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Integrated management of wilt of cumin (*Cuminum cyminum* L.)

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Abstract

Four components of integrated management namely, soil solarization, crop rotation, chemicals and biocontrol agents were tested under field condition at Junagadh (Gujarat) for the management of wilt of cumin (*Cuminum cyminum*) caused by *Fusarium oxysporum* f. sp. *cumini*. Growing of sorghum (*Sorghum bicolor*) or maize (*Zea mays*) during *kharif* season did not reduce wilt incidence during the following *rabi* season. Soil solarization with 25 µm LLDPE plastic cover for 15 days in summer proved most effective in reducing wilt incidence to 26.27% as against 44.90% in non-solarization and increasing yield to 396 kg ha^{-1} as against 286 kg ha^{-1} in non-solarized plots. Application of carbendazim granules @ 10 kg ha^{-1} one month after sowing or *Trichoderma viride* in organic carrier @ 62.5 kg ha^{-1} at sowing time were also effective. Integrating soil solarization followed by growing of sorghum in *kharif* and application of either carbendazim granules @ 10 kg ha^{-1} one month after sowing or application of *T. viride* in organic carrier @ 62.5 kg ha^{-1} was effective for the management of cumin wilt.

Keywords : cumin, *Cuminum cyminum*, *Fusarium oxysporum* f. sp. *cumini*, integrated management, wilt.

Introduction

Wilt caused by *Fusarium oxysporum* f. sp. *cumini* is a serious disease of cumin (*Cuminum cyminum* L.) in India (Dange 1995). The disease manifests from the seedling stage itself and continues till the maturity of the crop. Since the pathogen is soil and seed borne, chemical control alone is not sufficient to manage the disease. The present investigation was undertaken with a view to integrate different management components like crop rotation, soil solarization, fungicide application and biocontrol for the management of the disease.

Materials and methods

The field experiment was conducted in wilt sick field at the Department of Plant Pathology, College of Agriculture, Junagadh (Gujarat) during 2003–04 and 2004–05. The experiment was laid out in a strip split plot design with three main treatments namely, (i) maize (ii) sorghum (iii) fallow (without any crop) and two sub treatments namely, (i) field solarization with 25 µm LLDPE clear plastic in May for 15 days (ii) no solarization, and six sub-sub treatments (chemicals and bioagents) namely, (i) seed treatment with carbendazim 50% WP (2 g kg^{-1} of seed) +

Thiram 75% WP (2 g kg^{-1} seed) (ii) seed treatment with *Trichoderma harzianum* 3 x 10^6 spores ml^{-1} @ 25 ml kg^{-1} of seed in slurry form (iii) broadcasting of carrier based *T. viride* (Monitor-S) @ 62.5 kg ha^{-1} at the time of sowing (iv) carbendazim granules (Jekestin 5%) at the time of sowing @ 10 kg ha^{-1} (v) carbendazim granules (Jekestin 5%) after one month of sowing @ 10 kg ha^{-1} and (vi) control.

Solarization

During summer the whole field (33 m x 27 m) was divided into four divisions which was again split into two parts accommodating solarization (S) and no solarization (NS) treatments. Before plastic covering for solarization, the plot was made moist with very light irrigation during May. The plastic was removed after 15 days. The S and NS plots were marked and inter-cultural operation was done for *kharif* crops (sorghum and maize).

Crop rotation

Two crops namely, maize (*Zea mays* L.) and sorghum (*Sorghum bicolor* Monech.) were selected for crop rotation along with fallow for *kharif* in each S and NS plot. Each S and NS plot was divided into three equal parts accommodating maize, sorghum and fallow treatments. The local varieties of maize and sorghum were used.

Chemical and bioagent application

The method and time of application of fungicides and bioagents have been indicated earlier. Gujarat Cumin-2 was sown (broadcasting method) during first week of November. The gross sub-sub plot size was 5 m x 1 m. Six sub-sub treatments in each of maize, sorghum and fallow land were accommodated in respective S and NS plots. Total plant stand was recorded in each sub-sub plot after emergence. Number of wilted plants were counted every week from third week of sowing up to crop maturity. During each observation, the wilted plants were removed from the field. On the basis of initial plant count and accumulated wilted plant count, per cent wilt incidence in each plot was calculated. The seed yield in each plot was also recorded during harvest.

Results and discussion

During 2003–04 the seed yield was low due to heavy incidence of blight disease. There was no effect of crop rotation on wilt incidence, but significantly higher seed yield was obtained during 2004–05 with sorghum (402 kg ha^{-1}) as compared to maize (308 kg ha^{-1}) or fallow (314 kg ha^{-1}) treatments (Table 1). Significantly low wilt incidence was recorded in S soil (26.3%) as against NS soil (44.9%). Similarly higher seed yield (396 kg ha^{-1}) was obtained in S treatment in comparison to NS

Table 1. Effect of crop rotation on wilt incidence and seed yield of cumin

Treatment	Wilt incidence (%)			Seed yield (kg ha^{-1})		
	2003–04	2004–05	Pooled mean	2003–04	2004–05	Pooled mean
Maize	45.92	31.22	38.53	115	500	308
	(51.60)	(26.85)	(38.80)			
Sorghum	41.23	27.93	34.63	160	644	402
	(43.60)	(22.95)	(32.30)			
Fallow	40.99	31.50	36.19	118	510	314
	(42.85)	(27.30)	(34.84)			
CD (P=0.05)	1.04	0.78	NS	4.65	13.50	26.06
CV %	5.69	5.22	-	10.40	11.69	7.44

Data in parenthesis are transformed values treatment (286 kg ha^{-1}) (Table 2). Significant differences in disease reduction and seed yield were observed among various fungicides or biocontrol agents (Table 3). Lowest wilt incidence (28.4%) and highest seed yield (437 kg ha^{-1}) were obtained with carbendazim application one month after sowing which was at par with broadcasting carrier based *T. viride* @ 62.5 kg ha^{-1} at sowing time.

Interaction effect

There was no significant difference in wilt incidence among the four interactions namely, crop rotation x S/NS, crop rotation

Table 2. Effect of solarization on wilt incidence and seed yield of cumin

Treatment	Wilt incidence (%)			Seed yield (kg ha^{-1})		
	2003–04	2004–05	Pooled mean	2003–04	2004–05	Pooled mean
Solarization	38.58	23.14	30.83	158	635	396
	(38.90)	(15.45)	(26.27)	104	468	286
Without solarization	46.85	37.29	42.07			
	(53.25)	(36.70)	(44.90)			
CD (P=0.05)	0.37	0.89	5.46	3.04	11.25	51.61
CV %	5.69	5.50	5.62	10.40	9.49	7.44

Data in parenthesis are retransformed values

Table 3. Effect of chemical and biocontrol treatments on wilt incidence and seed yield of cumin

Treatment	Wilt incidence (%)			Seed yield (kg ha^{-1})		
	2003–04	2004–05	Pooled mean	2003–04	2004–05	Pooled mean
Seed treatment with carbendazim 50% WP (2 g kg^{-1}) + Thiram 75% WP (2 g kg^{-1})	45.85 (51.45)	33.06 (29.70)	39.46 (40.39)	99	457	278
Seed treatment with *Trichoderma harzianum* 3 x 10^6 spores ml^{-1} @ 25 ml kg^{-1} in slurry form	43.40 (47.20)	30.30 (25.50)	36.85 (35.94)	124	507	316
Broadcasting of carrier based *T. viride* (Monitor-S) @ 25 kg $acre^{-1}$ at the time of sowing	39.11 (39.80)	27.44 (21.25)	33.19 (29.94)	170	685	429
Application of carbendazim granules (Jekestin 5%) at the time of sowing @ 10 kg ha^{-1}	42.54 (45.70)	30.50 (25.75)	36.52 (35.41)	130	506	318
Application of carbendazim granules (Jekestin 5%) after one month of sowing @ 10 kg ha^{-1}	38.36 (38.50)	26.03 (19.30)	32.20 (28.40)	176	699	437
Control	47.01 (55.30)	33.95 (31.20)	40.48 (42.12)	88	455	271
CD (P=0.05)	1.41	0.89	1.62	6.73	7.79	17.13
CV %	5.69	5.50	5.62	10.40	6.07	7.44

Data in parenthesis are retransformed values x chemical and bioagent, S/NS x chemical and bioagent and crop rotation x S/NS x chemical and bioagent. In the interaction of crop rotation x solarization x chemical and bioagent, lowest wilt incidence in the first year was observed in fallow solarized plots with broadcasting *T. viride* at sowing time (21.83%) which was at par with application of carbendazim granules after one month of sowing (23.98%). In the second year, low wilt incidence was recorded under solarized sorghum rotation plots with application of carbendazim granules after one month of sowing (10.55%) and broadcasting *T. viride* at sowing time (10.95%) (Table 6).

Carbendazim application one month after sowing as well as *T. viride* application at sowing time in crop rotation with *kharif* sorghum combination produced significantly higher seed yield of 541 and 524 kg ha^{-1} respectively, as against 302 kg ha^{-1} in control (Table 4).

The chemical and biocontrol treatments which were better in crop rotation with sorghum were also most effective under S treatment and yielded 518 and 517 kg ha^{-1} as compared to 302 kg ha^{-1} in control (Table 5).

The interactions of crop rotation x S/NS and crop rotation x S/NS x chemical and bioagent for seed yield were non significant. Here again the individual year results were significant. In the interaction of crop rotation x S x chemical and bioagent, highest seed yield was recorded in the solarized sorghum rotation plots with application of *T. viride* at sowing time during first year (235 kg ha^{-1}). In the second year, highest seed yield was obtained in S plots with carbendazim granules application after one month of sowing (995 kg ha^{-1}) (Table 7).

Table 4. Interaction of crop rotation x chemical and bioagent on seed yield of cumin

Treatment	Crop rotation						Pooled mean		
	2003–04			2004–05					
	M	S	F	M	S	F	M	S	F
Seed treatment with carbendazim 50% WP (2 g kg^{-1}) + Thiram 75% WP (2 g kg^{-1})	85	133	79	436	502	432	260	318	255
Seed treatment with *Trichoderma harzianum* 3 x 10^6 spores ml^{-1} @ 25 ml kg^{-1} in slurry form	109	160	103	471	576	474	290	368	289
Broadcasting of carrier based *T. viride* (Monitor-S) @ 25 kg $acre^{-1}$ at the time of sowing	162	195	153	597	853	605	382	524	379
Application of carbendazim granules (Jekestin 5%) at the time of sowing @ 10 kg ha^{-1}	95	154	140	469	564	486	282	358	312
Application of carbendazim granules (Jekestin 5%) after one month of sowing @ 10 kg ha^{-1}	141	215	171	611	868	619	376	541	394
Control	99	101	64	417	503	444	258	302	254
CD (P=0.05)		11.90			13.49			29.64	
CV %		10.40			6.07			7.44	

Values indicate seed yield in kg ha^{-1}; M= Maize; S=Sorghum; F=Fallow

Table 5. Interaction of solarization x chemical and bioagent on seed yield of cumin

Treatment	Solarization (S) No solarization (NS)				Pooled mean	
	2003–04		2004–05			
	S	NS	S	NS	S	NS
Seed treatment with carbendazim 50% WP (2 g kg^{-1}) + Thiram 75% WP (2 g kg^{-1})	114	83	518	396	316	240
Seed treatment with *Trichoderma harzianum* 3 x 10^6 spores ml^{-1} @ 25 ml kg^{-1} in slurry form	167	81	572	442	369	261
Broadcasting of carrier based *T. viride* (Monitor-S) @ 25 kg ha^{-1} at the time of sowing	219	114	812	558	518	340
Application of carbendazim granules (Jekestin 5%) at the time of sowing @ 10 kg ha^{-1}	148	111	563	449	356	280
Application of carbendazim granules (Jekestin 5%) after one month of sowing @ 10 kg ha^{-1}	200	152	835	563	517	375
Control	97	78	508	402	302	240
CD (P=0.05)	9.71		11.01		24.22	
CV %	10.40		6.07		7.44	

Values indicate seed yield in kg ha^{-1}; M=Maize; S=Sorghum; F=Fallow

Soil solarization with plastic film mulching was also earlier proved effective against *Fusarium* wilt of cumin (Baradia & Rai 2007). Polyethylene mulching for 15 days in mustard residue or oil-cake amended field drastically reduced *Fusarium* population in soil and in subsequent *rabi* season effectively reduced incidence of cumin wilt (Israel *et al.* 2005). Aghnoom *et al.* (1999) have reported that seed dressing of *T. harzianum* (T-2 isolate) was effective in cumin wilt reduction in laboratory and greenhouse conditions. Israel & Lodha (2005) also suggested soil application of heat tolerant strain of *Aspergillus versicolor* and *T. harzianum* for the reduction of soil inoculum of *F. oxysporum* f. sp. *cumini* and increased plant root length of cumin.

The study indicated that, there was no significant effect of sorghum or maize as *kharif* crop in reduction of cumin wilt but seed yield increased in sorghum-cumin rotation. Soil solarization treatment reduced cumin wilt incidence and produced higher seed yield. Application of *T. viride* at sowing time or carbendazim one month after sowing was effective in wilt reduction with higher seed yield. The combination of biocontrol treatment or chemical treatment with sorghum rotation and solarization was better for obtaining higher seed yield as compared to their individual effect.

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Table 6. Interaction of crop rotation x solarization x chemical and bioagent on cumin wilt incidence (%)*

Crop rotation	S/NS	Chemical and bioagent treatment											
		1		2		3		4		5		6	
		(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
Maize	S	49.55	25.16	40.26	23.56	39.74	21.76	41.40	24.21	36.51	19.31	44.14	26.55
		(50.96)	(18.15)	(41.76)	(15.95)	(40.86)	(13.75)	(43.73)	(16.85)	(35.40)	(10.95)	(48.50)	(19.95)
	NS	51.01	43.01	49.92	36.67	47.60	34.97	52.19	39.91	47.20	33.92	51.48	42.54
		(60.42)	(46.55)	(58.55)	(40.75)	(54.53)	(32.85)	(62.41)	(41.25)	(53.83)	(29.55)	(61.21)	(45.75)
Jowar	S	45.61	23.57	36.67	21.45	32.91	19.33	40.24	20.38	32.03	18.92	46.10	23.72
		(51.06)	(15.95)	(35.66)	(13.35)	(29.51)	(10.95)	(41.73)	(12.65)	(28.13)	(10.55)	(51.91)	(16.15)
	NS	43.20	36.91	45.41	35.04	43.44	31.28	44.41	34.19	38.89	29.92	47.03	40.40
		(46.05)	(36.05)	(50.72)	(33.00)	(47.28)	(26.95)	(48.96)	(31.55)	(39.42)	(24.90)	(53.56)	(42.00)
Fallow	S	37.04	27.83	40.45	24.20	27.85	22.79	31.92	24.19	29.32	21.12	42.67	28.41
		(36.28)	(21.80)	(42.06)	(16.80)	(21.83)	(15.00)	(27.82)	(16.15)	(23.98)	(12.95)	(45.96)	(22.65)
	NS	48.70	41.81	47.71	37.92	43.12	34.15	45.05	40.12	46.23	32.98	50.62	42.06
		(54.46)	(44.45)	(54.72)	(37.75)	(46.71)	(32.10)	(50.08)	(41.55)	(52.16)	(29.65)	(59.76)	(44.95)
CD (P=0.05)						3.43	2.28						
CV %						5.69	5.35						

S=Solarization; NS=No solarization; (a)=2003–04; (b)=2004–05; Chemicals and bioagents 1 to 6 as shown in Table 3
*Pooled interaction non-significant; Data in parenthesis are retransformed values

Table 7. Interaction of crop rotation x solarization x chemical and bioagent on seed yield of cumin (kg ha^{-1})*

Crop rotation	S/NS	Chemical and bioagent treatment											
		1		2		3		4		5		6	
		(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
Maize	S	92	477	158	514	231	713	110	515	167	750	114	443
	NS	77	396	60	428	93	481	81	423	116	472	81	391
Jowar	S	160	587	210	670	235	983	149	631	207	995	104	562
	NS	105	417	111	481	156	723	159	496	222	741	95	444
Fallow	S	90	488	134	531	192	741	185	543	225	760	71	518
	NS	67		72	417	115	469	94	429	117	476	56	370
CD (P=0.05)						16.83	6.78						
CV %						10.40	19.08						

S=Solarization; NS=No solarization; (a)=2003–04; (b)= 2004–05; Chemicals and bioagents 1 to 6 as shown in Table 3
*Pooled interaction non-significant

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