Journal of Spices and Aromatic Crops
Vol. 22 (2) : 165–169 (2013)
www.indianspicesociety.in/josac/index.php/josac

Indian Society for Spices

Weed dynamics and critical period of crop weed competition in cumin (*Cuminum cyminum)* under arid region of Rajasthan

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Received 5 October 2011; Revised 03 November 2012; Accepted 4 February 2013

Abstract

A field experiment was conducted to assess the effect of crop weed competition on yield and monetary benefit in cumin under arid conditions of Rajasthan. In the first year of the study *Heliotropium oralifolium* was the most dominating weed species with a relative density, relative frequency and importance value index (IVI) of 24.7, 23.5 and 48.2, respectively, while *Chenopodium murale* dominated during second year with a relative density, relative frequency and importance value index (IVI) of 47.8, 21.8 and 69.6, respectively. Weed competition index decreased with increasing weed free check period. However, weed competition index in weed free check maintained from 30 to 60 days after sowing (DAS) varied from 10.52 and 5.26, while it was 44.76 under weed free check up to 15 DAS. No significant difference in the growth, yield attributes and seed yield was recorded in weed free condition maintained beyond 30 DAS, but differed significantly over weed free check up to 15 DAS. Allowing weeds to compete with crop after 30 DAS and up to harvest significantly reduced yield attributes and seed yield compared to weedy check up to 15 DAS. The highest mean seed yield (437 kg ha^{-1}) was recorded in season long weed free check, but net monetary benefit was highest (Rs. 19,520 ha^{-1}) with weed free check up to 30 DAS. Thus, the crop should be weed free for at least initial 30 DAS.

Keywords: crop weed competition, nutrient use efficiency, seed yield, water use efficiency, weed dynamics

Introduction

Cumin (*Cuminum cyminum* L.) is one of the most important seed spice crop of India. It occupies 47% of total seed spices area, but accounts for 35.7% of total seed spices production in the country. The seeds of cumin are used for many purposes *viz*., condiments, medicine, flavourings and seasoning agents. This crop is widely adapted as an important commercial crop in the arid and semi arid regions of Rajasthan and Gujarat states. Both the states contribute more than 80% in the total cumin production of the country (Malhotra & Vashishtha 2008). However, its productivity (308 kg ha^{-1}) is very low. Besides, many biotic and abiotic factors, severe weed infestation is the major factor responsible for low productivity (Parihar & Singh 1994). Requirement of soil moisture for initial 10-15 days to get proper germination, slow initial growth, short stature of the crop and poor canopy cover provide congenial

environment for the luxurious growth of weeds, which offer severe competition for essential resources (water, nutrient and space) and cause yield reduction to the tune of 80% and some times complete crop failure (Yadav *et al*. 2004). Therefore, effective weed management is prerequisite to get the desired level of yield as well as to increase the resource use efficiency (water and nutrients) as arid and semi arid soils are already deficient in these resources (Praveen Kumar *et al*. 1998). Manual weeding is often used to manage the weeds in cumin field, which is expensive and labour intensive. Therefore, removal of the weeds throughout the crop season may not be beneficial and economical. However, knowledge of time of weed removal can play a vital role to avoid extravagant expenses. Moreover, knowledge of the weed flora and critical period of weed removal is of utmost important to suggest economic and effective weed management practices. Hence, the present investigation was undertaken to assess the weed dynamics and also to identify critical period of weed removal in cumin under arid region of Rajasthan.

Materials and methods

A field experiment was conducted at the research farm of Central Arid Zone Research Institute, Jodhpur during *rabi* seasons of 2005–06 and 2006–07. The soil of the experimental site was sandy loam in texture with a bulk density of 1.54 g cm^{-3} and pH 7.9. The soil was low in organic carbon (0.22%) and total nitrogen (0.03%) medium in available phosphorus (12.4 kg ha^{-1}) and available potassium (245 kg ha^{-1}). The experiment consisted of 10 different treatments including weedy check and weed free check conditions for initial 15, 30, 45, 60 days after sowing (DAS) and up to harvest (Table 1). The experiment was laid out in randomized block design with three replications. Cumin variety 'RZ 19' was sown in rows 30 cm apart, using a seed rate of 12 kg ha^{-1} on 11 and 9 November during 2005 and 2006, respectively. The crop was fertilized with recommended dose of nitrogen (30 kg ha^{-1}) and phosphorus (30 kg ha^{-1}) uniformly. Half dose of N and full of P was applied as basal, while remaining N (15 kg ha^{-1}) was top dressed at 30 DAS. The crop was harvested on 5th March during 2006 and 8th March during 2007, respectively. Observations on density and dry weight of weeds were recorded by placing a quadrate of 0.50 m × 0.50 m at four random places in each plot. The economics of various treatments were computed considering the weeding cost of each treatment over weedy check and gross return was worked out on prevailing market price of cumin seed as Rs. 120 kg^{-1}. The compiled data were analyzed as per the methods suggested by Mishra (1968) and Raju (1997) using the following formulae:

Absolute density = Total No. of individuals of a species in all quadrates/ Total No. of quadrates employed

Relative density (%) = [Absolute density for a given species/ Total absolute density for all species] × 100

Table 1. Weed dynamics in weedy check plots at harvest in cumin field

Weed flora	Absolute density (m^2)		Relative density (%)		Absolute frequency (%)		Relative frequency (%)		Importance value Index	
	I year	II year	I year	II year	I year	II year	I year	II year	I year	II year
Chenopodium murale	39.77	115.68	21.6	47.8	75.0	100	17.7	21.8	39.3	69.6
Chenopodium album	17.58	27.83	9.5	11.5	66.7	91.7	15.7	20.0	25.2	31.5
Asphodelus tenuifolius	41.62	65.34	22.5	27.0	50.0	91.7	11.8	20.0	34.3	47.0
Heliotropium oralifolium	45.69	8.33	24.7	4.5	100	50	23.5	10.9	48.2	15.4
Melilotus indica	15.72	8.23	8.5	3.4	50	33.3	11.8	7.3	20.3	10.7
Rumex dentatus	12.58	5.08	6.8	2.1	41.7	33.3	9.8	7.3	16.6	9.4
Amaranthus blitum	11.84	15.49	6.4	3.7	41.7	58.3	9.8	12.7	16.2	16.4

Absolute frequency (%) = [Quadrates in which species occurs/ Total No. of quadrates employed] × 100

Relative Frequency RF (%) = [Absolute frequency value for a species/ Total absolute frequency values for all species] × 100

Importance value index (I.V. I) = Relative density + Relative frequency

Results and discussion

Floristic composition of weeds

The major weed species recorded in the experimental field were *Chenopodium murale* L., *Chenopodium album* L., *Asphodelus tenuifolius* L., *Heliotropium oralifolium* L., *Melilotus indica* L, *Rumex dentatus* L. and *Amaranthus blitum* L. Among the total weed species, *Heliotropium oralifolium* was the most dominating weed species during the I year of the study with absolute density of 45.69% and relative density of 24.70% (Table 1). Maximum absolute frequency (100), relative frequency (23.5) and IVI (48.2) were also recorded with this species. But in the second year *C. murale* was found to be the most dominant weed species with 115.68% and 47.80% of absolute and relative density, respectively. The other dominating weed species in the I year were *A. tenuifolius* and *C. murale*. Change in the density of weed species could be attributed to the fact that only *kharif* crops were grown in the experimental field and the field used to be left fallow during *rabi* season. Under this condition *H. oralifolium* was the dominating weed species. Since cumin was grown for the first time in this site, *H. oralifolium* dominated during I season, but when cumin cultivation was continued during II year in the same field, some associated weed species like *C. murale, A. tenuifolius* and *C. album* emerged as the dominant weed species. Sankaran & Chinnamuthu (1993) also reported that intensive cropping helps in the shifting and eradication of many weed species.

Weed growth

Density and dry weight of weeds were significantly influenced by different treatments (Table 2). The minimum density and dry weight of weeds were recorded in the plots kept weed free up to harvest, while maximum was recorded in season long weedy check. Plots kept weed free for initial 30, 45 and 60 DAS significantly decreased density and dry weight of weeds as compared to weed free check up to 15 DAS. No significant difference was observed

Table 2. Weed density and weed dry weight at harvest as influenced by crop weed competition in cumin

Treatment	Weed density (No. m^{-2})			Dry weight of weeds (g m^{-2})		
	I year	II year	Mean	I year	II year	Mean
Weed free up to						
15	122	140	131	36.8	44.8	40.8
30	36	42	39	10.2	10.5	10.35
45	19	23	21	5.7	7.18	6.44
60	14	10	12	3.3	5.3	4.3
Harvest	0	0	0	00	00	00
Weedy check up to						
15	0	0	0	0	0	0
30	0	0	0	0	0	0
45	0	0	0	0	0	0
60	0	0	0	0	0	0
Harvest	206	224	215	64.1	63.4	63.75
CD (P<0.05)	21	27	24	6.2	5.6	5.9

in the density and dry weight of weeds recorded in weed free check up to 15 DAS and weedy check up to harvest. This could be due to the fact that removal of weeds at early stage was not able to check the weeds which emerged at later stage. Mehriya e*t.al* (2007) also reported significant reduction in the weed dry matter due to weed free check period maintained up to 75 DAS compared to 15 DAS. Choudhary and Gupta (1991) also reported that weeds offered maximum competition up to 60 DAS.

Effect on crop

Growth and yield attributing parameters showed significant variation due to different treatments (Table 3). Maximum plant height, branches plant^{-1}, umbels plant^{-1}, seeds umbel^{-1} and test weight were obtained in the plots kept weed free up to harvest and minimum in season long weedy check. Plots kept weed free up to 30, 45 and 60 DAS and weedy check up to 15 DAS also resulted in significant improvement in all growth and yield attributes and recorded at par with that of weed free check up to harvest. Weedy check for initial 30, 45 and 60 DAS and weed free up to 15 DAS recorded at par with weedy check up to harvest. This indicated that unchecked weeds beyond 15 DAS and weed free condition at early stage (up to 15 DAS) failed to check crop weed competition, which was detrimental to cumin growth.

The seed yield was higher in 2005–06 compared to 2006–07, which was due to aphid infestation in the field during 2006–07. However, the trend of the seed yield was not affected due to different treatments. Highest mean seed yield (437.5 kg ha^{-1}) was recorded in season long weed free check, but recorded at par with that of weed free check up to 30, 45 and 60 DAS. This might be because of lesser crop weed competition, which positively contributed to higher growth and yield attributing parameters as well as seed yield. Kumar (2001) also reported significant increase in the seed yield of cumin with increase in duration of weed free check. Weeds allowed to compete with crop plants up to 30, 45 and 60 DAS reduced the seed yield by 44.7, 51.4 and 54.8%, respectively over season long weed free check. Maintaining weed free environment at

Table 3. Effect of different crop weed competition treatments on yield attributes of cumin (mean of two years)

Treatment	Plant height (cm)	Branches plant^{-1}	Umbels plant^{-1}	Seeds umbel^{-1}	Test weight (g)	Seed yield (kg ha^{-1})			Net returns over weedy check up to harvest (Rs. ha^{-1})
						2005–06	2006–07	Mean	
Weed free up to									
15	28.2	3.7	12.5	24.4	3.1	289	210	249.5	5040
30	31.5	5.9	14.4	29.6	3.8	408	374	391.0	19520
45	32.1	6.1	14.8	30.2	3.9	431	388	409.0	18940
60	32.5	6.2	15.2	31.3	3.9	442	396	419.0	16780
Harvest	33.4	6.4	15.8	32.6	3.95	457	418	437.0	14200
Weedy check up to									
15	31.2	6.1	14.2	29.2	3.8	392	381	386.5	10480
30	26.4	4.8	12.6	22.1	3.4	249	234	241.5	-1170
45	25.2	4.2	11.7	20.6	3.2	228	197	212.5	-3600
60	24.6	3.8	9.6	18.6	3.0	217	178	197.5	-3800
Harvest	23.2	3.2	8.2	15.8	2.9	164	151	157.5	0
CD (P=0.05)	2.68	0.56	1.36	2.58	0.45	76	54	65	-

early stage (up to 15 DAS) significantly reduced seed yield, which was 75% lower than season long weed free check. Results on seed yield indicated that early removal of weeds (up to 15 DAS) is not enough to check the weeds that emerged at later stage, while weeding at later stage is not capable to recover the loss caused due to delay in weeding. The results are in line with the findings of Mehria *et al*. (2007). Weedy check up to harvest recorded lowest seed yield (157.5 kg ha^{-1}), which was 64% lower over season long weed free check.

Economics

Among all the treatments, highest net return (Rs. 19,520 ha^{-1}) over weedy check up to harvest was fetched by weed free check maintained up to 30 DAS, which was 3, 14 and 27.3% higher over plots kept weed free up to 45, 60 DAS and up to harvest, respectively (Table 4). Crop kept weed free up to 15 DAS gave net return of Rs. 5,040 ha^{-1}, while season long weed free check gave net return of Rs. 14,200 ha^{-1}. Weed free check up to 30 DAS proved to be the most remunerative treatment because of involvement of lesser weeding cost compared to weed free check up to 45, 60 DAS and up to harvest, while weed free check up to harvest gave highest seed yield. However, due to involvement of higher weeding cost in repeated weeding, it was less remunerative than weed free check up to 30, 45 and 60 DAS. All the weedy check treatments exhibited negative net return except weedy check up to 15 DAS, which recorded net return of Rs. 1,04,80 ha^{-1}. The reduction in the net return could be attributed to the production of lower seed yield due to higher crop weed competition in weedy check compared to weed free check.

It was concluded that keeping the cumin crop weed free up to 30 DAS positively influenced growth, yield attributing parameters, seed yield and provided highest net return. Thus, cumin crop should be weed free for initial 30 DAS under arid conditions of Rajasthan.

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