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Critical period of crop–weed competition in rainy-season sunflower (*Helianthus annuus*)

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ABSTRACT

A field study was carried out at the experimental farm of the Indian Agricultural Research Institute, New Delhi, to determine the critical period of crop–weed competition in sunflower *(Helianthus annuus* L.) during the rainy (*kharif*) seasons of 1995 and 1996. *Trianthema portulacastrum* L., *Digera arvensis* Forsk, *Acrachne racemosa* Ohuy, *Dactyloctenium aegyptium* Beauv. and *Cyperus rotundus* L. were the dominant weed species associated with the crop. *Trianthema portulacastrum* and *Digera arvensis* were the predominant weeds. Seed yield loss increased with the increase in the duration of competition and maximum loss (54.6%) occurred due to full-season competition . Seed yield of sunflower increased significantly with the increase in initial duration of weed-free condition up to harvest. Critical period of weed competition was found to be 20 to 49 days after sowing.

Key words : Sunflower, Weed, Weed index, Critical period

Sunflower is an important oilseed crop of India. Though it has high yield potential, its yield is very poor due to severe weed competition (Krishnagowda *et al.*, 1985). Wider row spacing and slow initial growth of sunflower provide congenial environment for the growth of weeds. Moreover, it is necessary to find out the critical period of crop–weed competition to make weed-control method more effective and economical.

MATERIALS AND METHODS

The field experiment was conducted during the rainy (*kharif*) seasons of 1995 and 1996 at the Research Farm of the Indian Agricultural Research Institute, New Delhi. The soil of the experimental field was sandy loam and medium in phosphorus (17.4 kg/ha) and potassium (208.0 kg/ha). The sunflower cv. 'MSFH 8 ' was sown @ 10 kg/ha at 60 cm × 30 cm spacing with the recommended dose of 60 kg N, 90 kg P_2O_5 and 60 kg K_2O/ha. Half of nitrogen was applied at sowing and remaining half was top-dressed 25 days after sowing (DAS). Ten treatments consisting of weed-free and weedy periods at 15, 30, 45 and 60 days

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after sowing along with a weedy and weed-free check were arranged in randomized block design with 3 replications. As a prophylactic measure against insect pest, spray of Thiodon was made about 35 days after sowing. Crop was irrigated only once because of sufficient rainfall (716.6 mm) in the first year.

The weed dry matter from each plot was periodically recorded by using a quadrat of 0.25 m^2. In case of initial weed-free treatments (weed-free up to 15, 30, 45, 60 days after sowing and at harvest), total dry-matter accumulation of weed was recorded only at harvest. However, in case of weed-infested treatments (weed infestation up to 15, 30, 45, 60 days after sowing and at harvest) it was at their respective period of completion, i.e. at 15, 30, 45, 60 days after sowing and at harvest, respectively. Mean weed-growth rate (WGR) was calculated as follows:

$$\text{Mean WGR} = \frac{W_2 - W_1}{t_2 - t_1} \quad \text{..... mg/m}^2\text{/day}$$

where w_2 and w_1 are the total dry weight of weeds in g/m^2 at t_2 and t_1 days respectively.

Table 1. Effect of different weed-free and weedy periods on total weed dry weight (g/m^2) and weed-growth rate (mg/m^2/day) at different dates of observations (mean data of 2 years)

Treatment	Weedy dry weight (g/m^2)	Weed-growth rate (mg/m^2/day) Days after sowing				
		15	30	45	60	At harvest
WF up to 15 DAS	14.05	0.7	64.4	69.3	50.1	31.7
	(197.1)	(0.0)	(4,150)	(4,806)	(2,511)	(1,003)
WF up to 30 DAS	9.3	0.7	0.7	47.0	42.5	32.1
	(86.0)	(0.0)	(0.0)	(2,212)	(1,803)	(1,032)
WF up to 45 DAS	6.92	0.7	0.7	0.7	40.0	30.6
	(47.4)	(0.0)	(0.0)	(0.0)	(1,597)	(938)
WF up to 60 DAS	4.55	0.7	0.7	0.7	0.7	28.4
	(20.2)	(0.0)	(0.0)	(0.0)	(0.0)	(808)
Weed-free check	0.70	0.7	0.7	0.7	0.7	0.7
	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)
Wl up to 15 DAS	5.55	44.9	0.7	0.7	0.7	0.7
	(30.3)	(2,017)	(0.0)	(0.0)	(0.0)	(0.0)
Wl up to 30 DAS	10.0	45.7	67.8	0.7	0.7	0.7
	(100.3)	(2,087)	(4,601)	(0.0)	(0.0)	(0.0)
Wl up to 45 DAS	13.0	45.4	68.1	68.4	0.7	0.7
	(170.6)	(2,062)	(4,620)	(4,673)	(0.0)	(0.0)
Wl up to 60 DAS	14.3	45.3	68.0	68.3	47.6	0.7
	(203.9)	(2,049)	(4,620)	(4,661)	(2,263)	(0.0)
Unweeded control	15.18	45.5	68.1	68.3	47.4	32.0
	(229.9)	(2,072)	(4,643)	(4,668)	(2,241)	(1,026)
LSD (P=0.05)	2.38	2.82	2.67	3.12	2.85	2.44

$\sqrt{X+0.5}$ transformation

WF, Weed-free; Wl, weed infestation; DAS, days after sowing

Figures in the parentheses indicate original values

The WGR was recorded 15, 30, 45 and 60 days after sowing and at harvest.

RESULTS AND DISCUSSION

The major weed flora associated with the crop comprised *Trianthema portulacastrum, Digera arvensis, Acrachne racemosa, Dactyloctenium aegyptium* and *Cyperus rotundus* along with other species of minor importance like *Digitaria sanguinalis, Echinochloa colonum; Eragrostis tenella, Tribulus terrestris* and *Commelina benghalensis.*

Weed dry matter

Since the trend in respect of dry matter was similar in both the years, only pooled data presented and discussed. The total dry weight of weeds (Table 1) increased up to harvest. However, rapid increase was recorded up to 45 days after sowing under weed-infestation treatment. Weed-free treatment for the first 30, 45 and 60 days after sowing resulted in significant reduction in total dry–matter accumulation compared to weed free only up to 15 days after sowing and unweeded control. This is probably because when weed–free periods were extended up to 45 days after sowing or longer, strong canopy cover of sunflower smothered the later-emerging weeds, which resulted in significantly lower dry matter of weed. Similarly, the weed index was lowest in weed-free treatment up to 60 days after sowing and highest in unweeded control.

Weed-growth rate

The different weed-free and weedy conditions significantly influenced the weed-growth rate (WGR) at all the dates of observation. At 45 days after sowing, almost all the treatments recorded the maximum WGR. With the advancement of weed-free duration, the WGR reduced proportionally. The WGR was significantly lower due to weed-free treatment, primarily

Table 2. Effect of different weed-free and weedy periods on yield and yield attributes of rainy-season sunflower (mean data of 2 years)

Treatment	Capitulum diameter (cm)	Seeds/ capitulum	Seed weight/ capitulum (g)	Test weight (g)	Oil content (%)	Seed yield (q/ha)	Stalk yield (q/ha)	Harvest index (%)
WF up to 15 DAS	9.06	472	15.64	33.24	38.85	8.69	34.90	19.94
WF up to 30 DAS	10.58	641	22.50	34.89	39.35	12.48	47.31	20.87
WF up to 45 DAS	11.09	728	26.23	36.00	40.60	14.58	56.55	20.49
WF up to 60 DAS	11.71	792	29.53	37.32	41.00	16.25	61.14	21.00
Weed-free check	12.03	803	30.05	37.43	41.20	16.69	61.90	21.24
WI up to 15 DAS	11.35	782	28.95	36.50	41.30	16.07	60.30	21.04
WI up to 30 DAS	10.26	615	21.85	34.50	40.60	12.20	46.38	20.83
WI up to 45 DAS	9.23	502	16.88	33.58	39.50	9.30	35.64	20.69
WI up to 60 DAS	8.51	435	14.40	33.00	39.35	8.25	32.67	20.16
Unweeded control	8.02	418	13.64	32.54	39.65	7.57	29.56	20.38
LSD (P=0.05)	0.89	68.93	2.76	0.80	NS	1.65	6.72	NS

WF, Weed-free; WI, weed infestation; DAS, days after sowing

because of greater reduction in dry weight of weeds. When weeds were left uncontrolled throughout the season, the WGR was gradually increased up to 45 days and declined in later stages. The mean weed-growth rate was, however, maximum from 15 to 45 days after sowing. This coincided with the critical period of weed competition, indicating rapid weed growth and dry-matter accumulation during this period.

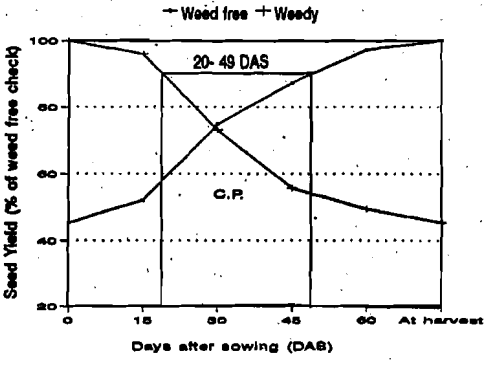
Yield and yield attributes

Initial weed–free treatments resulted in significant improvement in yield attributes, viz. capitulum diameter, seeds/capitulum, seed weight/capitulum and 1,000-seed weight (Table 2). Weedy period of initial 30 days and more resulted in significant reduction of these yield attributes. Due to season-long crop–weed competition, the average reduction in capitulum diameter was 33.1%,while further reduction was recorded to the tune of 47.8 and 54.4 % with respect to seeds/capitulum and seed weight/capitulum respectively. The 1,000-seed weight was also influenced due to full-season weed infestation, however, the reduction was lower (13.07%) as compared to other yield attributes. These findings are in accordance with those of Patel *et al.* (1994).

Seed yield was adversely affected in plots maintained weed-free only for 15, 30 and 45 days after sowing as compared to 60 days after sowing and weed infestation for 15 days after sowing or weed-free treatments. This was because of re-emergence of large number of weeds under these plots. Weed-free check treatment recorded maximum yield, followed by weed-free up to 60 days after sowing and weedy up to 15 days after sowing. However, harvest index was not altered due to different treatments. Likewise, different weed-free and weedy periods failed to evoke any significant influence on oil content in seeds of sunflower. It is probably because oil content is genetically controlled. Similar findings were also reported by Rakesh Kumar (1988).

Critical period

Weed interference for only first 15 days caused no significant loss in seed yield (Table 2; Fig. 1). When weeds were allowed to remain beyond 15 days, i.e. up to 30 days or longer, the yield was reduced significantly. The LSD (P=0.05) for seed yield was 1.65 q or 10% of weed-free check (Table 2). By using this LSD=10% we can see that the seed yield was statistically at par with weed-free check when weedy period last only up to initial 20 days and weed-free period onward up to 49 days or more (Fig. 1). Therefore, critical period of weed competition worked out to be



Days after sowing (DAS)

Fig. 1. Interpretation of critical period (C.P.) of crop–weed competition in rainy-season sunflower

between 20 and 49 days after sowing in rainy-season sunflower. Chhokar *et al.* (1995) also used LSD (P=0.05) to find out the critical period of weed competition. If the chemical methods of weed control are to be adopted for control of weeds, the herbicides should have residual effect, so as to last at least up to the end of this critical period. The season-long weeds infestation caused 54.6% reduction in the yield (Table 1). The presence of weeds for the first 45 days caused 44.3% reduction in yield indicating that initial weed infestation was harmful to the crop. In contrast, crop initially weed–free for 45 days recorded only 12.6% reduction, probably because weeds emerged after 45 days did not pose any adverse effect on crop yield.

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