Flavonoid Content (mg/g QE/ crude extract)	Antioxidant content (mg/gm BHTE/crude extract)
Mean	57.990	13.984	14.323
Max	71.785(GCr-1)	17.983(RCr41)	25.795(A. Dhania)
Min	42.041(Sadhna)	10.167(RCr684)	11.859(RCr20)
SD	7.822	2.292	3.189

Table-5.28 Fatty oil, volatile oil and medicinal attributes in different fenugreek genotypes

	Total Phenolic Content (mg/g GAE/crude extract)	Total Flavonoid Content (mg/g QE/ crude extract)	Antioxidant content (mg/gm BHTE/crude extract)
Mean	82.301	17.538	13.214
Max	98.658(RMt-1)	26.169 (AFg-3)	16.566(Afg-3)
Min	66.657(RMt-351)	8.873(AM-1)	7.613(Suver na)
SD	8.339	4.301	1.840

Table-5.29 Fatty acid analysis in coriander genotypes

	Palmitic aicd (%)	Elaidic acid (%)	Stearic acid (%)
Mean	6.56	81.83	2.25
Max	8.21 (P. Haritima)	89.06 (A Dhania)	6.30 (Sindhu)
Min	4.72 (Sindhu)	70.35 (Sindhu)	1.42 (RCr684)
SD	1.09	6.26	1.18

Table-5.30 Chemical characteristics of fixed oil of coriander and fenugreek genotypes

	Peroxide value (Meq/ kg oil)		Free fatty acid value (Mg KOH/g)	
	Fenugreek	Coriander	Fenugreek	Coriander
Mean	8.053	1.857	0.735	12.556
Max	14.000 (GM-2)	5.000 (RCr-20)	1.122 (H. Mukta)	23.001 (CO-3)
Min	6.000 (Pant Ragini)	1.000 (CO-4)	0.505 (AFg-3)	7.854 (H. Sugandha)
SD	2.297	1.014	0.170	3.541

Table-5.31 Free amino acid and 4-hydroxyisoleucine content in different genotypes of fenugreek

	Free amino acid content (%)	4-hydroxyisoleucine content (%)
Mean	0.547	0.438
Max	1.201 (AFg-3)	0.970 (AFg-3)
Min	0.390 (AM-413)	0.312 (AM-413)
SD	0.231	0.187

BS-7: Biochemical basis of defense mechanism in cumin (*Cuminum cyminum* L.)(2011-15)

(S.S. Rathore, S.N. Saxena and Y.K. Sharma)

An experiment was conducted during the year 2013-2014 to evaluate the effect of antioxidants on plant growth, yield, quality and some biochemical attributes related to plant defense in two genotypes of cumin (GC 4 and RZ 209). Four antioxidants (Ascorbic acid, Salicylic acid, Jasmonic acid and Benzoic acid) were taken at two concentrations *i.e* 100 and 200 ppm were applied by seed soaking and foliar spray. Germination percentage and mortality at 30 DAS due to wilt disease at 60 DAS due to blight disease and at 100 DAS due to repeated wilt and blight disease was significantly affected by antioxidant treatments. All the results were significant within treatments and their combinations with genotypes. Plant defense related bio-molecules, total phenol and flavonoids were found in leaf and root tissues. Antioxidants treatments also increased plant vigour, growth and development. These antioxidants can be used as effective bio-alternatives for harmful fungicides and chemicals.

BS-8: Physiological approaches for enhancing yield and quality in seed spices under biotic stresses (2012-15)

(S.N. Saxena, R.K. Kakani, S. S. Rathore, S.S. Meena and R. K. Solanki)

Usefulness of hydro-matrix seed priming in cumin (*Cuminum cyminum* L.) for hastening germination

An experiment was conducted to address the seed germination and seedling establishment problem in cumin during 2012-13 at NRCSS, Ajmer. Seeds of two popular genotypes of cumin viz. GC 4 and RZ 209 were taken. Hydro-matrix seed priming was done for hastening the germination under laboratory and field conditions. Six hours hydro priming followed by 72 hours matrix priming with synthetic soil proved best in hastening the germination in which more than 90% seeds have been germinated on 4th day after inoculation as compare to 8th day under control conditions. Genotype GC 4 is more responsive to priming than RZ 209. Similar results were obtained under field conditions. However, time taken in 90% germination was 6th day after sowing as compared to 10 days in non primed seeds. This method of seed priming is not only hastening the germination but cost effective also and can be performed by farmer himself. It does not include any chemical treatment thus may be used in organic cumin production. This also save one irrigation which otherwise required before germination of cumin seeds under normal conditions. Seed physiology of cumin indicated that flavonoid content in seed coat is mainly responsible for delay in seed germination. Exogenous application of Jasmonic acid 100 ppm, Proline 600 µM, BH, 7µM, SA, 7 µM, KH_2PO_4 1%, PEG (8000) 20% gave significantly more yield than control.

Project 6 (CPd): Improving knowledge and skill of stakeholders for improving productivity of seed spices

CPd-21: Design and development of database for seed spices (2011-15)

(M. K. Vishal, G. Lal, R. K. Kakani, S.N. Saxena, Y.K. Sharma, Krishna Kant, J. K. Ranjan and M.A. Khan)

Designed and developed the administrator modules for the database and website of NRCSS and also modules for database updating, deletion and modification. Data compilation on major APMC/seed spices mandi and scheme on seed spices from secondary/various sources. Collected information was integrated in database (Fig 18).

CPd-22. Development of seed spices atlas of India using GIS approach

Data compiled for Eastern state by visiting their Directorate like WB, Orissa, Assam and Bihar. For all major and minor crops the thematic map on area, production, productivity, soil texture, soil depth, Mandi in India, AESR etc prepared. For some minor crops whose production data was not found or missing for theme the thematic map for production of reported areas are also mapped.

Cumin area and production

Gujarat soil Texture

Major mandi's of cumin

Fig 18 Cumin Database

SS/13.16.1: Dissemination of seed spices production and post-harvest technology through demonstrations, trainings, workshops and seminars under NEH and TSP (2014-17)

(G.Lal, R.S. Mehta, R.S. Meena, N.K. Meena, S.P. Maheria)

Three preliminary farmers trainings (one day each) on "Importance and introduction of seed spices in TSP area" were organise on 10, 11 and 12 September, 2013, respectively in Dungarpur, Banswara and Pratapgarh districts in which total 185 farmers benefited. Three farmers' capacity building programmes (one day each) on "Promotion of seed spice production in tribal areas" were organised on 17, 18 and 19 October, 2013, respectively in Dungarpur, Banswara and Pratapgarh districts. In all 108 beneficiaries attended the programmes. Three exposure trips of farmers from Tribal are (Dungarpur, Banswara and Pratapgarh) to NRCSS, Ajmer were organised during Western Zone Krishi Vigyan Mela-2014 held on 4-7, February, 2014 in which 150 farmers participated.

Front Line Demonstrations: Eighty four field demonstrations on seed spices (Coriander, cumin, fennel, fenugreek, nigella and ajwain) in Dungarpur, Banswara and Pratapgarh districts were carried out for demonstrating performance of seed spices in non-traditional seed spice growing area (diversification of traditional agriculture through seed spices). In Pratapgarh district the average yield in field demonstration of fenugreek (AFg-1) was recorded 23.47 q/ha which is 25.66 percent higher over local check (18.7 q/ha). In field demonstration of coriander (ACr-1) in Pratapgarh district average yield was 19.26 q/ha which is 19.92 percent higher over local check (16.06 q/ha). In nigella average yield of demonstration was 9.8 q/ha which is 34 percent higher over local check (7.3 q/ha) in Pratapghar district. In Dungarpur and Banswara farmers took leaf as well as grain of both coriander and fenugreek. In coriander the grain yield ranged from 4.0 to 5.0 q/ha along with green leaf yield of 10 to12 q/ha in one cutting in different demonstrations. In fenugreek the grain yield ranged from 4.5 to 6.0 q/ha along with 12.0 to 15.0 q/ha green leaf yield in one cutting in different demonstrations.

Two farmers trainings on "Promotion of seed Spices production in NEH region" were conducted, first during 18-19 November, 2013 at College of Horticulture and Forestry, Pashighat, Arunacha Pradesh and second during 21-22, November, 2013 at Regional Station CPCRI, Kahikuchi, Guwahati Assam. In all 110 beneficiaries participated in both programmes. Besides this, a book on "Hi-Tech Seed Spices Production" Published by Director, NRCSS, Ajmer was distributed among the participants in both the programmes and 55 Plastic Crates were given to farmers of Assam state for safe handling of seed spices and other horticultural crops.

About 220 demonstrations (20-25 m^2 each) on seed spices comprising of coriander, fenugreek, ajwain & nigella were given to farmer's of Arunachal Pradesh and Assam states of NEH region. In Arunachal Pradesh, the yield of coriander was recorded up to 2500 kg/ha green leaf and up to 275 kg/ha grain, fenugreek up to 2000 kg/ha green leaf and 600 kg/ha grain, nigella up to 400 kg/ha grain and ajwain up to 225 kg/ha. Similarly in Assam, the yield of coriander recorded up to 3200 kg/ha green leaf and up to 600 kg/ha grain, fenugreek up to 2400 kg/ha green leaf and 720 kg/ha grain, nigella up to 650 kg/ha and ajwain up to 400 kg/ha.

Externally funded project

Exploitation of seed spices as a potential source of natural antioxidants, essential oil and oleoresins for enhancing export of value added products (NMPB, New Delhi)

(S.N. Saxena, R.K. Kakani, S.S. Rathore and R.K. Solanki)

During the period 2014-15 the project on Exploitation of seed spices as a potential source of natural antioxidants, essential oil and oleoresins for enhancing export of value added products was continue. This year essential oil extraction of 91 fennel germplasm and their profiling have been done. Genotypes collected from various parts of India showed significant variation. Essential oil content was ranging from a minimum of 1.0% in GF-2 to a maximum of 3.28% in AF-05-12-1genotype. All the fennel genotypes were grouped in to five distinct classes based on essential oil percentage. Maximum genotypes (44) fall under class 2nd having 2-3% essential oil followed by class 3rd in which 30 genotypes having essential oil ranging from 1.5-1.9%. Four genotypes were showing more than 3% essential oil while only one genotype showed less than

1.0% essential oil. In all the genotypes eleven major compounds including α- pinenen, camphene, β-pinene, myrecene, cymenen, γ-terpinene, 4-allyl anisole/methyl chevicol or estyragol, anethole, geranyl acetate and P-anisaldehyde were found. Coefficient of variation for each constituent depicted significant genotypic variation. Anethole was found most abundant compound in all fennel genotypes. Apart from this 141 coriander germplasm have also been evaluated for essential oil and its profiling. Coriander germplasm have been grouped on the basis of main essential oil constituents. Total phenolic, flavonoid content in methanol seed extract of 80 coriander germplasm have been analyzed. Steam distillation unit for essential oil extraction from crop residues has been established. Comparative analysis of essential oil obtained from seeds and crop residues of cumin and ajwain have been done.

Table 5.32 Fennel essential oil constituents (%)

Constituents	Min	Max	Mean	SD	CV
Alpha Pinenen	0.048	2.084	0.650	0.335	51.560
Camphene	0.001	0.187	0.060	0.035	70.900
Beta Pinene	0.000	0.376	0.070	0.074	105.050
Myrecene	0.000	0.615	0.250	0.177	70.920
Cymenen	0.000	0.449	0.080	0.092	114.380
Gamma terpinene	0.128	14.947	6.140	3.412	55.580
4-ally anisole	2.038	83.014	44.180	20.895	47.300
Geraniol	0.000	1.138	0.210	0.265	126.140
P-anisaldehyde	0.015	1.308	0.420	0.285	67.780
Anethole+Estyragol	9.147	96.643	44.330	21.451	48.390
Geranyl acetate	0.000	1.129	0.160	0.200	124.700

Table 5.33 Coriander essential oil constituents (%)

Constituents	Min	Max	Mean	SD	CV
Alpha Pinenen	0.001	11.456	4.810	2.616	54.390
Camphene	0.000	0.616	0.100	0.119	118.910
Beta Pinene	0.001	1.156	0.340	0.244	71.730
Myrecene	0.001	0.820	0.270	0.186	68.830
Cymenen	0.002	4.798	0.830	0.893	107.550
Gamma terpinene	0.000	13.325	2.140	2.640	123.370
Linalool	16.596	96.695	79.180	9.228	11.650
4-ally anisole	0.008	0.719	0.100	0.107	106.800
Geraniol	0.100	4.698	1.430	0.886	61.950
Anethole+Estyragol	0.013	5.434	0.290	0.708	243.990
Geranyl acetate	0.085	60.956	9.790	7.253	74.090
Essential oil%	0.049	0.297	0.180	0.052	28.940

Management of pest and diseases of seed spices using biocontrol products through on farm demonstration at farmers fields. (Department of Biotechnology, Govt. of India)

(K. Kant, Y.K. Sharma and S.S. Meena)

Under the project farmers fields were selected across the Ajmer district for management of wilt/root rot complex, aphids and thrips management in crop of cumin ,coriander and fennel through application of biocontrol agents produced at the centre. Under the project salient achievements are

- 148 farmers were selected from Ajmer district.
- Distributed *T. viride* and *Verticillium lecanii* control of wilt and aphids in cumin, coriander and fennel.
- Organised one training programme for farmers on "Bio control agents for diseases and pests management in Seed Spice crops" on 24-25 March, 2014. Total 150 farmers benefited during the training programme

DUS testing guideline in seed spices crops

(R.S. Meena, R.K. Kakani and S. Choudhary)

NRCSS was identified as nodal center for seed spices since 2006. NRCSS has already completed the task of development of DUS guidelines of coriander and fenugreek and were notified for registration. The work on fennel and cumin is being taken during reporting period. DUS experiments are being conducted at two locations *viz.*, NRCSS, Ajmer and DMAPR, Anand (Gujarat). In cumin a total of 9 varieties and in fennel 17 varieties are being tested for DUS characters. In fennel observations has been recorded at different stages for different traits like days to germination, early plant vigour, young plant length of petiole of first leaf, fully bloom leaf foliage density, young plant cotyledon length (right/left), king umbel sheath length, king umbel sheath leaf (drophy/straight), king umbel sheath width/length, no of branches at base, foliage intensity of green colour very light /light /medium /dark, main stem girth (measure from first internode), first internode length, second internode length, third internode length, fourth internode length, first internode leaf thickness, first internode feaf length/width, first internode leaf shape triangular/rhomboidal/oblong, first internode leaf sheath length/width, foliage attitude erect/semi erect/spreading, foliage density sparse/medium/dense, fourth internode leaf density of

feathering loose/medium/dense, fourth internode leaf width of segment, king umbel petiole length, king umbel petiole length, king umbel leaf thickness (at base), primary branches, secondary branches, umbel per plant, umbellate per umbel, seed per umbellate, umbel diameter, plant height, test weight and seed yield. While in cumin observations have been recorded for different characters like young plant cotyledon length, no of branches at base, foliage intensity of green colour, pigmentations tip of first leaf, main stem girth, first internode length, second internode length, third internode length, fourth internode length, first internode leaf petiole length, first internode leaf length/width, foliage density, king umbel petiole length, foliage attitude, primary branches, secondary branches, umbel per plant, umbellate per umbel, seed per umbellate, plant height, test weight and seed yield.

Intellectual Property Management and Transfer/Commercialization of Agricultural Technology Scheme

(S.N. Saxena)

Consultancy

ICAR-National Research Centre on Seed Spices, Tabiji, Ajmer has done pioneering research in the field of cryogenic grinding of spices for better retention of flavour, taste and medicinal properties of spices. Several processors visited the centre in view of adopting the technology for spices grinding. **Sh. B. K. Jain,** Managing Director, Marson's Electrical ndustries, 1/189, Delhi Gate, Civil Lines, Agra-282002 was interested in setting up the cryogenic grinding unit at a suitable place in Rajasthan and requested for providing consultancy of this aspect. Dr. S.N.Saxena, Principal Scientist and Incharge Cryogenic grindimng laboratory provided the consultancy on technical features of cryogenic grinder suitable for grinding of coriander, cumin, fennel, fenugreek and turmeric.

Patents filed

In an interinstitutional project with ICAR-CIAH, Lucknow some value added products viz., Fennel-aonla squash & RTS, Dill-aonla squash & RTS, Coriander aonla squash & RTS, Probiotic drink of seed spices, Dill-aonla capsules as functional food, Dill Parag, Dill Prash, Mehtica Tea were prepared have been developed. Project Incharge Dr. Gopal Lal, Principal Scientist, ICAR-NRCSS have filed the application for granting patents at Indian Patent Office, New Delhi on 9.10.2014

Mega Seed Project on Seed Production of Agricultural Crops and Fisheries

(R.K. Kakani)

During 2014-15 TFL seed production of improved varieties of different seed spices have been taken at Farmer's field under Farmer's Participatory Seed Production Programme. The production details are as under:

Table 5.34 Breeder seed produced during 2014-15 at NRCSS, Ajmer

Crop	Variety	DAC Indent	Production (kg)
Coriander	Ajmer Coriander-1	Nil	900.0
Fennel	Ajmer Fennel-1	Nil	70.0
Fenugreek	Ajmer Fenugreek-1	Nil	1100.0
Fenugreek	Ajmer Fenugreek-2	Nil	200.0
Fenugreek	Ajmer Fenugreek-3	Nil	1550.0
Fenugreek	Ajmer Fenugreek-4		120.0
Ajwain	Ajmer Ajwain-1	Nil	40.0
Ajwain	Ajmer Ajwain-93		90.0
Nigella	Ajmer Nigella-1	Nil	100.0
Anise	Ajmer Anise-1	Nil	5.0
Fenugreek leaf type	Kasuri methi	Nil	92.0
Total	**(TFL)**		**4265.0**

Table 5.35 TFL seed produced under farmers participatory seed production programme

S. NO.	Crop	Variety	Production (Quintals)
1.	Cumin	GC-4	79.19
2.	Fennel	AF 1	41.69
3.	Coriander	ACr 1	11.95
4.	Fenugreek	AFg 3	40.90
5.	Ajwain	AA 1	1.93
6.	Ajwain	AA 93	1.74
7.	Nigella	AN	1.78
	Total		**179.18**

Table 5.36 Total quantity of seed spices seeds produced during 2014-15

Grade	Quantity (Q.)
TFL seed	180.0
Breeder seed	41.7
Total	**221.7**

6. Technology Assessed and Transfer

The centre is also involved in transfer of proven technologies by conducting training programmes and demonstration of new varieties and production technologies. Seed spice growers and other stakeholders are attended by the experts of relevant subjects and provided with the literature on production technology of seed spices crops. Field visits, demonstrations and farmers training programmes are organized in collaboration with KVK, State Department of Agriculture/Horticulture and other extension agencies for dissemination of latest technologies. During the reporting year following activities have been carried out by NRCSS.

6.1 Transfer of Technology under Mission for Integrated Development of Horticulture (MIDH)

Frontline Demonstrations on Seed Spices

Forty five front line demonstrations (FLDs) were conducted in collaboration with Agriculture Department, Pokaran (Jaisalmer), KVK, Pali, KVK, Jhunjhunu, KVK, Gudamalani (Barmer) and State Department of Agriculture, Sikar on cumin (25), fenugreek (16) and ajwain (04). Improved varieties of cumin, fenugreek and ajwain were taken in to consideration with recommended package of practices (POP) including seed treatments, line sowing, weed management, nutrient management and plant protection measures. Results of the FLDs at different places revealed that yield of cumin under demonstrations was higher in the range of 19.42% to 48.24% than that of local check/ practices. The yield of fenugreek under demonstrations was 7.74% to 35.04% higher as compared to crops grown with traditional practices with local varieties. Similarly the yield of ajwain was recorded 40.40% to 56.90% higher than the yield under local check/ practices.


Input distribution for FLDs in Jaisalmer and Jhunjhunu districts


Fenugreek FLDs in Varispura, district Jhunjhunu


Fenugreek FLDs in Kukanwali , district Nagaur


Fenugreek FLDs in Dadia, District Sikar


Cumin FLDs in Pokaran, Jaisalmer District

Farmers' training programme at NRCSS, Ajmer

A two days farmer training programme was organized on contribution of scientific technologies in seed spices production during 16-17 February, 2015 at National Research Centre on Seed Spices Ajmer (Rajasthan) and sponsored by Director, DASD Calicut under MIDH. In two days, deliberations covered all aspects of seed spices production like irrigation and water management, storage and processing, disease and insect management in seed spices, role of bio-fertilizer and macro element in seed spices, role of biotechnology and mechanization in seed spice crops. In this training programme total 63 farmers were participated of different areas of Rajasthan.


Farmers in training programme at NRCSS

Farmers' training at KVK (SURE), Barmer

A two days farmer training programme was organized on post harvest technology and processing of seed spices for value addition during 12-13 March, 2015 at KVK (SURE) Barmer, Rajasthan by NRCSS, Ajmer and was sponsored by Director, DASD Calicut under MIDH. Lectures were delivered by scientists of NRCSS and officers of State Agricultural Departments covering all aspects of seed spices production like irrigation and water management, storage and processing, disease and insect management in seed spices, role of bio-fertilizer and macro element in seed spices, mechanization in seed spice crops apart from post harvest processing and value addition in seed spices. Mr. K.L Verma, Deputy Director (Ag. Extension), Government of Rajasthan, Barmer delivered lecture on present scenario of production and productivity and medicinal value of seed spice crops especially in western Rajasthan. Dr. Gopal Lal, Principal Scientist, NRCSS delivered lectures on improved varieties of seed spices, post harvest management for value addition of seed spices and marketing and trade in the field of seed spices. Dr. R. S. Mehta, Dr. N.K. Meena, from NRCSS also participated in the programme and interacted with the farmers to adopt improved production technologies and plant protection measures, respectively.




Farmer's training programme held at KVK, Barmer

6.2 Technology transfer in North Eastern Hill Region

Two Days Farmers Training on "Improved Production Technology and Post-Harvest Management of Seed Spices" at Shillong

ICAR- NRCSS, Ajmer (Rajasthan) in collaboration with CPRI-Regional Station, Upper Shillong, Meghalaya organized two days farmers training programme on "Improved Production Technology and Post-Harvest Management of Seed Spices" on 27-28 November, 2014 at CPRS, Shillong. Dr. T.K. Bag, Principal Scientist & Head, ICAR-CPRI Regional Station Upper Shillong, Meghalaya was the Chief Guest of inaugural function of the programme. Mr. K. Inavi, Deputy Project Officer, DRDA, Nagaland was the guest of honour of the programme. Dr. T.K. Bag, emphasized that possibilities and scope of seed spices specially coriander and fenugreek production in Meghalaya. He also pointed out that presently farmers of Meghalaya are growing coriander and fenugreek for leafy vegetable purposes. Dr. G. Lal adressed that seed spices are low water and nutrient requiring crops with very low cost of production having low volume and high values. In two days programme, training was imparted on improved seed spice production technology, including high yielding varieties of seed spices for Meghalaya, organic seed spices production and possibilities of seed spices with new and existing orchards. In the Programme 55 farmers participated. Each farmer participant was given fenugreek seeds for demonstration of performance in Meghalaya.

Two days farmers Training on "Production and Promotion of seed spices in Sikkim

ICAR-NRCSS, Ajmer in collaboration with ICAR-Research Centre on Orchids organized two days farmers training on "Production and Promotion of seed spices in Sikkim" at NRC on Orchids, Pakyong, Sikkim on 1-2 December, 2014. A team of four scientists namely Dr. G. Lal, Dr R.S. Mehta, Dr. R.S. Meena and Dr. N.K. Meena from NRCSS, Ajmer imparted training to farmers. Dr. D. Barman, Director, NRC on Orchids and Chief Guest of the function appreciated the efforts of NRCSS, Ajmer for organizing the training on seed spices for the benefit of farmers of Sikkim. He further mentioned that seed spices specially coriander and fenugreek may be very potential crops for inclusion as intercrops with orchards and farmers may harvest both

leaf for vegetables and seed for spices. In this training programme resource persons from NRC on Seed Spices, Ajmer and NRC on Orchids, Pakyong Sikkim delivered lecture on improved varieties, production and protection technologies of coriander, fennel, fenugreek, ajwain, nigella, possibilities of organic production of seed spices, prospect and possibilities of seed spice production in Sikkim. About 55 farmers of different corners of Sikkim participated in the training programme. At the end of the programme, participation certificate were given to farmers.

FLDs during 2014-15 in NEH region

Total 110 demonstration (55 in Meghalaya and 55 in Sikkim) on coriander and fenugreek, (25 m2 each) were conducted at farmer's fields during the Rabi 2014-15. A packet of 100g seed of improved varieties of both the seed spices were given to the growers with the package of practices to grow and see the performance in NEH region. The FLDs were monitored by scientists of CPRI regional station Upper Shillon. Meghalaya and NRC for Orchids, Pakyong, Sikkim.

6.3 Technology transfer activities under Tribal Area Sub-Plan

Farmers- Scientist interaction Workshop

During the *Rashtriya Beej Vitran Kisan Mela-2014*, Scientist farmer's interaction workshop was also organized on 29-30 September, 2014 in the auditorium of NRCSS, Ajmer. In the workshop Dr. Ram Chandra, Chairman, Ajmer Dairy, advised TSP farmers for adoption of dairy enterprises also along with crops so that system becomes integrated farming for benefit of small and marginal farmers of tribal region. In the workshop scientists of NRCSS, KVK, Ajmer, and officers of department of agriculture, Ajmer also participated and various issues of seed spice production in tribal region were discussed. In the workshop 157 tribal farmers from Dungarpur, Banswara and Pratapgarh participated. In the opening session of workshop Dr. Balraj Singh Director, NRCSS, welcomed all the guest, delegates and farmer's participant and were advised to include seed spices for crop diversification in the tribal area. Dr. G. Lal, Principal Scientist appraised about the different activities undertaken by NRCSS in the tribal region for last two years.

Dr. Balraj Singh delivering lecture in workshop

One day Farmers Training on *"Unnat Sasya Kriyaa"* at KVK Dungarpur

Under Tribal sub-plan of NRCSS, Ajmer, one day farmers training on *"Bijiya Masala Ki Unnat Sasya Kriya"* was organized on 18" November 2014 at Krishi Vigyan Kendra, Dungarpur (Rajasthan). Sixty farmers from different tribal area of Dungarpur district participated. Lctures on various aspect of seed spices production were delivered by scientist of NRCSS, Ajmer and subject matter specialist of KVK, Dungarpur. In the inaugural function, Dr. G. Lal, organizing secretary emphasized on possibilities of introduction of seed spices in Dungarpur area. Dr. R.S. Mehta, Coordinator of the training advised farmers to adopt organic farming practices for getting quality seed spices and other crops. Dr. S.N. Ojha, Programme Coordinator, KVK highlighted strengths and weaknesses of seed spices in Dungarpur. Dr. R. S. Meena and Dr.N.K.Meena, Co-coordinator of the program imparted training on improved varieties of seed, control of insect pest and disease in seed spices respectively. Dr. R.K. Jalwania, Subject Matter Specialist, KVK, Dungarpur was local coordinator of the training programme.

One day farmers training on *"Vegyanik Vidhi Se Bijya Masala Phasal ki Kheti"* at KVK, Banswara

In the inaugural function, economic importance of seed spices for diversification of exiting cropping system was highlighted by Dr. G. Lal, Principal scientist and organising secretary of program. Dr. R. L. Soni, Local coordinator of the training emphasized that seed spices may be one of the important economical alternative for replacing existing maize based cropping pattern during Rabi season. Dr. R.S. Mehta, Co-coordinator, advised farmers to grow vegetable crops with long duration seed spices. He advised farmers that that fennel with cabbage in 1:1 and fennel with knoll-khol in1:2 ratios is beneficial for realizing higher yield and net return. Dr. N. K. Meena, Coordinator

of the programme advised farmers to use safe pesticide for control of insect pest and disease in crops.

One day farmers Training *"Bijya Masala phasal ki Unnatt Prodhiyogiki"* at Gomteswar, Arnod, Pratapgarh

Farmers training on *"Bijya Masala phasal ki Unnatt Prodhiyogiki"* was organized under TSP on 16 Nov, 2014. In the training program 60 farmers from different tribal areas participated. The training program was organized in tribal village itself. In the training, farmers of Pratapgarh district were made aware about the improved production technologies of seed spices. A team of four scientists, comprising Dr. G. Lal, Dr. R. S. Mehta, Dr. R. S. Meena and Dr. N. K. Meena, imparted training to farmers.

FLDs during 2014-15 under TSP

One hundred and nine (109) FLDs of coriander, cumin, fennel, fenugreek, ajwain and nigella (0.25 ha each) were conducted on farmers' field of Dungarpur, Banswara and Pratapghar under Tribal Sub Plan during Rabi 2014-15. Seed of improve varieties of said seed spices with recommended POP and other inputs (fertilizers and pesticides) were supplied to the TSP farmers. The FLDs were monitored by scientists of NRCSS and respective KVKs located in TSP area.

Organised *Rastrya Beej Vitaran Kisan Kisan Mela Karya Shala avem Krishak Sangosthi*-2014

Rastrya Beej Vitran Kisan Mela ,KaryaSala ayon Krishak Sangosthi-2014 was organized on 29-30, September,2014 at National Research Centre on Seed Spices, Ajmer (Rajasthan). The Mela and exhibition was inaugurated by Dr. J.S. Samra Chief Executive Officer, National Rain fed Area Authority Planning Commission, Government of India on 29th September, 2014 at 11.00 AM. Dr. G.N. Mathur, Programme Coordinator, KVK was guest of honour. Dr. Balraj Singh, Director, NRCSS, Ajmer welcomed all the guest on the dias, other delegates and farmers participant. During the occasion 15 exhibition stalls of different agricultural products and inputs were displayed for the benefit of the farmers..700 farmers from different parts of Rajasthan and adjoining states participated in the Mela. In the Kisan Gosthi, Scientists farmers' interaction was held on farmer's problem in respect to seed spices and other crops. Dr. Balraj Singh suggested to farmers for inclusion of seed spices in their cropping system for realizing higher profit. In presidential address DR J.S.Samra appraised about the importance and role of soil and water conservation for the benefit of forthcoming generation. In Valedictory function of the Mela Dr Ram Candra Choudhury, Chairman Ajmer Dairy was chief guest and he advised farmers to rear good breed of livestock for enhancing their income. Dr. R.S. Mehta, Convener of the mela rendered vote of thanks.

inauguration of mela-2014

Release of technical bulletin

Participants of Rashtiya Beej Vitran Kisan Mela-2014

Rashtriya Krishi Vigyan Mela-2015 celebrated at NRCSS, Ajmer

Rashtriya Krishi Vigyan Mela-2015 was organized on 16-17 February, 2015 at National Research Centre on Seed Spices, Ajmer (Rajasthan). Dr. S.L. Mehta, Ex Vice Chancellor, MPUA&T, Udaipur was the chief guest and Dr. B. R. Chipa Vice Chancellor, SKRAU, Bikaner, was the president of inaugural function. Nearly 2500 farmers from Rajasthan and adjoining states participated in two days event. Dr. Balraj Singh, Director NRCSS, appraised about the technologies generated by NRCSS for addressing emerging problems of seed spices. During the Mela, Kisan Gosthi was also organized. After deliberations with delegates, stake holders, officials of line department, scientific staff of NRCSS, KVKs and farmer's participant, the following major recommendations were brought out for the benefit of the growers and other stake holders. During the 2 days interactive session with farmers following points were emerged:

- The major challenges of seed spices are, blight in cumin, and stem gall in coriander and gummosis in fennel. Therefore research efforts need to be intensified to address the major challenges of seed spices so that seed spices cultivation may become blessing for farmers.

- The practice of organising pre sowing season farmers fair should be strengthened for addressing the farmer's problem and arrangement should also be made imparting practical learning to farmers during the fair.

- Seed replacement rate of seed spices is low compared to other crops. Hence efforts are to be made for enhancing seed replacement rate of seed spices.
- More FLDs should be conducted on farmer's field for demonstrating performance of technology developed at research organisation of National Agriculture Research System.
- Efforts should be made to make available good quality seeds of improved variety of crops and fertilizers well in advance of commencement of sowing season

6.4 Visit of farmers at centre's farm

A number of groups of farmers, students, researchers and traders have visited NRCSS research farm. During 2013-14 more than 11000 famers and students from different parts of Rajasthan, Gujarat, Punjab, Haryana, U.P., Uttarakhand, M.P., Himachal Pradesh, Jharkhand and Maharashtra visited the centre under various training and visit programme. The lectures were delivered by scientists to aquaint them with the new technologies laid in the field.

6.5 Television talks

Name of Scientists	Topic	Date of broadcast
Dr Balraj Singh	Phone-in programme	AIR, Jaipur on 12.07.2014
	Phone-in programme	AIR, Jaipur on 02.08.2014
	"Sanrakshit Kheti Aaj Ki Avashyakta"	DD-1 on 27.11.2014
	Krishi Kya Laabh ka Sauda Ban Sakta Hai	DD-2, Delhi on 30.10.2014
Dr. Balraj Singh	Phone-in programme	AIR, Jaipur on 02.08.2014
Dr. Gopal Lal	Post-harvest handling and processing of seed spices for vale addition	Recorded on DD Gyan Bharti 27.03.2015.
	A documentary on spices to make aware the common man by DST for	
Dr. Gopal Lal	Present scenario of seed spices in India, their importance and how to handle them after harvesting and in storage	ETV Rajasthan on 10.04.2014
Dr Ravindra Singh	बीजीय मसाला फसलों में बूंद–बूंद सिंचाई प्रणाली	डी.डी.- राजस्थान प्रसारण 02-2015
Dr Ravindra Singh	राजस्थान में बीजीय मसाला फसलों की पौध उत्पादन एवं रोपाई अधिक उत्पादन के लिए वरदान	Baatcheet Aakashwani Jaipur, 10-11-2014
Dr. R. S. Meena	*"Masala fasalo main unnath prajatiya"*	Aakaashwani, Jaipur on 13/11/14, live at 7.15PM
Dr. Sharda Choudhary	*"Uttak Samvardhan ka mahtav"*	Aakashwani Jaipur live at 7.15PM 13/11/14
Dr. N.K.Meena	Phone in programme *"Kishana Ri Banta"*	Live broadcast on All India Radio (Aakaashwani), Jaipur (Rajasthan) 07th June, 2014
Dr. N.K.Meena	Phone in programme *"Kishana Ri Banta"*	Live broadcast on All India Radio (Aakaashwani), Jaipur (Rajasthan) 17th February, 2015
Dr. N.K.Meena	Phone in programme *"Kishana Ri Banta"*	Live broadcast on All India Radio (Aakaashwani), Jaipur (Rajasthan) 21st October, 2014

6.5 Exhibition conducted/Participated

NRCSS is actively involved in showcasing the technologies to seed spice stakeholders including farmers through various extension programmes. A team of scientists and technical staff of NRCSS participated in the the Kisan Melas organized by different agriculture institutions and exhibited seed spice technologies. Thousands of the farmers visited NRCSS stall and their queries were solved by the representatives. The literature in the form of pamphlet and booklet was also given to the interested farmers. During the year 2014-15 NRCSS has participated in following events:

National Research Centre on Seed Spices, Ajmer (Rajasthan), (29-30, September, 2014)

Central Arid Zone Research Institute, Jodhpur (Rajasthan), (24 September, 2014)

National Research Centreon Seed Spices, Ajmer (Rajasthan), (19-20 January, 2015)

Directorate of Rape Seed & Mustard Research, Bharatpur (24-26 February, 2015)

Central Sheep and Wool Research Institute, Avikanagar (Rajasthan), (12 September, 2014)

National Research Centre on Seed Spices, Ajmer (Rajasthan), (16-17 February, 2015)

Central Potato Research Institute, Shimla at CPRS-Patna (19-21 February, 2015)

Indian Agricultural Research Institute, Pusa, New Delhi (10-12, March, 2015)

7. Education and Training

7.1 Education

7.1.1 Student guided

Name	Degree	Title of thesis	Guide
Asha K Yogi	M.Sc. Ag (Hort.)	"Effect of weed competition on growth and yield of ajwain (*Trachyspermum ammi* L.)"- MJRP University, Jaipur	Dr. Bairaj Singh
Brij Mohan Barolia	M.Sc. Ag (Hort.)	"Effect of different packaging materials on shelf life and quality of fennel (*Foeniculum vulgare* L.)" MJRP University, Jaipur	Dr. Gopal Lal
Yogendra Singh	M.Sc. Ag (Hort.)	"Effect of different levels of NPK under protected environments, MJRP University, Jaipur	Dr. Gopal Lal
Jeetendra Singh	M.Sc. Ag (PBG)	Evaluation of fenugreek (*Trigonella foenum-graecim* L.) genotypes for water limiting conditions MJRP University, Jaipur	Dr. S.N. Saxena
Rohit Nanoma	M.Sc. Ag (Hort.)	"Effect of spacing and fertilizer levels on different genotypes of ajwain (*Trachyspermum ammi* L.)" MJRP University, Jaipur	Dr. S.S. Meena
Yogesh Sanai	M.Sc. Ag (Hort.)	"Effect of varying nitrogen and phosphorus levels on growth and yield of anise (*Pimpinella anisum* L.)" MJRP University, Jaipur	Dr. S.S. Meena
Narendra Kumar Nagar	M.Sc. Ag (Hort.)	"Performance of ajwain (*Trachyspermum ammi* L.) germplasm under semi-arid conditions of Rajasthan" MJRP University, Jaipur	Dr. S.S. Meena

7.2 Training Programme organized at NRCSS for farmers

Title of training	Duration	Coordinator	Sponsoring agency
बीजीय मसाला फसलों के उत्पादन की उन्नत प्रौद्योगिकीया	Nov 14-18, 2014	Dr. R.S. Mehta Dr. P.N. Dubey	Project, Director, ATMA, Chandrapur, and Maharashtra.
Improved production technology of seed spice	Dec 22-24, 2014	Dr. S.S. Rathore Mr. Harisha, C.B	Indian Grameen Service Bhopal funded by NABARD
Cultivation of Spice Crops	Feb 9-13, 2015	Dr. B.K. Mishra, Dr.A.K.Verma	State Agriculture Management Institute, Rehmankhera, Lucknow (UP)
Cultivation of Spice Crops	Feb 12-16, 2015	Dr. S.S.Meena, Mr. H. Asangi	State Agriculture Management Institute, Rehmankhera, Lucknow (UP)
मसाला फसलों की उन्नत कृषि तकनिकीयॉं एव प्रसंस्करण	Feb 16-17, 2015	Dr. G. Lal Dr. Ravindra Singh Dr. R.K. Solanki	National Horticulture Mission Teh, Ladnu, Distt. Nagore, Rajasthan
बीजीय मसाला उत्पादन में वैज्ञानिक तकनिकीयों का योगदान	Feb 16-17, 2015	Dr. R.S.Meena Dr. S.S. Rathore Dr. N.K.Meena	National Horticulture Mission
बीजीय मसाल फसलों की उन्नत उत्पादन तकनिकीया	Mar 9-13, 2015	Dr. O.P. Aishwath Dr. K. Kant Dr. S.Choudhary	Project Director, ATMA, Jodhpur (Raj.)
Value addition and processing of seed spices	Mar 12-13, 2015	Dr. G. Lal Dr. R.S. Mehta Dr. N.K. Meena	National Horticulture Mission

8. Awards and Recognition

8.1 Awards

Name of Personnel	Name of Award	Given by (Organizer/Place)
डॉ एन के मीणा (वैज्ञानिक)	पुस्तक "आर्किड: परिदृश्य एवं उत्पादन प्रौद्योगिकी" लेखन हेतु "इन्दिरा गाँधी राजभाषा" पुरस्कार (लेखक: एन.के. मीणा, आर.पी. मेवी एवं रामपाल)	महामहिम राष्ट्रपति, भारत सरकार द्वारा दिनांक 14 सितम्बर 2014 को राष्ट्रपति भवन नई दिल्ली में प्रदान किया गया।
Dr. R.S.Mehta (Principal Scientist)	Best Scientist of NRCSS (2014-15)	Director, NRCSS on Republic Day function, 2014
Dr. R. Singh	Bharat Shiksha Ratan Award	Global Society for Health & Educational Growth, New Delhi on 22 Sept 2014

8.2 Recognitions

Name of Scientists	Particulars
Dr. Balraj Singh	Fellow of the Indian Society of Vegetable Science, IIVR, Varanasi in the year 2014 Academic member of the Athens Institute for Education and Research (ATINER), belonging to the Agriculture Research Unit w. e. f. January 2015 BOM member of the Jodhpur Agriculture University, Jodhpur during 2014 for the period of three years Member of the working group on "Horticulture", The European Plant Science Organization (EPSO), Brussels Member of the working group on "Opportunities beyond present crops", The European Plant Science Organization (EPSO), Brussels Moderator at national seminar on Development and Export of Seed Spices, under MIDH organised by Spices Board, Govt. of India, Department of Horticulture, Govt. of Gujarat and APMC, Unjha, Gujarat Guest of Honour at national farmers fair and vegetable show casing held at IIVR, Varanasi from January 30-31, 2015 Chief Guest over the meeting of scientific advisory committee, KVK, Ajmer on March 17, 2015 Chairman at the International symposium on "Innovations in Horticulture for Nutritional Security, Conserving Bio-diversity and Poverty Alleviation" held at BBAU, Lucknow from October 16-18, 2014 Guest of Honour at National Seminar on "Strategies for enhancing production of quality spices for domestic use and export" held at SKN Agriculture University Jobner, Rajasthan from March 16-17, 2015

Name of Scientists	Particulars
Dr. Gopal Lal	Member, Seed Spices Task Force Committee, Cochin
	Member, Scientific Advisory Committee, KVK, Barmer
	Vice president, Indian Society of Seed Spices, Ajmer
	Best poster award on "Protected cultivation of coriander for safe and assured production" by Indian Society of Seed Spices & Indian Society of Protected Cultivation. During: National Seminar on "Hi-tech Horticulture for Enhancing Productivity, Quality and Rural Prosperity" held on 19-20 February, 2015 at NRCSS, Ajmer (on 20.02.2015)
	Best poster award on "Development of novel products from seed spices" in National Seminar on Hi-Tech Horticulture for Enhancing Production, Quality and Rural Prosperity, January 19-21, 2015 held at ICAR- NRC on Seed Spices, Tabiji, Ajmer
Dr. S.N. Saxena	Chief Editor of International Journal of Seed Spices published by Indian Society of Seed Spices, Ajmer
Dr. R.K. Kakani	Joint Secretary, Indian Society of Seed Spices, Ajmer
Dr. R. S. Mehta	Secretary, Indian Society of Seed Spices, Ajmer
Dr. Krishnkant	Best poster award on "Seed wasp, Systole albipennis walker (Eurytomidae: Hymenoptera) management in fennel". Presented in International Conference: Changing Scenario Of Pest Problems In Agri-Horti Ecosystem And Their Management, during 27-29 November, 2014 held at RCA, MPUAT, Udaipur
	Joint Secretary, Indian Society of Seed Spices, Ajmer
Dr. O.P. Aishwath	Editor-in-Chief for 'Global Journal of Biology Agriculture & Health Sciences' (GJBAHS), recognized and appointed by Global Institute for Research & Education.
	Senior Member for 'Standing committee on Policy and Bye-Laws' Council of ISSS nominated and elected for the year 2015
	Member in a "Judging committee", for adjudicating Indian Society of Soil Science 'Zonal Award' and 'Best Doctoral Research Presentation Award', the meeting for contest was held on 27th September, 2014 at MPUAT, Udaipur, Rajasthan.
	Recognized as one of the "Outstanding participants" while undergoing ICAR short course on 'Advances in nutrient dynamics in soil-plant atmosphere system for improving nutrient use efficiency' held during September 02-11, 2014 at Indian Institute of Soil Science, Bhopal, M.P.

Name of Scientists	Particulars
	Best Poster Award for the research paper entitled 'Cumin as a major cash crop is a boon for arid and semi-arid regions of India: A livelihood perspective' presented during National Seminar on Sustainable Management of Land Resources for Livelihood Security held on January, 28-30, 2015 at NBSS & LUP, Nagpur
	Life member of the Indian Society of Soil survey and Land Use Planning, Nagpur, Maharashtra, India
Dr. R. Singh	Received best poster award for research paper "Effect of nursery raising and transplanting with mulching on yield of seed spices". During National Seminar on Hi-Tech Horticulture for enhancing Productivity, Quality and Rural Prosperity held on 19-20 January 2015 at ICAR-NRCSS Ajmer
	Received best presentation award on research paper"Losses due to weeds in seed spices and their management before critical stage" in International Conference on "Changing Scenario of Pest Problems in Agri-horti Ecosystem and their Management" at RCA, Maharana Pratap University of Agriculture and Technology, Udaipur, November 27-29, 2014
	Received best presentation award on research paper "Effect of irrigation methods and land configuration on yield and water productivity of cumin in India" 3rd International Conference on "Agriculture & Horticulture" at Hyderabad International Convention Centre (HICC), India, October 27-29, 2014.
Dr. S.S. Meena	Tresurer, Indian Society of Seed Spices, Ajmer
Dr. S.S. Rathore	Best presentation award for paper entitled "Assessment of variability of three coriander (*Coriandrum sativum* L.) cultivars using leaf essential" oil present in National Seminar on Hi-Tech Horticulture for Enhancing Production, Quality and Rural Prosperity, January 19-21, 2015 held at ICAR- NRC on Seed Spices, Tabiji, Ajmer.
Dr. B.K. Mishra	Nominated as Member of Academic Council of Bhagwant University, Ajmer for two years w.e.f. 18/02/2015.
	Life member of Indian Society of Soil Survey and Land Use Planning, NBSS & LUP, Amravati Road, Nagpur-440033, India.
Dr. P.N. Dubey	Best poster award on "Temporal and Spatial Evaluation of sewage irrigation water quality and soil health in peri-urban Nagpur" during National Seminar on "Hi-tech Horticulture for Enhancing Productivity, Quality and Rural Prosperity" held during 19th to 20th January 2015 at ICAR-NRCSS, Ajmer.
	Life member of Indian Society of Seed Spices, Ajmer

Name of Scientists	Particulars
Dr. R.S. Meena	Best Poster award on "Characterization and evaluation of cumin (*Cuminum cyminum* L.) germpalsm". in National Seminar on "Hi-Tech Horticulture for Enhancing Productivity, Quality and Rural Prosperity" at National Research Centre on Seed Spices, Ajmer, January 19-20, 2015.
Dr. N.K. Meena	Life member of Indian Society of Seed Spices, Ajmer
Dr. S. Choudhary	Best presentation award for research paper "Molecular Studies of Cumin *(Cuminum cyminum L.)* for diversity and modelling" in 3rd International Conference on "Agriculture & Horticulture" at Hyderabad International Convention Centre (HICC), India, October 27-29, 2014. Best Poster award on "Molecular analysis to define the genetic diversity of Cumin (*Cuminum cyminum* L.)" in National Seminar on "Hi-Tech Horticulture for Enhancing Productivity, Quality and Rural Prosperity" at National Research Centre on Seed Spices, Ajmer, January 19-20, 2015. Member, Editorial board of International Journal of Seed Spices
Dr. R.D. Meena	Member, Editorial board of International Journal of Seed Spices
Sh. M.K.Vishal	Editor and reviewer of International Journal of Seed Spices during year 2014-15. Received best poster presentation award for research paper entitled " Assam and Meghalaya as potential coriander producing area in north-eastern states" authored by me in the Technical Session Extension, Trade Marketing & Export of Horticulture Crops during National Seminar on " Hi-tech Horticulture for Enhancing Productivity, Quality and Rural Prosperity" held on January 19-20, 2015 at National Research Centre on Seed Spices, Ajmer Received best poster presentation award for research paper entitled "Cumin is a major cash crop is boon for Arid and Semi-Arid regions of India: A livelihood perspective". In National Seminar on Sustainable management of land resources for livelihood security during January 28-30, 2015 organized by ISSLUP Nagpur, Maharashtra, India. Life membership of the Indian Society of Soil survey and Land Use Planning, Nagpur, Maharashtra, India.
Dr. A.K. Verma	Best poster presentation award on Effect of acute exposure of gamma rays on seed germination and seedling growth of Fennel presented in National Seminar Organised by Indian Society of Seed Spices and Indian Society for Portended Cultivation during 19-20 January 2015. Life member of The Medicinal and Aromatic Plant Association of India, Anand, Gujarat Life member of Indian Society of Seed Spices, Ajmer, Rajasthan

9. Linkages and Collaborations

Linkages and collaboration is the key of success in modern era. Output of research programmes may be manifold by effective linkages and collaboration. NRCSS is always encouraging collaborative research work with parellal institutes or Universities. Presentely NRCSS have linkages with following research organizations in the country.

9.1 AICRP on Spices

9.2 AICRP on Vegetables

9.3 Various ICAR Institutes/ SAUs/State Agriculture/Horticulture Departments

The National Research Centre on Seed Spices is maintaining linkages with the following institutes/agencies

- ICAR-Indian Agricultural Research Institute, New Delhi and its regional stations
- ICAR-Indian Institute of Spices Research (IISR), Calicut
- ICAR-Central Plantation Crops Research Institute, Regional Station, Guwahati
- ICAR-Directorate of Medicinal and Aromatic Plants Research, Anand, Gujarat
- ICAR-National Bureau of Plant Genetic Resources (NBPGR), New Delhi
- All India Coordinated Research Project on Spices , (AICRPS) Calicut
- ICAR-Central Arid Zone Research Institute (CAZRI), Jodhpur, Rajasthan
- ICAR-Central Institute of Arid Horticulture (CIAH), Bikaner, Rajasthan
- SAU's *i.e.*, SKRAU, Bikaner, MPUAT, Udaipur, SKN Agricultural University, Jobner, Kota Agricultural University, Kota, Jodhpur Agricultural University, Jodhpur, SDAU, Dantiwara, CCS HAU, Hisar, PAU, Ludhiana, SKUAT, Sri Nagar, APHU, Hyderabad, UAS, Dharwar and NDUAT, Faizabad.
- Central Agricultural University, campus Pasighat
- Spices Board, Cochin, Kerala
- Directorate of Arecanut and Spices Development (DASD), Calicut
- State Agriculture Department of Rajasthan and Gujarat
- State Horticulture Department of Rajasthan and Gujarat
- ICAR-Central Sheep and Wool Research Institute, Avikanagar
- ICAR-Central Research Institute for Dryland Agriculture, Hyderabad, AP
- ICAR-Central Institute of Post Harvest Engineering and Technolog (CIPHET), Ludhiana
- ICAR-Protection of Plant Varieties and Farmer Rights Authority (PPVFRA), Govt of India, New Delhi
- Zonal Project Coordinators, Jodhpur, Rajasthan and Barapani, Meghalaya
- ICAR-Indian Institute of Horticulture Research, Bangaluru
- ICAR-National Bureau of Agriculturally Important Micro-oraganisms, Mau, UP
- ICAR-National Research Center on Grapes, Pune
- ICAR-Centeral Soil Salinity Research Institute, Karnal
- ICAR-National Bureau of Soil Survey and Land Use Planning, Nagpur
- ICAR-Central Institute of Sub-Tropical Horticulture, Lucknow
- ICAR-Indian Institute of Farming Systems Research, Modipuram
- KVKs: Jhunjhunu, Pokhran, Gudamalani, Jalore, Mandor, Pali, Dungarpur, Banswara, Pratapgarh, Ajmer & Barmer
- College of Horticulture & Forestry, Jhalawar
- ICAR-CPRI, Regional Station, Upper Shilong, Meghalaya
- ICAR-NRC for Orchids, Pakyong, Sikkim
- Farmers, NGOs and KVKs

10. Publications

International Journals

1. Barnwal, P., Singh, K., Mohite, A., Sharma, A. and Saxena, S.N. (2014). Influence of cryogenic and ambient grinding on grinding characteristics of fenugreek powder. A comparative study. *J. Food Processing and Preservation*. DOI: 10.1111/jfpp. 12342.
2. Barnwal, P., Singh, K.K., Sharma, A., Chaudhary, A.K., Zachariah, T.J. and Saxena, S.N. (2014). Biochemical, antioxidant and thermal properties of cryogenic and ambient ground turmeric powder. *Int. Agril. Eng. J.*, 23(1):39-46
3. Lal, G. (2014). Impact of adoption of scientific interventions in fenugreek on grain yield and farmers income: An assessment by FLD's in Arid Zone of Rajasthan, India. *African J. Agril. Res.* 9(31): 2391-2396.
4. Saxena, S.N., Rathore, S.S., Barnwal, P., Sharma, L.K. and Singh, B. (2014). Effect of cryogenic grinding on essential oil constituents of coriander (*Coriandrum sativum* L.) genotypes. *J. Essential Oil Bearing Plants*. 17(3):385-392.
5. Singh, R.K., Vishwakarma, R.K., Vishal, M.K., Singh, S.K. and Saharan, V.K. (2015). Moisture dependent physical properties of nigella seeds. *Afri. J. of Agri. Res.* 10(2):58-66.

National Journals

1. Aishwath, O.P., Singh, R., Jha, B.K. and Mehta, R.S. (2015). Growth kinetics and yield of coriander under limed acid soils of Eastern Plateau Hill Regions. *Int. J. Seed Spices* 5 (1):49-55.
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