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Nutrient utilization by cumin (*Cuminum cyminum*) and weeds as influenced by different weed-control methods

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ABSTRACT

A field study was conducted during the winter season of 2003–04 and 2004–05 at Mandor, Jodhpur with 15 weed-management treatments, to study the nutrient uptake by cumin (*Cuminum cyminum* L.) and depletion by associated weeds. Amongst the weed-management treatments, oxyfluorfen and oxadiargyl at 50 g/ha applied 20 days after sowing (DAS) along with 1 hand-weeding 35 DAS caused maximum reduction in weed biomass production and nutrient depletion by weeds 90 DAS and resulted in higher weed-control efficiency. These treatments also enhanced cumin yield, essential oil content in the seed and uptake of N, P and K by the crop and net monetary returns. Weeds in check plots cornered 93.5 kg N, 14.5 kg P and 142.6 kg K/ha recorded 90 DAS, which was significantly higher than in other treatments. Paraquat and glyphosate applied 7 DAS failed to check depletion of nutrients by weeds significantly. Application of oxadiargyl @ 50 g/ha applied 20 DAS was found better than its application 7 DAS. Early post-emergence application of oxyfluorfen and oxadiargyl 50 g/ha followed by 1 hand-weeding computed considerably higher net returns (Rs 25,595 and 24,823/ha respectively) and benefit : cost ratio (2.92 and 2.80), and lower nutrient uptake compared to other integrated weed-control treatments.

Key words : Cumin, Herbicides, Integrated weed management, Nutrient uptake

Cumin (*Cuminum cyminum* L.) is an important seed spice crop of arid region of Rajasthan and Gujarat, which is used both as medicinal as well as flavouring agent. Cumin, a short-statured crop with slow initial growth, is severely smothered due to the infestation of weeds at early stages of growth, which causes severe competition and may result in complete crop failure (Yadav *et al.*, 2004a). It is well known fact that weeds compete with crop and deprive it of limited essential resources, prominent amongst which are nutrients. To minimize the magnitude of nutrients drained by weeds and effective utilization of resources by the crop, control of weeds is essential. Yadav and Dahama (2003) and Yadav *et al.* (2004b) reported that herbicides caused an appreciable decrease in density, dry weight and depletion of nutrients by weeds in cumin. Since single method is not able to control weeds to the desired level in cumin, integration of chemical and mechanical methods might be an answer to achieve higher weed control efficiency which, in turn, may decrease the depletion of nutrient by weeds. As limited information is available about the nutrient depletion by weeds under integrated weed management in cumin, the present study was carried out to study the nutrient uptake by the crop as well as depletion by weeds under various methods of weed control.

MATERIALS AND METHODS

The experiment was conducted during the winter season of 2003–04 and 2004–05 at Agricultural Research Station, Mandor-Jodhpur (Rajasthan). The soil was sandy loam (13.0% clay, 10.7% silt and 76.3% sand), low in organic C (0.13%) and available N (170 kg/ha), medium in P (26 kg/ha) and high in K (391 kg/ha) contents with soil pH 8.0. The treatments comprised application of paraquat (0.4 kg/ha) and glyphosate (0.5 kg/ha) at 7 days after sowing (DAS) either alone or along with 1 hand-weeding 35 DAS; oxadiargyl (50 g/ha) at 7 or 20 DAS and oxyfluorfen (50 g or 75 g/ha) at 20 DAS either alone or with 1 hand-weeding (35 DAS) along with fluchloralin @ 1.0 kg/ha (pre-plant incorporation). In addition to these, weedy check and weed-free control were also maintained. These treatments were replicated thrice in randomized block design. Dry seeding of cumin cv 'RZ 19' was done in rows 30 cm apart on 23 November 2003 and 21 November 2004, and then irrigation was applied to basins (4

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m × 3 m). Since cumin seeds took 10–12 days for complete germination, another light irrigation was given 9 DAS to ensure uniform germination. Half dose of N (15 kg N/ha) and full dose of P (20 kg P/ha) were drilled as basal application uniformly just before sowing. The remaining half dose of N was top-dressed at the time of irrigation applied 32 DAS. Plant-protection measures were followed as per recommendation. Since irrigation was applied immediately after dry seeding, a few weeds germinated within a week's time, whereas major flush of weeds emerged after applying light irrigation 9 DAS. Flat-fan nozzle was used for herbicidal application, using 500 litres water/ha. Weed dry weight was recorded by putting a quadrat (0.25 m^2) at 2 random spots. Nitrogen, phosphorus and potassium were estimated by standard methods. The crop was harvested on 14 March 2004 and 15 March 2005. The experimental data recorded for growth, yield and quality characters were statistically analysed. The critical differences for the treatment comparison were worked out, wherever the F test was found significant at 5% level of significance.

RESULTS AND DISCUSSION

Weed growth

The dominant weeds in the experimental field were *Chenopodium murale* L., *C. album* L. and *Rumex dentatus* L. In general, there was greater dry matter of weeds during 2004–05 compared to 2003–04. Weed population and their dry matter were significantly reduced due to weed-control treatments compared to weedy check (Table 1). Oxyfluorfen or oxadiargyl @ 50 g/ha applied 20 days after sowing (DAS) significantly reduced the dry matter of *Chenopodium* spp. and total weeds compared to fluchloralin @ 1.0 kg/ha or oxadiargyl @ 50 g/ha 7 DAS during both the years. Yadav *et al.* (2004) also reported that oxadiargyl at 50 g/ha at 20 DAS showed better control of weeds in cumin. Singh *et al.* (2005) also reported better control of weeds by oxyfluorfen applied at 15 DAS in blond psyllium (*isabgol*). Paraquat and Glyphosate applied at 7 DAS failed to decrease the dry matter of weeds. This might be due to the emergence of major flush of weeds after 7 DAS in these treatments. Oxyfluorfen @ 50 or 75 g/ha or oxadiargyl @ 50 g/ha 20 DAS + hand-weeding 35 DAS resulted in the minimum and significantly lower dry matter of weeds and consequently improved weed-control efficiency (WCE) compared to all other treatments during both the seasons. Parihar and Singh (1994) also reported better control of weeds in cumin with integrated method of weed control.

Nutrient uptake

All the weed-control treatments significantly decreased the N, P and K uptake by total weeds compared to weedy check (Table 1). Application of oxyfluorfen @ 50-75 g/ha or oxadiargyl @ 50 g/ha applied 20 DAS significantly lowered the N, P and K uptake by total weeds compared to fluchloralin, paraquat, glyphosate and oxadiargyl (50 g/ha) applied 7 DAS. Integration of 1 hand-weeding at 35 DAS with oxyfluorfen @ 50-75 g/ha or oxadiargyl @ 50 g/ha significantly reduced the uptake of N, P and K by total weeds compared with sole application of the herbicides. Yadav *et al.* (2004a) also reported reduction in depletion of nutrients by weeds in different weed-control treatments.

Crop productivity

Presence of weeds adversely affected umbels/plant, seeds/umbel, test weight, nutrient uptake, essential oil content and seed yield of cumin (Table 2). Application of oxyfluorfen @ 50-75 g/ha or oxadiargyl @ 50 g/ha applied 20 DAS + 1 hand-weeding gave significantly higher yield of cumin compared with all other weed-control treatments except their sole application in 2003. This might be due to effective control of weeds which in turn significantly increased the umbels/plant, seed/umbel and test weight and consequently improved the seed yield of cumin. Parihar and Singh (1994) also reported that superimposition of 1 hand-weeding along with herbicide produced umbels/plant similar to weed-free environment. Oxadiargyl @ 50 g/ha applied 7 DAS failed to improve the seed yield of cumin compared to its application at 20 DAS. This might be due to the emergence of major flush of weeds after 7 DAS in these treatments. Yadav *et al.* (2004a) also reported that oxadiargyl at 50 g/ha applied 20 DAS significantly improved seed yield of cumin. The losses in seed yield of cumin, if weeds were not controlled for entire season, were 87.9 and 94.3% during 2003–04 and 2004–05, respectively.

Essential oil content in cumin seed improved significantly by different weed-control treatments compared to weedy check except Paraquat and Glyphosate. Weed-free treatment gave maximum essential oil content (4.13%) while minimum (3.33%) was recorded in weedy check.

Nutrient uptake

Different weed-control treatments resulted in significantly higher N, P and K uptake by cumin compared to weedy check (Table 2). The maximum N, P and K uptake was computed due to weed-free treatment and was found statistically at par with oxyfluorfen @ 50 or 75 g/ha with 1 hand-weeding. The N, P and K content drained by weeds was lower in the herbicide-treated plots, and consequently there was higher uptake of these nutrients by cumin. The weeds under weedy check removed 97.6, 95.0 and 97.9% N, P and K, respectively, out of the total uptake by crop

Table 1. Effect of different weed-control treatments on dry-matter accumulation, weed-control efficiency and mean nutrient uptake by weeds at 90 days stage

Treatment	Weed dry-matter accumulation (g/m^2)								WCE (%)		Mean nutrient uptake (kg/ha)		
	C. murate		*C. album*		*Rumex dentatus*		Total		2003–04	2004–05			
	2003–04	2004–05	2003–04	2004–05	2003–04	2004–05	2003–04	2004–05			N	P	K
Weedy check	153.2	173.1	72.8	81.5	101.2	110.2	350.7	424.8	0.0	0.0	93.53	14.52	142.65
Weed-free treatment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	100.0	0.0	0.0	0.0
Fluchloralin 1.0 kg/ha as PPI	50.2	62.1	15.8	21.8	12.0	14.0	82.4	101.8	76.5	76.0	22.22	3.45	33.91
Paraquat 0.4 kg/ha 7 DAS	63.5	84.6	35.6	52.3	48.3	81.1	168.0	233.1	52.1	45.1	48.39	7.50	73.89
Paraquat 0.4 kg/ha 7 DAS + HW	25.7	36.1	21.2	18.3	0.0	1.8	59.7	66.1	83.0	84.4	15.17	2.35	23.12
Glyphosate 0.5 kg/ha 7 DAS	67.3	141.8	74.8	81.9	90.8	81.8	252.3	307.4	28.0	27.6	67.50	10.46	103.06
Glyphosate 0.5 kg/ha 7 DAS + HW	30.5	42.9	21.5	31.8	10.5	16.8	65.7	93.6	81.2	78.0	19.22	2.98	29.35
Oxadiargyl 50 g/ha 7 DAS	46.1	48.3	17.3	21.9	51.3	61.3	117.1	134.3	66.6	68.4	30.32	4.70	46.24
Oxadiargyl 50 g/ha 7 DAS + HW	17.8	24.4	14.3	18.8	13.0	9.4	48.2	54.4	86.2	87.2	12.37	1.92	18.88
Oxadiargyl 50 g/ha 20 DAS	10.3	21.6	5.6	14.7	26.7	46.8	44.8	85.0	87.2	80.0	15.66	2.44	23.95
Oxadiargyl 50 g/ha 20 DAS + HW	5.2	9.8	6.9	11.3	0.0	6.0	17.2	29.8	95.1	93.0	5.67	0.88	8.66
Oxyfluorfen 50 g/ha 20 DAS	7.8	18.5	8.5	14.6	22.3	38.6	42.4	74.7	87.9	82.4	14.13	2.20	21.61
Oxyfluorfen 50 g/ha 20 DAS + HW	5.4	6.3	6.8	4.3	0.0	8.1	17.0	20.6	95.2	95.2	4.51	0.70	6.88
Oxyfluorfen 75 g/ha 20 DAS	4.1	12.2	1.8	11.8	19.2	30.8	29.0	56.8	91.7	86.8	10.35	1.61	15.84
Oxyfluorfen 75 g/ha 20 DAS + HW	3.8	2.8	2.1	3.8	0.0	7.8	14.2	15.2	95.9	96.4	3.54	0.55	5.40
SEm±	2.0	2.4	1.3	1.9	1.6	1.8	5.2	6.2			0.98	0.19	1.50
CD (P=0.05)	5.9	7.1	3.6	5.8	4.7	5.3	15.0	18.0			2.78	0.55	4.24

PPI; DAS, days after sowing; HW, hand-weeding

Table 2. Effect of different weed control treatments on yield attributes, seed yield, essential oil content, nutrient uptake by cumin and economics (pooled data of 2 years)

Treatment	Umbels/ plant	Seeds/ umbel	Test weight (g)	Seed yield (kg/ha)		Oil content (%)	Nutrient uptake (kg/ha)			Net returns (Rs/ha)	Benefit : cost ratio
				2003–04	2004–05		N	P	K		
Weedy check	5.80	20.23	3.37	80	41	3.33	2.27	0.76	2.96	-8,646	0.29
Weed-free treatment	15.13	34.18	4.14	665	719	4.13	27.94	7.94	31.04	26,427	2.70
Fluchloralin 1.0 kg/ha as PPI	12.63	30.67	3.93	532	443	4.07	19.77	5.64	22.12	15,936	2.19
Paraquat 0.4 kg/ha 7 DAS	7.08	23.33	3.51	125	62	3.52	3.23	1.08	4.14	-7,255	0.43
Paraquat 0.4 kg/ha 7 DAS + HW	11.40	29.27	3.69	374	565	4.10	18.45	5.40	20.33	14,401	2.00
Glyphosate 0.5 kg/ha 7 DAS	6.52	21.57	3.40	129	78	3.60	3.60	1.20	4.59	-6,579	0.48
Glyphosate 0.5 kg/ha 7 DAS + HW	11.78	30.10	3.68	467	554	4.11	19.41	5.63	21.36	16681	2.16
Oxadiargyl 50 g/ha 7 DAS	11.43	29.77	3.72	458	454	4.07	17.77	5.03	19.14	14,721	2.15
Oxadiargyl 50 g/ha 7 DAS + HW	13.47	31.87	3.94	570	580	3.94	22.25	6.35	24.76	20,318	2.40
Oxadiargyl 50 g/ha 20 DAS	13.77	30.63	4.01	594	560	4.08	22.09	6.48	24.66	21,996	2.71
Oxadiargyl 50 g/ha 20 DAS + HW	14.65	32.43	4.01	633	643	4.00	24.03	7.08	27.47	24,823	2.80
Oxyfluorfen 50 g/ha 20 DAS	11.53	28.30	3.95	590	565	4.11	22.21	6.24	24.53	22,189	2.75
Oxyfluorfen 50 g/ha 20 DAS + HW	14.58	33.73	4.04	629	657	4.09	25.36	7.19	28.42	25,595	2.92
Oxyfluorfen 75 g/ha 20 DAS	13.12	29.57	3.95	575	552	4.07	22.68	6.44	25.81	21,143	2.65
Oxyfluorfen 75 g/ha 20 DAS + HW	14.92	33.63	4.00	614	686	4.12	26.10	7.42	29.42	25,948	2.92
SEm±	0.49	1.14	0.13	23	26	0.12	0.70	0.19	0.83	1,074	
CD (P=0.05)	1.40	3.24	0.36	68	76	0.33	1.98	0.55	2.35	3,043	

and weeds. Yadav *et al.* (2004b) also reported higher uptake of nutrients by cumin in herbicide-treated plots.

Economics

Oxyfluorfen or oxadiargyl @ 50 g/ha 20 DAS followed by 1 hand-weeding computed considerably higher mean net returns and benefit : cost ratio compared to all the weed-control treatments (Table 2). This might be owing to higher weed-control efficiency in these treatments (95.2 and 94.1%). The lower net returns and benefit : cost ratio in weed-free environment might be because of more mandays engaged, and consequently more cost was required to create weed-free condition for entire period in the crop season.

It was concluded that integration of oxyfluorfen or oxadiargyl @ 50 g/ha applied 20 days after sowing (DAS) with 1 hand-weeding 35 DAS proved the most promising treatment pertaining to greater weed-control efficiency and consequently recorded significantly higher growth, seed yield, net returns and benefit : cost ratio in cumin.

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