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# Effect of Crop-Weed Competition on Seed Yield and Quality of Cumin (*Cuminum cyminum* L.)

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## ABSTRACT

A study was conducted during the winter seasons of 2003-04 and 2004-05 at the Agricultural Research Station, Mandor, Rajasthan to determine the effect of crop-weed competition on seed yield and quality of cumin (*Cuminum cyminum* L.). The results revealed that weed-free upto 60 DAS gave the lower mean weed density and total weed dry matter at harvest and increased yield attributes viz., mean final plant stand, umbels/plant, seeds/umbel and test weight by 157.9, 147.4, 166.2 and 37.2%, respectively, and mean seed yield by 788.7% over weedy check. This treatment stood at par with complete weed-free and weedy upto 15 DAS with regards to yield attributes and seed yield. The critical period of crop-weed competition was observed between 15 to 60 DAS in cumin. Weed-free environment throughout crop season produced the maximum oil and protein content, and was significantly higher compared to weedy check.



## INTRODUCTION

Cumin (*Cuminum cyminum* L.), locally known as '*zeera*', is an important seed spice crop of western India particularly of Rajasthan and Gujarat. Cumin is valued for its typical pleasant aroma from its essential oil, which ranges between 2.5-3.5% in indigenous collections and upto 5.5% in exotic ones. Cumin is a short stature crop with slow initial growth and, therefore, heavily infested with wide spectrum of weeds, which lead to severe crop-weed competition for light, moisture, nutrients and space. Growers often assume that removal of weeds at any time during the growing season is equally beneficial to the crop. However, substantial evidences (Zimdhal, 1980) indicate that time of weed removal is as important as removal *per se*. Investigations have revealed a loss of 80-90% in the seed yield of cumin due to weed infestation depending upon the intensity and type of weed flora (Yadav and Dahama, 2003). This shows the extent of weed problem and necessitates the development of an effective schedule of weed control in cumin. To bring down the competition and losses due to weeds to zero, it is necessary that crop is kept weed-free throughout the growing season but it is usually neither economical nor feasible. Thus, knowledge of critical period of crop-weed competition is an essential requirement for developing any method of weed control in cumin. The present investigation was, therefore, undertaken to investigate the critical period of crop-weed competition and its effect on yield and quality of cumin.

## MATERIALS AND METHODS

The field experiment was conducted at Agricultural Research Station, Mandor, Rajasthan during the winter seasons of 2003-04 and 2004-05. The soil was sandy loam in texture (13.0% clay, 10.7% silt and 76.3% sand), low in organic carbon (0.13 %) and available nitrogen (170 kg/ha), medium in phosphorus (26 kg $P_2O_5$/ha) and high in potassium (391 kg $K_2O$/ ha) content with a pH of 8.0. The preceding crop taken in both the years was pearl millet [*Pennisetum glaucum* (L.) R. Br. emend. Stuntz].

There were 12 treatments consisting initial weed-free periods of 15, 30, 45, 60 and 75 days after sowing (DAS) and weedy upto 15, 30, 45, 60 and 75 DAS alongwith weed-free till harvest (weed-free check) and weedy till harvest (unweeded check). The treatments were replicated three times in a randomized block design. Dry sowing of cumin cv. 'RZ 19' was done in 30 cm rows and then irrigation was applied. Another light irrigation at 9 DAS was given to ensure uniform germination. A basal dose of half nitrogen (15 kg N/ha) and full dose of phosphorus (20 kg $P_2O_5$/ha) was drilled uniformly just before sowing. The remaining half dose of N was top dressed at the time of irrigation i. e. 32 DAS. Plant protection measures were followed as per

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Table 1. Effect of crop-weed competition on density and dry matter accumulation of total weeds at different stages (DAS) of cumin (Pooled data of two years)

| Treatment | Weed density (No./m$^2$) | | | | | | Dry matter (g/m$^2$) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 15 | 30 | 45 | 60 | 75 | Harvest | 15 | 30 | 45 | 60 | 75 | Harvest |
| $T_1$ | - | 8.2 (68) | 8.9 (79) | 8.6 (75) | 8.4 (71) | 8.2 (68) | - | 3.3 | 22.3 | 65.4 | 128.4 | 109.5 |
| $T_2$ | - | - | 3.2 (10) | 5.9 (34) | 6.0 (35) | 6.2 (38) | - | - | 3.6 | 9.3 | 32.4 | 78.9 |
| $T_3$ | - | - | - | 3.3 (11) | 4.4 (19) | 4.8 (23) | - | - | - | 3.5 | 9.5 | 36.8 |
| $T_4$ | - | - | - | - | 2.2 (5) | 3.8 (14) | - | - | - | - | 4.2 | 27.2 |
| $T_5$ | - | - | - | - | - | 1.5 (2) | - | - | - | - | - | 4.3 |
| $T_6$ | 0.7 (0) | 0.7 (0) | 0.7 (0) | 0.7 (0) | 0.7 (0) | 0.7 (0) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| $T_7$ | 13.1 (178) | - | - | - | - | - | 3.1 | - | - | - | - | - |
| $T_8$ | 12.7 (167) | 16.2 (275) | - | - | - | - | 3.0 | 14.9 | - | - | - | - |
| $T_9$ | 12.9 (173) | 15.6 (251) | 14.9 (239) | - | - | - | 3.0 | 14.6 | 106.5 | - | - | - |
| $T_{10}$ | 12.8 (170) | 15.6 (256) | 14.6 (233) | 14.4 (223) | - | - | 3.0 | 15.3 | 106.0 | 192.6 | - | - |
| $T_{11}$ | 12.7 (165) | 15.3 (245) | 14.8 (233) | 14.3 (218) | 14.3 (219) | - | 3.1 | 14.8 | 108.5 | 187.1 | 251.1 | - |
| $T_{12}$ | 12.8 (168) | 15.7 (256) | 15.0 (238) | 14.3 (218) | 14.4 (222) | 14.4 (224) | 3.1 | 15.3 | 108.2 | 191.0 | 249.2 | 175.3 |
| LSD (P=0.05) | 1.4 | 1.3 | 1.1 | 1.0 | 0.6 | 0.6 | 0.3 | 0.8 | 6.5 | 11.1 | 11.7 | 8.7 |

Figures in parentheses are original, Weed density transformed to $\sqrt{n+0.5}$, DAS–Days after sowing, $T_1$–Weed-free upto 15 DAS, $T_2$–Weed-free upto 30 DAS, $T_3$–Weed-free upto 45 DAS, $T_4$–Weed-free upto 60 DAS, $T_5$–Weed-free upto 75 DAS, $T_6$–Weed-free, $T_7$–Weedy upto 15 DAS, $T_8$–Weedy upto 30 DAS, $T_9$–Weedy upto 45 DAS, $T_{10}$–Weedy upto 60 DAS, $T_{11}$–Weedy upto 75 DAS, $T_{12}$–Weedy check.

recommendation. Weed density and dry weight were recorded by putting a quadrat (0.25 $m^2$) at random spots. For statistical analysis, the data of weed density were subjected to square root transformation $\sqrt{X+0.5}$ to normalize their distribution as per Gomez and Gomez (1984). While presenting the results of weed density and dry matter, the columns of data where weeds did not exist due to employment of weed-free treatments, have been left blank and the statistical analysis was done after subtracting respective degrees of freedom of weed competition periods. Weed competition index was calculated by using the formula given by Yadav and Mishra (1982).

## RESULTS AND DISCUSSION

### Weed Spectrum

Weed flora of the experimental field consisted of *Chenopodium murale* L., *Chenopodium album* L., *Rumex dentatus* L., *Asphodelus tenuifolius* L., *Launea asplenifolia* L., *Cynodon dactylon* L. and *Cyperus rotundus*. However, predominant weeds were *C. murale* L., *C. album* L. and *R. dentatus* L.

### Effect on Weeds

The mean maximum density of total weeds was 275 plants/$m^2$ at 30 DAS stage and decreased thereafter upto crop harvest in weedy treatments. Treatments of weed-free periods ($T_1$-$T_5$) significantly reduced the mean total weed density at all the stages of crop growth compared to weedy treatments ($T_7$-$T_{12}$). At harvest, the weed-free period from 30 ($T_2$) to 75 DAS ($T_5$) resulted in significant reduction in mean weed density than weed-free period upto 15 DAS ($T_1$).

The dry matter of weeds was increased upto 75 days after sowing (DAS) stage and declined progressively thereafter upto crop harvest (Table 1). The total weed dry matter in weed-free upto 15 DAS was significantly higher over weed-free period from 30 to 75 DAS. However, weed-free period of 30 DAS had significantly higher weed dry matter compared to 45, 60 and 75 DAS periods. Weed-free period upto 75 DAS recorded significantly lower weed dry matter production at harvest compared to other weed-free periods (15, 30, 45 and 60 DAS). In nutshell, weed removal too early in the season leads to regeneration of weeds, whereas under delayed removal conditions, weeds have already caused irreparable damage to the crop. Similar effect on weed dry matter due to different weedy and weed-free periods had been reported by Kumar (2001) in cumin and Singh and Tripathi (1990) in coriander.

### Effect on Crop Growth

Plant height of cumin was adversely affected keeping the weed-free only upto 15 DAS and weedy periods of 45 DAS and beyond. While branches/plant were decreased considerably keeping weed-free upto 30 DAS and weedy periods of 30 DAS and thereafter. This was because of higher emergence and growth of weeds in these plots which was evident from their higher dry matter production (Table 2) and a severe competition existed between crop plants and the weeds, which, in turn, decreased the branches/plant and plant height of cumin.

### Effect on Yield Attributes and Yield

Seed yield and their attributes were significantly influenced by the different weed-free and weedy periods. Where weed-free environment was maintained upto harvest, the crop obtained the highest final plant stand, umbels/plant and seeds/umbel which were significantly higher over weed-free upto 15, 30 and 45 DAS and weedy upto 60, 75 DAS and harvest (Table 2). Weedy upto 15 DAS had significantly higher plant and umbels/plant and seeds/umbel compared to weed-free period of 15, 30 and 45 DAS. However, test weight in weed-free treatment was significantly higher over weed-free upto 15 DAS and weedy upto 60, 75 and weedy checks only, while rest of the treatments were found statistically at par with each other. The seed yield was the maximum in weed-free treatment (545 and 632 kg/ha in 2003-04 and 2004-05, respectively) and the minimum in weedy check (75 and 50 kg/ha). In the plots where weeds were not controlled until crop harvest, they reduced the seed yield by 86.3 and 92.1% in 2003-04 and 2004-05, respectively, as indicated by weed competition index (Table 3). Weed-free periods of first 60 DAS and thereafter (75 DAS and harvest) or weedy period of 15 DAS produced significantly higher seed yield of cumin which were found statistically at par with complete weed-free treatment ($T_6$). Further, weedy upto 15 DAS crop stood at par with weed-free upto 60 DAS plots. It clearly indicated that the critical period of crop-weed

Table 2. Effect of crop-weed competition on growth and yield attributes of cumin (Pooled data of two years)

| Treatment | Plant height (cm) | Branches/ plant | Umbels/ plant | Seeds/ umbel | Test weight (g) | Final plant stand ('000/ha) |
|---|---|---|---|---|---|---|
| $T_1$ | 25.87 | 3.29 | 11.45 | 23.58 | 3.33 | 294 |
| $T_2$ | 28.95 | 4.30 | 12.23 | 26.13 | 3.76 | 328 |
| $T_3$ | 28.80 | 4.87 | 13.48 | 27.33 | 3.85 | 353 |
| $T_4$ | 30.75 | 4.90 | 14.25 | 28.17 | 3.91 | 374 |
| $T_5$ | 30.78 | 5.09 | 15.05 | 30.48 | 3.88 | 393 |
| $T_6$ | 31.48 | 5.11 | 15.52 | 30.87 | 3.92 | 409 |
| $T_7$ | 31.52 | 4.92 | 14.80 | 29.63 | 3.95 | 398 |
| $T_8$ | 29.38 | 4.33 | 13.33 | 25.80 | 3.80 | 350 |
| $T_9$ | 26.43 | 3.86 | 11.10 | 20.52 | 3.51 | 306 |
| $T_{10}$ | 24.43 | 3.23 | 8.37 | 16.08 | 3.30 | 225 |
| $T_{11}$ | 22.22 | 2.69 | 6.48 | 12.18 | 3.19 | 170 |
| $T_{12}$ | 21.93 | 2.65 | 5.76 | 10.58 | 2.85 | 145 |
| LSD (P=0.05) | 2.83 | 0.42 | 1.20 | 2.28 | 0.30 | 31 |

Details of treatments are given under Table 1.

competition in cumin was between 15 and 60 DAS. The interpretation of Fig. 1 also confirmed the above statement. Present results are in close proximity to the findings of Nieto *et al*. (1968). Better growth i. e. plant height and branches/plant consequently increased the seed yield and its attributes with different weedy and weed-free periods due to reduced competition between crop and weed. Kumar (2001) also reported similar results. It could further be supported by lower weed competition index (WCI) in weed-free upto 60 DAS and beyond or weedy upto 15 DAS treatments in the present investigation.

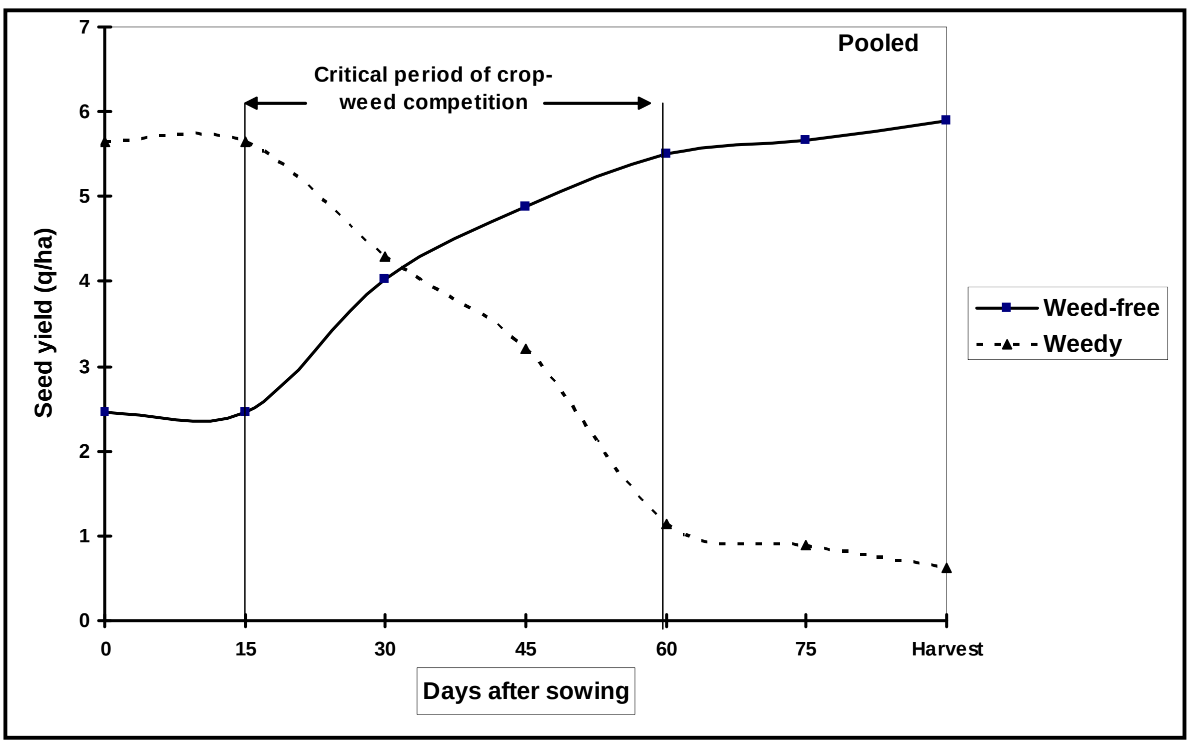


Fig. 1. Seed yield of cumin under different weedy and weed-free treatments showing critical period of crop-weed competition.

Higher harvest index in the treatments of lower crop-weed competition ($T_2$ to $T_7$) also supports the greater photosynthetic partitioning efficiency of cumin in these treatments (Table 3). The presence of weeds adversely affected the final plant stand of cumin. This might be attributed to greater crop-weed competition. Parihar and Singh (1994) also reported similar findings.

**Effect on Quality**

Essential oil and protein content of cumin seed were improved by different weed-free treatments during both the years (Table 3). Weed-free treatment produced the maximum oil and protein contents, which were significantly higher over weedy check. Weedy upto 60, 75 DAS and weedy check treatments caused to produce significantly low oil content compared to weed-free treatments which was higher by 8.8, 14.3, 15.9 and 17.6% compared to weed-free upto 15 DAS, weedy for 60, 75 DAS and harvest, respectively. Yadav *et al*. (2004) also reported similar results.

Table 3. Effect of crop-weed competition on yield, weed control index (WCI) and quality of cumin (Pooled data of two years)

| Treatment | Seed yield (q/ha) | | | WCI (%) | | | Harvest index (%) | Oil content (%) | Protein content (%) |
|---|---|---|---|---|---|---|---|---|---|
| | 2003-04 | 2004-05 | Pooled | 2003-04 | 2004-05 | Pooled | | | |
| $T_1$ | 1.82 | 3.11 | 2.46 | 66.67 | 50.79 | 58.15 | 35.3 | 3.75 | 15.06 |
| $T_2$ | 3.65 | 4.42 | 4.03 | 30.26 | 26.94 | 28.48 | 40.5 | 4.05 | 16.10 |
| $T_3$ | 4.75 | 5.01 | 4.88 | 12.84 | 20.73 | 17.07 | 42.7 | 4.03 | 16.49 |
| $T_4$ | 5.26 | 5.75 | 5.51 | 3.55 | 9.02 | 6.48 | 43.1 | 4.07 | 16.31 |
| $T_5$ | 5.33 | 6.01 | 5.67 | 2.29 | 4.91 | 3.70 | 43.3 | 4.02 | 16.29 |
| $T_6$ | 5.45 | 6.32 | 5.89 | - | - | - | 42.9 | 4.08 | 16.67 |
| $T_7$ | 5.23 | 6.05 | 5.64 | 4.06 | 4.27 | 4.17 | 43.3 | 4.02 | 16.50 |
| $T_8$ | 4.15 | 4.45 | 4.30 | 23.89 | 29.59 | 26.95 | 41.8 | 3.88 | 16.34 |
| $T_9$ | 3.42 | 3.00 | 3.21 | 37.21 | 52.53 | 45.44 | 41.7 | 3.88 | 15.64 |
| $T_{10}$ | 1.51 | 0.77 | 1.14 | 72.22 | 87.82 | 80.59 | 29.0 | 3.57 | 14.26 |
| $T_{11}$ | 1.09 | 0.69 | 0.89 | 80.06 | 89.08 | 84.90 | 28.9 | 3.52 | 14.14 |
| $T_{12}$ | 0.75 | 0.50 | 0.62 | 86.32 | 92.09 | 89.42 | 32.4 | 3.47 | 14.03 |
| LSD (P=0.05) | 0.55 | 0.58 | 0.39 | - | - | - | 3.6 | 0.36 | 1.18 |

Details of treatments are given under Table 1.

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