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CRITICAL PERIOD OF WEED-CROP COMPETITION IN FENNEL (*Foeniculum vulgare* Mill.)

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ABSTRACT

A field experiment was conducted during Rabi season 2005-06 to find the critical period of weed-crop competition in fennel crop. There were seven treatments in the experiment including zero competition, weed-crop competition for 40, 50, 60, 70, 80 days after emergence and a weedy check. The data were recorded on weed density, weed dry weight and yield parameters of the crop. Total weed density and weed dry weight showed an increasing trend as the competition period increased. Seed yield also showed linear decrease with increasing duration of the weed-fennel competition. Statistically maximum seed yield was obtained where there was no weed-crop competition followed by weed-crop competition for 40 & 50 DAE which were statistically at par with each other. Minimum seed yield was recorded in plots where weeds were allowed to grow throughout the season. As conclusion, weeds control in fennel crop should be done before 50 days of emergence as it was the critical period of competition found in the experiment.

Keywords: Weed-crop competition, fennel, yield, weeds, Pakistan.

INTRODUCTION

The commercial crops which occupy large acreage have received priority of attention and some crops which are important in some other specific spheres, have not received due consideration so far. One such crop is fennel (*Foeniculum vulgare* Mill.) It is locally known as 'Saunf', belonging to family Apiaceae. Fennel is grown as an ornamental and as a seed crop almost all over the world. On account of its numerous pharmaceutical uses, it ranks among the most important medicinal plants and is being used in the indigenous 'Unani' and allopathic system of medicines. In Pakistan, the

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cultivation of fennel on a commercial scale does not exist, yet on account of its medicinal value, the farmers all over the country grow it on small scale which is not sufficient to meet the national demand and consequently it is imported from other countries of the world. In view of its importance as a multi-purpose crop, it is imperative to bring some area under its cultivation and determine agronomic requirements for its successful cultivation. The factors like optimum sowing time, sowing method, plant population maintenance, water and nutrient management, weeds competition affect the production of fennel. Among all these factors, presence of weeds is one of the major agronomic factors reducing yield of crops up to 44.2% (Mehra and Gill, 1988).

Weeds compete with crop for light, water, nutrients, space etc. There is a period during the life cycle of a crop when it is most sensitive to presence of weeds, known as critical period of competition. During this period, weeds offer maximum competition and cause significant yield losses. Critical period of weed-crop competition was determined between 30 to 60 DAS in wheat (Ahmad and Sheikh, 2003). Ghafoor and Sadiq (1991) recorded 30% reduction in wheat grain yield by full season competition with *Phalaris minor* at the density of 200 plants m^{-2}. Critical period of competition varies from crop to crop depending on weed emergence time, weed type, weed density and management practices. It is important to determine critical period of weed-crop competition to plan effective weed control. Present study was therefore conducted to assess the critical period of weed-crop competition in fennel and to observe the effects of weeds on growth and yield of fennel under field conditions.

MATERIALS AND METHODS

The investigations on critical period of weed-crop competition in fennel (*Foeniculum vulgare* Mill.) were carried out at the student's farm, Department of Agronomy, University of Agriculture, Faisalabad. The experiment was laid out in randomized complete block design with four replications on October 22, 2005. The treatments comprised of different weed-crop competition periods i.e. no competition, competition for 40, 50, 60, 70 and 80 days after emergence or throughout the season. Crop was sown in a plot size of 5m×1.8m with a single row hand drill using a seed rate of 25 kg ha^{-1} with 30 cm row to row and 10 cm plant to plant distance. Nitrogen and P were applied at rates of 57 kg and 20 kg ha^{-1}. Source of fertilizer was urea and diammonium phosphate. Whole of P and N

were side dressed at sowing with a single row hand drill. Crop received four irrigations viz first at the completion of germination, second after 15 days of first irrigation, third at flowering and last irrigation was applied at seed development stage. After prescribed period, weeds were removed from plot and kept weed free till harvest. Data on following observations were recorded during the course of experiment.

Individual and total weed density and biomass were recorded from randomly selected area of 1 m^2 at two places from each plot. Ten plants were selected at random to record plant height, fresh and dry weight plant^{-1}, number of branches umbel^{-1}, number of umbels plant^{-1} and seeds umbel^{-1}. From the yield of each treatment, 5000 seeds were taken and weighed separately with an electric balance for recording 1000-seed weight. Biological and seed yield were recorded on per plot basis and were converted to kg ha^{-1}. Data collected on growth and yield parameters of the crop were analyzed statistically by using fisher's analysis of variance technique. Least Significant Difference (LSD) test at 0.05 probability level was employed to compare the treatment means (Steel *et al.*, 1997).

RESULTS AND DISCUSSION

Density of *Phalaris minor* (m^{-2})

Phalaris minor density was significantly affected by weed-crop competition periods (Table-1). There was a progressive increase in number of *P. minor* plants as weeds-crop competition period increased. The maximum *P. minor* density (105.8) was found in weedy check because longer time was available for *P. minor* to grow. Minimum number of *P. minor* plants (31.53) was found in weed-crop competition period of 40 days after emergence. These results were in line with those of Mehra and Gill (1988).

Density of *Chenopodium album* (m^{-2})

The density of *C. album* was significantly affected by different weed-crop competition durations (Table-1). The maximum number of *C. album* plants (18.92) was found in plots where weeds were removed after 60 days of emergence, followed by weed density in 50 and 80 DAE that were statistically at par with one another. Minimum *C. album* plants (2.91) were recorded in plots where weeds competed with fennel for 40 DAE. These results were quite in line with those of Ahmad *et al*. (1998).

Density of *Anagallis arvensis* (m^{-2})

Number of plants of *A. arvensis* was also significantly affected by weed-crop competition periods. Maximum density of *A. arvensis*

(6.0) was found in plots where *A. arvensis* plants were allowed to compete with Fennel for 80 days after emergence followed by plants in 70 and 50 DAE, which were statistically similar to each other. The minimum number of *A. arvensis* plants was found in competition duration of 40 DAE (Table-1). Weed free plots showed zero density because weeds from these were removed by successive hand hoeing. The results were in consonance with those of Ahmad *et al.* (1998).

Density of *Convolvulus arvensis* (m^{-2})

Different weed-crop competition periods had a strong effect on density of *C. arvensis*. The maximum *C. arvensis* density (7.37) was found in plots where *C. arvensis* was allowed to compete with fennel throughout the season, which was statistically at par with all other durations except zero competition.

Total weed density (m^{-2})

No weeds were found in zero competition treatment. Total weed density increased significantly with each increase in competition period except 60 and 70 days (W_4 and W_5) respectively which were statistically at par. The significantly maximum weed density (147.1) was obtained in plots where weeds were allowed to compete through out the season. Minimum number of weeds was observed in plots where weeds were controlled 40 DAE. The increase in weed density with increased competition period might be due to more availability of time for emergence of weeds. The weeds might have emerged time to time when ever conditions were favorable for their germination (Table-1). These results were in line with Saeed *et al*. (1987) who reported that individual weeds, when allowed to compete with wheat crop resulted in substantial decrease in grain yield with highest depression in *Chenopodium album* having a population density of 248 plants m^{-2}.

Dry weight of *Phalaris minor* (g m^{-2})

All the treatments were significantly different from each other (Table-2). The significantly maximum dry weight of *P. minor* (150.4g) was noted in plots with weed-crop competition prevailed throughout the season. There was zero weight of *P. minor* in weeds free plots because no weed plants were allowed to grow and flourish there. Dry weight of *P. minor* increased with increasing competition durations. Maximum dry weight of *P. minor* in weedy check was due to its higher density and longer growth period, resulting in more accumulation of photosynthates. Akhtar *et al*. (2000) also found that increasing weed crop competition duration increased weed biomass.

Table-1. Effect of weed crop competition period on weed density (m^{-2}) in *Foeniculum vulgare* Mill.

Weed Crop Competition	Density of *P. minor* (m^{-2})	Density of *C. album* (m^{-2})	Density of *A. arvensis* (m^{-2})	Density of *C. arvensis* (m^{-2})	Total Weed density (m^{-2})
Zero competition	00.00 a	00.00 c	00.00 d	00.00 b	00.00 f
40 DAE	31.53 b	2.91 c	1.68 cd	2.50 ab	50.63 e
50 DAE	47.41 c	17.02 ab	4.18 ab	7.25 a	88.42 d
60 DAE	62.49 d	18.92 a	3.86 b	6.25 ab	107.60 c
70 DAE	76.90 e	2.92 c	4.85 ab	5.75 ab	107.30 c
80 DAE	91.87 f	6.99 abc	6.00 a	5.50 ab	127.40 b
Throughout The season	105.80 g	6.58 bc	3.72 bc	7.37 a	147.10 a
LSD	1.58	12.20	2.06	6.51	12.21

Dry weight of *Chenopodium album* (g m^{-2})

The maximum dry weight of *C. album* (27.42 g m^{-2}) was found in plot where weeds were removed 50 DAE (Table-2). It was due to higher density of *C. album* followed by weed-crop competition for 60 and 80 DAE. The above competition durations were statistically at par with one another. While there was zero dry weight of *C. album* in weeds free treatment as no weed was allowed to grow through out the growing season. Competition duration of 70 days after emergence showed the least dry weight. Competition durations of 40, 70, through out the season were statistically similar to plots where there were no weeds. It was due to the density of *C. album* present in the respective treatments. The results are in accordance with those of Akhtar *et al.* (2000).

Dry weight of *Anagallis arvensis* (g m^{-2})

Maximum dry weight of *A. arvensis* (3.59 g m^{-2}) was recorded in plots where weeds were allowed to compete with fennel for 80 DAE followed by competition duration of 70, 50 and throughout the season (Table-2). The aforesaid durations were statistically at par with one another. Zero dry weight of *A. arvensis* was found in weed free plots as these plots were kept weed free by continuous hand hoeing throughout the growing season. Minimum dry weight of *A. arvensis* was found in plots where it competed freely with fennel for 40 DAE. The probable reason was number of *A. arvensis* in these plots.

Dry weight of *Convolvulus arvensis* (g m^{-2})

The maximum dry weight of *C. arvensis* (14.41g) was recorded in plots where *C. arvensis* competed with Fennel for 50

DAE of crop (Table-2). It was statistically at par with all the competition periods except in plots where weeds were removed after 40 DAE and weed free treatments. Zero dry weight of *C. arvensis* was found in weed free plots as no weed was allowed to grow. Minimum dry weight of *C. arvensis* (5.3g) was found in weed-crop competition duration of 40 DAE. These results are owed to number of *C. arvensis* plants in these plots. The results were in line with those of Akhtar *et al*. (2000).

Total dry weight of weeds (g m^{-2})

Dry weight of weeds showed an increasing trend as the competition period increased and this increase in weed dry weight with each increased competition period was statistically significant (Table-2). The significantly maximum dry weight of weeds (267.7g) was recorded in weedy check where weeds competed throughout the season and it was statistically at par with competition period of 60-70 DAE. Zero dry weight of weeds was recorded in weed free plots. Maximum dry weight of weeds in weedy check might have been due to higher weed density and longer growth period resulting in more accumulation of photosynthates and greater biomass. The zero dry weight in zero competition treatment was due to complete control of weeds. Shamsi and Ahmad (1987) reported increase in dry weight of weeds with increased competition period in wheat.

Table-2. Effect of weed crop competition period on weed dry weight (g m^{-2}) in *Foeniculum vulgare* Mill.

Weed Crop Competition	Dry weight of *P. minor* (g m^{-2})	Dry weight of *C. album* (g m^{-2})	Dry weight of *A. arvensis* (g m^{-2})	Dry weight of *C. arvensis* (g m^{-2})	Total Dry weight of weeds (g m^{-2})
Zero competition	00.00 g	00.00	00.00	00.00	00.00 f
40 DAE	45.38 f	7.75	1.10	5.30	99.54 e
50 DAE	67.69 e	27.42	2.86	14.41	155.80 d
60 DAE	88.22 d	25.00	2.32	8.16	175.40 cd
70 DAE	108.30 c	7.66	2.93	11.60	193.80 c
80 DAE	129.40 b	11.26	3.59	10.50	229.40 b
Throughout The season	150.40 a	10.55	2.44	14.02	267.70 a
LSD	3.585	16.45	1.211	6.86	29.35

Number of plants per plot of fennel

Effect of different weed-crop competition periods on number of plants per plot of fennel was non significant. The uniform plant population can be attributed to use of uniform seed rate of similar seed test weight. Further the plant to plant distance was also maintained by thinning at early growth stages (Table-3). The results are in accordance with those of Christmas, 2004 who reported that planting wheat based on bushels acre^{-1} can result in substantial over- or under seeding, which is not recommended.

Plant height (cm) at harvest

Maximum plant height (141.9cm) was observed in weed-crop competition duration of 40 DAE (Table-3). This was statistically at par with competition duration of 80 DAE while the minimum plant height (133.6cm) was observed in plots where weeds were not allowed to grow and it was statistically similar with the competition periods of 50 and 70 DAE. The results were quite in agreement with Rajput *et al*. (1987).

Number of umbels plant^{-1}

Number of umbels plant^{-1} was affected significantly by weed competition periods (Table-3). Weed free treatment (zero competition) showed maximum number of umbels plant^{-1} (37.13) which was statistically similar to number of umbels in competition periods of 40 and 50 DAE. Minimum number of umbels plant^{-1} (28.13) was obtained in plots with competition throughout the season. This was at par with weed-crop competition of 60, 70, and 80 DAE. Absence of weeds in zero competition or their short time presence in 40 and 50 DAE, competition period might had enabled the crop to make best use of available resources and produce more number of umbels. Weeds competing with fennel for 60, 70, 80 DAE or for full season got maximum chances to utilize environmental resources at the cost of crop and ultimately resulted in lesser number of umbels plant^{-1}.

Number of branches umbel^{-1}

Maximum number of branches (29.53) umbel^{-1} was found in weed free treatment (zero competition). This was statistically at par with competition duration of 40 DAE (Table-3). A gradual and progressive decrease in number of branches per umbel was recorded with increasing competition duration. Minimum number of branches umbel^{-1} (23.05) was found in plots where weeds competed with fennel throughout the season. The minimum number of branches umbel^{-1} in weedy check can be attributed to greater weed density and biomass resulting in weaker plants and crop was unable to make full use of the available resources.

Number of seeds umbel^{-1}

Number of seeds umbel^{-1} is one of the most important yield components and had direct bearing on the final yield of fennel. In weed-crop competition treatments, weed free plots produced maximum number of seeds umbel^{-1} but was statistically similar with competition period of 40 and 50 days (Table-3). The number of seeds showed a decreasing trend as competition period was increased and minimum number of seeds was recorded in weedy check. Plots where weeds were not allowed to compete with plants resulted in the better growth of fennel and increased seed number. Akhtar *et al*. (2000) reported similar results.

1000-seed weight (g)

The 1000-seed weight was affected significantly by weed-crop competition durations (Table-3). The maximum seed weight was recorded in weed free treatment. The trend of results showed that the weight of 1000 seeds was decreased as the competition durations were increased. Minimum seed weight was recorded in weedy check. The decrease in seed weight with increased competition period might have been due to increase in weed density. The severe weed competition in weedy check resulted in suppressed growth and photosynthetic activity resulting in lighter seeds. These findings were confirmed by those of Akhtar *et al*. (2000).

Biological yield (kg ha^{-1})

In weed-crop competition durations, maximum biological yield was recorded in plots where weeds were not allowed to compete with crop throughout the season, which was significantly different from all other competition durations. Plots where weeds competed with crop for 40 and 60 DAE were statistically similar. Minimum biomass was recorded in plots having competition throughout the season (Table-3).

Seed yield (kg ha^{-1})

A linear decrease in seed yield was observed by increasing duration of fennel-weed competition. The maximum seed yield 2336 kg ha^{-1} was obtained where there was no weed-crop competition and it was statistically at par with weed-crop competition for 40 and 50 DAE. Minimum seed yield 1472 kg ha^{-1} was recorded in full season competition. The decrease in seed yield with increasing weed-crop competition duration was due to decrease in the number of umbels plant^{-1}, number of branches umbel^{-1}, number of seeds umbel^{-1} and seed index. The reduction in yield due to weed competition was also reported by Akhtar *et al*. (2000) and Rajput *et al*. (1987).

Table-3. Effect of weed crop competition period on yield and yield components of *Foeniculum vulgare* Mill.

Weed Crop Competition	No. of plants plot^{-1}	Plant height (cm)	No. of umbels plant^{-1}	No. of branches umbel^{-1}	No. of seeds umbel^{-1}	1000 seed weight (g)	Biological Yield (kg ha^{-1})	Seed Yield (kg ha^{-1})	HI (%)
Zero competition	30.18	133.60 d	37.13 a	29.53 a	248.2 a	19.31 a	10718 a	2336 a	23.49 a
40 DAE	303.50	141.90 a	35.63 a	28.40 ab	240.0 ab	19.23 a	10270 c	2250 ab	21.90ab
50 DAE	306.80	134.60 cd	32.63ab	26.55 b	237.1 abc	16.88 b	10570 b	2236 ab	21.15 b
60 DAE	308.80	137.30 bc	29.50 b	26.20 b	219.4 bcd	15.48 c	10240 c	2139 bc	20.89 b
70 DAE	302.50	135.10 cd	29.13 b	25.85 b	218.1 bcd	15.41 c	9988 d	2083 bc	20.86 b
80 DAE	307.30	140.80 a	28.70 b	26.10 b	216.4 cd	14.46 d	9489 e	1972 c	20.78 b
Throughout the season	304.00	140.10 ab	28.13 b	23.05 c	209.2 d	12.43 e	8243 f	1472 d	17.86 c
LSD	-	2.94	5.68	2.69	22.9	0.94	103	174	1.85

Harvest index (%)

The production efficiency of a crop at variable agronomic practices is also measured in terms of harvest index (Table-3). The data on biological and economic yield were recorded and then harvest index was calculated for each treatment. These values showed that maximum harvest index was observed in plots kept weed free throughout the crop season, which was higher than all the treatments and followed by a treatment where weeds were removed after 40 DAE. Minimum harvest index was found in plots where there was competition of fennel with weeds throughout the season. There was gradual decrease in harvest index as weed-crop competition duration was increased. The result is supported by the finding of Sarwar (1994).

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