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Crop-weed competition studies in okra [*Abelmoschus esculentus* (L.) Moench] under mid-hill conditions of Himachal Pradesh

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Abstract

A set of ten treatments comprising 5 each of weedy and weed-free conditions up to 20, 40, 60 and 80 days after sowing and up to harvest was evaluated at Palampur during rainy (*kharif*) seasons of 2007 and 2008 to find out the critical period of crop-weed competition in okra [*Abelmoschus esculentus* (L) Moench]. Weed competition index increased with an increase in duration of weedy conditions ranging from 3.53-75.22 during 2007 and 1.82-61.8 during 2008. On the other hand, increase in weed free period from sowing to harvest decreased weed competition index to 2.65-75.22 during 2007 and 7.27-61.8 during 2008. Weed free conditions beyond 40 days after sowing did not bring significant improvement in okra yield. The highest additional net returns (Rs. 41,700) and additional net returns/rupee invested (4.73) were recorded where the plots were kept weed-free up to 40 days after sowing. The critical period for crop-weed competition was observed to be between 28-37 days after sowing when the crop should be kept free from weeds to prevent the potential yield loss. Uninterrupted weed growth throughout the crop growth reduced okra yield by 70.8 % as compared to weed free throughout.

Key words: Okra, crop-weed competition, weed competition index, monetary returns.

Introduction

Okra is an important vegetable, which is widely grown during summer and *kharif* in mid hills of Himachal Pradesh. Among the several factors responsible for low yield of okra, competition due to weeds is important one. Competition is more severe especially during *kharif*. Slow initial growth, wider spacing and fairly good application of FYM along with inorganic fertilizers provide congenial environment for weeds. Uncontrolled weed growth in okra has been reported to cause yield reduction of 80% (Singh *et al.*, 1991). Removal of weeds throughout the crop season may not be beneficial and economical. It is therefore, important to know the critical period of crop-weed competition to optimize herbicide use or adopt integrated weed management practices. Information on this aspect particularly in hills of Himachal Pradesh is meager. Hence, the present investigation was undertaken to find out the critical period of crop-weed competition in okra.

Material and Methods

A field experiment was conducted during *kharif* 2007 and 2008 at Research farm of Department of Agronomy, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur (32^0 6' N Latitude, 76^0 3' E longitude, 1280 m above msl). The soil of the experimental site was silty clay loam, acidic in reaction, medium in available N (3264 kg ha^{-1}), P (20.5 kg ha^{-1}) and high in K (210.8 kg ha^{-1}). Ten treatments comprising the weedy and weed-free conditions up to 20, 40, 60 and 80 days after sowing and upto harvest were evaluated in randomized block design with three replications. The okra variety *'Arka Anamika'* was planted in rows 45 cm apart on 2 June, using 20 kg seed/ha. Well decomposed FYM 10 t/ha was applied uniformly at the time of field preparation. In addition, the crop was fertilized with 60 kg N, 50 kg P_2O_5 and 30 kg K_2O/ha as basal dose. Required amount of N, P and K was supplied through urea, single super phosphate and muriate of potash, respectively. Weed removal as per treatment was done with the help of local weeding tool *'Khunti'*. The recommended cultural practices and plant protection measures were followed to raise the healthy crop. Two quadrates of 25 cm x 25 cm were placed randomly in each plot and weeds within the quadrates were removed and after drying them in hot air oven (70 ± 1^0 C for 72 h), weed dry weight at 60 days after sowing and at harvest were recorded. Effects on crop weed competition on yield and yield attributes were also recorded. Weed competition index was worked out as per the method given by Walia (2003). Economics of the treatments was computed based on the prevalent prices (market price or that fixed by the university)

Results and Discussion

The predominant weed species infesting the crop were: *Echinochloa colona, Cyperus* sp.,

Panicum dichotomiflourum, Commelina benghalensis, Ageratum conyzoides, Digitaria sanguinalis, Polygonum alatum and *Aeschynomene indica.*

Weed growth

Total weed count and dry weight at 60 days after sowing and at harvest were significantly influenced due to crop-weed competition period. Weed count and dry weight decreased with increase in duration of weed-free condition, whereas the total count and weed dry matter accumulation increased with increase in weedy duration (Table 1). At 60 days after sowing, the lowest count and dry weight were recorded in plots which were kept weed-free upto harvest and this was statistically at par with weedy period for 0-20, 0-40, 0-60 weed free for 0-60 and 0-80 during both the years of study. Similarly at harvest, the lowest count and dry weight of weeds was recorded in plots which were kept weed-free up to harvest and was statistically at par with the plots kept weed-free up to 80 days after sowing and weedy till 60 days after sowing. Weed competition index increased as the duration of weedy conditions increased. On an average, weed competition index was highest (70.83) when weeds were allowed to grow up to harvest.

Okra yield

Green okra yield increased with increase in duration of weed-free condition and decreased with increased weedy duration (Table 1). Decrease in okra yield with delayed weed removal was attributed to increased weed competition as progressive increase in dry matter accumulation by weeds was observed. Weedy conditions up to 20 days after sowing only did not have any competition with crop as green okra yield was similar with that of whole-season weed-free conditions. However, the green okra yield reduced drastically when weedy period increased from 20 days to 40 days after sowing. Increase in weedy period thereafter did not influence the okra yield significantly. Weed-free conditions up to 40 days after sowing and thereafter, till harvest yielded at par with that of whole season weed-free conditions during both the years of study. The green okra yield was reduced by 3.5, 31.0, 66.4, 68.1 and 75.2 per cent during 2007 and 1.8, 23.6, 40.0, 41.8 and 61.8 per cent during 2008 due to unchecked weed growth up 20, 40, 60, 80 days after sowing and harvest, respectively, compared to weed-free conditions up to harvest. On the other hand, enhancement in green okra yield due to weed-free conditions up to 20, 40, 60, 80 days after sowing and harvest over full- season weedy conditions was 132, 267, 278, 293 and 363 percent during 2007 and 57, 123, 138, 142 and 161 per cent during 2008, respectively. This was understandable due to reduced crop-weed competition in these treatments. The plots kept weed-free up to harvest had significantly higher okra yield than the yield obtained under the weedy plots up to 40, 60, 80 days after sowing and harvest and weed-free plots up to 20 days after sowing. Weed-free conditions beyond 40 days after sowing could not bring further significant improvement in okra yield. It appears that the crop required initial weed-free period of 40 days and weeds emerging after 40 days of sowing had no adverse effect on the crop.

Growth and yield attributes

Growth and yield attributes *viz.* plant height, plants/m row length, fruits/plant and length of fruit were significantly influenced due to weed-free and weedy periods (Table 2). All the growth and yield attributes increased with increase in duration of weed free condition and decreased with increased weedy period. Maximum values of these attributes were recorded in plots kept weed-free till harvest which resulted in significant improvement in yield over weedy up to 40, 60 and 80 days after sowing and up to harvest. Remarkable improvement in yield attributes due to weed control treatment over weedy check was also reported by Ved Prakash *et al.* (2001). The minimum values for all the yield attributes, however, were registered in the weedy plots upto harvest.

Monetary Returns

Additional mean gross returns over weedy up to harvest increased with increase in duration of weed-free conditions and decreased with increased weedy period (Table 3). Similarly, additional mean net returns and net returns/rupee invested increased with increase in duration of weed-free period up to 40 days after sowing and decreased with increased weedy period. The additional net returns over weedy check ranged from Rs. 2200 to 41,700/ha being highest under weed-free up to 40 days after sowing and lowest under weedy up-to 60 days after sowing. Weed-free conditions beyond 40 days after sowing did not enhance the additional net returns and net returns/rupee invested, mainly because of higher labour cost involved in repeated manual weeding for maintaining weed-free conditions up to harvest. The additional net returns and net returns/rupee invested decreased markedly

Table 1. Total weed count, total weed dry weight, green okra yield and weed competition index as influenced by crop-weed competition

Treatment	Total weed count (No./m^2)				Total weed dry weight (g/m^2)				Green okra yield (t/ha)			Weed competition index		
	60 DAS		At harvest		60 DAS		At harvest							
	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	Mean	2007	2008	Mean
Weedy period (DAS)														
0-20	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	1.4 (1.3)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	10.9	5.4	8.15	3.53	1.82	2.96
0-40	1.0 (0.0)	1.0 (0.0)	1.0 0.0)	1.9 (4.0)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	7.8	4.2	6.00	30.97	23.63	28.57
0-60	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	3.8	3.3	3.55	66.37	40.0	57.73
0-80	13.9 (193.3)	15.0 (223.3)	1.0 (0.0)	1.0 (0.0)	7.6 (56.6)	6.1 (36.2)	7.1 (50.1)	1.0 (0.0)	3.6	3.2	3.40	68.14	41.8	59.52
Up to harvest	15.3 (232.0)	17.6 (308.0)	16.2 (261.3)	14.4 (206.7)	8.3 (68.4)	7.0 (47.4)	8.3 (68.1)	7.5 (55.5)	2.8	2.1	2.45	75.22	61.8	70.83
Weed-free period (DAS)														
0-20	14.7 (214.7)	13.8 (190.7)	13.4 (180.0)	13.9 (194.7)	7.6 (56.5)	5.4 (28.8)	8.1 (64.4)	6.8 (46.0)	6.5	3.3	4.90	42.47	41.0	41.67
0-40	14.7 (216.0)	14.1 (197.3)	12.6 (158.7)	15.4 (237.3)	7.4 (54.7)	4.9 (23.1)	7.5 (55.3)	6.5 (41.9)	10.3	4.7	7.50	8.85	14.54	10.71
0-60	1.0 (0.0)	1.0 (0.0)	8.2 (93.3)	12.5 (156.0)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	6.3 (39.1)	10.6	5.0	7.80	6.19	9.09	7.14
0-80	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	11.4 (128.8)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	5.9 (34.0)	11.0	5.1	8.05	2.65	7.27	4.17
Up to harvest	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	11.3	5.5	8.40	-	-	-
LSD (P=0.05)	0.90	2.4	3.5	1.5	2.4	0.8	0.70	0.60	3.1	1.2	2.2	-	-	-

DAS: days after sowing ; Values given in the parentheses are the original means.

Table 2.Yield attributes as influenced by crop-weed competition

Treatment	Plant height (cm)		Plants /m row length		No. of fruits/plant		Length of fruit (cm)	
	2007	2008	2007	2008	2007	2008	2007	2008
Weedy period (DAS)								
0-20	98.9	92.9	5.9	5.8	6.4	5.9	12.5	12.1
0-40	92.4	91.2	5.8	5.8	6.2	5.7	12.4	12.1
0-60	92.1	89.6	5.4	5.3	5.7	5.3	12.2	11.9
0-80	84.4	74.5	5.3	5	5.4	5.3	12.1	10.9
Up to harvest	78.6	68.9	5.2	4.5	5.4	5.3	10.1	9.8
Weed-free period (DAS)								
0-20	82.2	77.3	5.4	4.8	5.9	5.8	11.1	9.0
0-40	86.8	81.3	5.5	5.0	6.2	5.9	11.4	10.4
0-60	92.4	86.7	5.8	6.3	6.2	5.9	11.8	10.7
0-80	96.6	86.5	6.6	6.8	6.3	6.1	11.9	11.0
Up to harvest	99.2	93.7	6.9	6.9	6.4	6.2	12.2	12.0
LSD (P=0.05)	4.8	5.6	1.3	2.2	1.3	1.2	2.1	2.5

DAS: days after sowing

Table 3. Monetary returns as influenced by crop- weed competition (mean of 2007 and 2008)

Treatment	Additional green okra yield (t/ha)	Additional gross returns(Rs./ha)	Treatment cost (Rs./ ha)	Additional net return(Rs./ha)	Additional net returns/rupee invested
Weedy period (DAS)					
0-20	5.7	57000	17600	39400	2.23
0-40	3.55	35500	13200	22300	1.69
0-60	1.10	11000	8800	2200	0.25
0-80	0.95	9500	4400	5100	1.15
Up to harvest	-	-	-	-	-
Weed-free period (DAS)					
0-20	2.45	24500	4400	20100	4.56
0-40	5.05	50500	8800	41700	4.73
0-60	5.35	53500	13200	40300	3.05
0-80	5.60	56000	17600	38400	2.18
Up to harvest	5.95	59500	22000	37500	1.70

DAS: days after sowing

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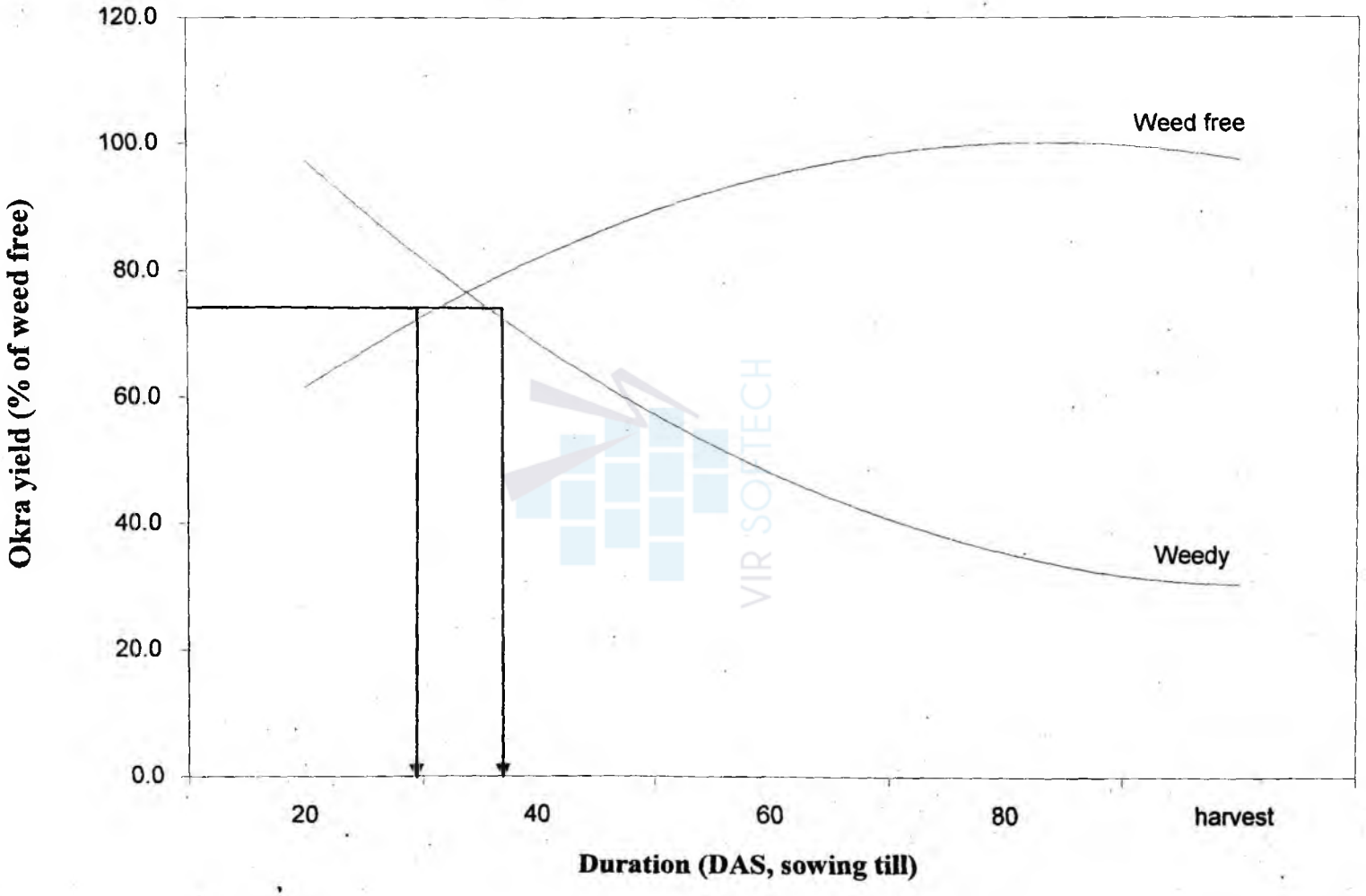


Fig 1. Critical period of weeds-crop competition in okra

when the plots were kept weedy beyond 20 to 80 days after sowing. It might be due to drastic reduction in okra yield because of severe crop-weed competition. The highest additional net returns/rupee invested (4.73) was recorded when the plots were kept weed-free upto 40 days after sowing, whereas it was lowest (0.25) when weeds were not removed till 60 days after sowing. These results are in close conformity with the findings of Patel *et al.* (2004).

Critical period of crop weed competition

The LSD (P=0.05) for mean okra fruit yield was 2.29 or 26% of the weed free check. By using the LSD 26%, it can be seen that the fruit yield (lower by 26% of the highest) was statistically at par with weed free check when weedy period lasted only upto about 37 days and weed free period upto 28 days after sowing (Fig. 1), caused non-significant reduction. Therefore, an extrapolated critical period of weed crop competition in okra was until 28-37 days after sowing. Chhokar *et al.* (1995) and Rana *et al.* (2008) also reported similar technique in determining critical period of weeds crop competition.

It is concluded that to realize the potential green okra yield higher monetary returns, crop should be kept weed-free up to initial 37 days after sowing.

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