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Effects of Weed Duration on Seed Yield and Yield Components of Double-cropped Soybean

[1]Ilhan Uremis, [2]Mehmet Arslan and [3]Ahmet Uludag
[1]Department of Plant Protection, Faculty of Agriculture, Mustafa Kemal University, Hatay, Turkey
[2]Department of Field Crops, Faculty of Agriculture, Mustafa Kemal University, Hatay, Turkey
[3]Plant Protection Research Institute, Bornova-Izmir, Turkey

Abstract: The objectives of this study were to determine the effects of weed infestation on seed yield and yield components of double-cropped soybean and to determine critical time of weed removal after emerging that double-cropped soybean can tolerate before yields are reduced. Eleven weed duration periods were created by removing weeds by weekly intervals after emergence. Plants grown in different weed duration plots were examined and compared with weedy and weed-free controls. The experimental design was Randomized Complete Blocks with three replications. Plants grown in weedy control plots had taller plant heights than weed-free control and the other weedy plots. Branch number, node number, pod number and seed number per plant decreased when the duration of weed infestation increased. Maximum soybean seed yield was obtained when plots were kept weed-free, followed by weedy 1 Week After Emerging (WAE). In weedy control plots, seed yield was reduced. The result of present study showed that 1-week delay in removing of weeds significantly reduces seed yield in double-cropped soybean.

Key words: Soybean (*Glycine max* L.), seed yield, weed competition, yield components

INTRODUCTION

Double crop soybean production following winter wheat is a common practice in the Eastern Mediterranean region of Turkey. However, soybean-planting area highly fluctuates due to the high cost of production and unstable, generally low, local market prices. To increase soybean production profitability, high production inputs such as cost of pest and disease control should be diminished by the application of proper management strategies. Weeds are among the major constraints of soybean production in the region. More than 20 weed species reported as common weeds in soybean fields in the Eastern Mediterranean region. However, purple nudsedge (*Cyperus rotundus* L.), common purslane (*Portulaca oleracea* L.), junglerice (*Echinochloa colonum* (L.) Link.), johnsongrass (*Sorghum halepense* (L.) Pers.), common cocklebur (*Xanthium strumarium* L.) and pigweeds (*Amaranthus* spp.) are ranked as the most troublesome ones[1].

Weed soybean competition starts with germination of the crop and continues up to maturity unless proper weed control measures are applied. Soybean is susceptible to early weed competition[2-4]. When weeds are uncontrolled for the entire season, yield reduction up to 75% occurs due to weed soybean competition[5-9].

Cost of weed control, comprise between 20 and 30% of total input, varies among soybean fields. One way to reduce cost of weed control is to build up an Integrated Weed Management (IWM) by the timely weed removal through determination of the critical time for weed removal.

The objectives of this study were to determine the effects of weed infestation on seed yield and yield components of double-cropped soybean and to determine critical time of weed removal after emerging that double-cropped soybean can tolerate before yields are reduced.

MATERIALS AND METHODS

Field experiments were conducted in 2002 and 2003 at the Experimental Farm of Agricultural Faculty, Mustafa Kemal University in Hatay (36°39' N, 36°40' E; 83 m elevation), located in the Eastern Mediterranean region of Turkey. The soil of the experimental site, developed from alluvial deposits of river terraces, is typical for the Eastern Mediterranean region in Turkey and is classified as Vertisol by FAO/UNESCO[10] having relatively high clay content with the predominant clay minerals smectite and kaolinite. The soil of the experimental plots was clay in texture (38.3% sand, 20.4% silt, 41.2% clay) with low organic matter content (0.60%) and was slightly alkaline

Corresponding Author: Dr. Ilhan Uremis, Department of Plant Protection, Faculty of Agriculture, Mustafa Kemal University, Hatay, Turkey Tel: + 90 326 245 58 36 Fax: +90 326 245 58 32

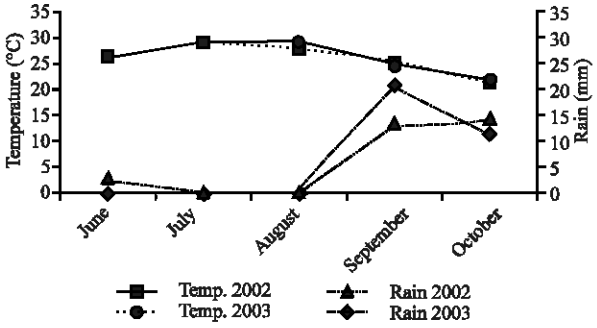

Fig. 1: Average temperature and rain fall at the experimental area in 2002 and 2003

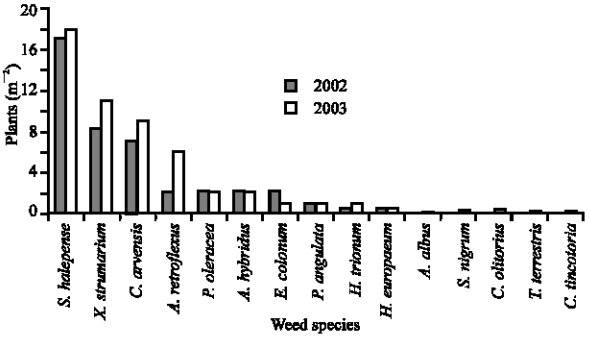

Fig. 2: Weed species and their densities at the experimental plots in 2002 and 2003

(pH 7.4) in reaction. The available total nitrogen, available phosphorus and potassium contents were 0.083%, 122.4 and 690 kg ha^{-1}, respectively. Mean air temperature was about 26°C at the cropping period (June-October) in both years (Fig. 1), while the mean relative humidity was around 54% during the growing periods in both years.

The field was tilled twice with a cultivator and disk harrow, following wheat harvest in both years. The soybean cultivar A 3935 (Asgrow Seed Co.) was planted at a rate of 25 seeds in 1 m row on June 13 and 29 in 2002 and 2003, respectively. Plots consisted of four 5 m rows, planted 0.65 m apart, that were end trimmed to final length of 5 m prior to harvest of the center two rows. The experimental design was randomized complete block with 3 replications. In both years, seed germination and plant emergence were helped by light sprinkler irrigation. Flood irrigation method was applied every 15 days interval after emergence. At time of sowing, 25 kg N ha^{-1} and 25 kg P_2O_5 ha^{-1} were applied as a 20-20 fertiliser. Lambda-cyhalothrin were sprayed twice to control insect pests each year. Weed removal started a week after soybean emergence and continued 11 weeks at weekly intervals. Weeds were allowed to interfere with soybean from emergence until a certain week, after which weeds were removed and plots maintained weed-free for the duration. Also, season-long weedy (unweeded control) and season-long weed-free plots (weed-free control) were maintained. Weeds were removed by hand and hand hoeing in all plots when required by the treatment.

Ten plants were harvested at maturity from the first and fourth rows of each plot for measuring plant height, number of branches/plant, number of nodes/plant, number of pods/plant and number of seeds/plant and 100 seed weight. Seed yield was estimated by harvesting 5 m of two central rows at maturity.

Measured plant parameters data were subjected to analysis of variance using the general linear models procedure in the SAS[11]. Means of measured plant parameters were compared by using Fisher's protected Least Significance Difference (LSD) at 95% level of probability. Simple correlations were obtained with the ANOVA procedure of SAS with the MANOVA option.

RESULTS AND DISCUSSION

The population of weed species was consisted of 2-monocotyledonous and 13-dicotyledonous weed species (Fig. 2). Johnsongrass (*Sorghum halepense* (L.) Pers.) was the dominant weed species with the density of 17 and 18 m^{-2} in 2002 and 2003, respectively. Common cocklebur (*Xanthium strumarium* L.) was the second dominant weed species followed by field bindweed (*Convolvulus arvensis* L.) and redroot pigweed in both years of the study (Fig. 2).

Duration of weed infestation significantly affected plant height in both years. The highest plant height was obtained from weedy control plot with 69.73 cm and the lowest was obtained from weed-free control treatment with 52.57 cm in 2002. In the both years, plant height increased with the increasing duration of weed infestation due to the weed crop competition for light (Table 1).

Duration of weed infestation significantly affected branch number/plant in the first year of the study whereas no significant effect was detected in the second year. However, similar trend was observed in both years which branch number decreased when weed removal was delayed. The highest branch number/plant was obtained from the weedy 1 WAE and the lowest was obtained from weedy control treatment in either year of the study. In 2002, node number per plant was not affected from the duration of weed infestation, whereas it was significantly affected in 2003. The significant effect of duration of weed infestation on node number plant resulted from planting date. Since in 2003, the crop was planted 16 days later than in 2002.

Table 1: Effects of weed duration on seed yield and yield components of double-cropped soybean in 2002 and 2003

	Plant height (cm)		Branch number/plant		Node number/plant		Pod number/plant		Seed number/plant		100 seed weight (g^{-1})		Seed yield (kg ha^{-1})	
Treatments	2002	2003	2002	2003	2002	2003	2002	2003	2002	2003	2002	2003	2002	2003
Weed-free control	52.57	49.23	3.73	3.60	14.60	13.70	79.80	50.10	284.93	156.17	14.06	13.83	4778.3	3980.0
Weedy 1 WAE*	52.60	44.93	4.76	3.80	18.96	10.26	86.63	45.03	252.20	147.20	14.10	15.33	4102.0	3797.0
Weedy 2 WAE	53.30	44.83	3.83	4.00	17.93	13.93	84.37	46.80	300.93	151.40	13.80	14.46	3715.0	3524.3
Weedy 3 WAE	56.06	45.63	3.53	3.80	17.46	14.16	72.73	54.40	196.60	157.67	14.46	14.80	3633.7	3081.0
Weedy 4 WAE	56.50	49.53	3.43	3.30	16.23	13.43	71.47	54.80	194.33	142.67	13.60	14.93	3409.7	2882.7
Weedy 5 WAE	59.40	50.73	3.07	3.60	18.06	12.50	61.13	63.70	143.47	138.57	15.26	14.63	2996.7	2566.3
Weedy 6 WAE	58.50	50.26	3.17	3.50	17.73	11.20	63.00	48.03	184.87	125.90	13.13	14.03	3042.7	2390.3
Weedy 7 WAE	61.70	49.33	3.17	3.30	18.70	12.03	74.33	46.70	176.33	128.53	12.83	14.56	2873.3	2325.0
Weedy 8 WAE	66.97	54.77	2.83	3.13	17.73	13.83	66.13	64.67	179.40	142.13	13.30	13.86	2684.7	2202.0
Weedy 9 WAE	59.66	53.13	2.83	3.16	15.50	13.30	51.10	48.40	133.33	106.03	14.20	14.66	2350.3	2015.7
Weedy 10 WAE	67.67	57.43	2.23	2.90	16.30	12.83	56.70	37.13	123.27	88.87	13.60	15.50	2226.3	1638.7
Weedy 11 WAE	68.96	54.50	1.97	2.70	14.23	12.16	59.07	31.97	121.67	67.13	11.63	15.23	1844.0	1426.0
Weedy control	69.73	57.57	1.86	2.13	14.46	13.00	41.80	34.97	88.90	65.10	11.73	14.40	1289.3	1007.3
LSD 0.05	16.50	14.90	1.20	1.70	NS	2.90	29.70	22.70	99.20	23.10	1.40	1.90	598.3	290.1

* Weeks after emerging

Table 2: Correlation coefficient of seed yield with its components

	PH	BN	NN	PN	SN	SW
Branch number/plant	-0.390**					
Node number/plant	0.244*	0.075				
Pod number/plant	-0.043	0.292*	0.584**			
Seed number/plant	-0.169	0.411**	0.443	0.746**		
Seed weight (g^{-1})	-0.257*	0.244*	-0.139	-0.186	-0.115	
Seed yield (kg ha^{-1})	-0.195	0.489**	0.278*	0.455**	0.725**	0.124

* and ** significant at the 0.05 and 0.01 probability level, respectively.
PH = Plant Height, BN = Branch Number/plant, PN = Pod Number/plant
SN = Seed Number/plant, SW= 100 Seed Weight (g^{-1}), SY = Seed Yield (kg ha^{-1})

Pod and seed number/plant are the most important yield components that determine seed yield per plant[12-15]. Both of the yield components were significantly affected from the duration of weed infestation in both years. Plants in weedy 1 and 2 WAE had the highest pod number/plant in 2002, whereas weedy 8 WAE and weedy at 5 WAE had the highest pod number/plant in 2003, respectively. Weed-free control plots expected to have the highest pod number/plant , but weed-free control plots had lower pod number plant than some of the weedy plots. Seed number/plant showed similar response to duration of weed infestation. Plant grown in weedy 2 WAE and 3 WAE had the highest seed number/plant in 2002 and 2003, respectively. Like pod number/plant , plants in weed-free control plots had slightly lower seed number/plant than some of weedy plots due to inner plant competition in weed-free control plots. However, pod and seed number per plant, in general, decreased when weeds competed in longer duration with soybean.

Hundred seed weight significantly varied among the duration of weed infestation. However, it did not correlated with the duration of weed infestation. Instead, it mostly depended on seed number per plant. Any decrease in seed number per plant increased seed weight (Table 2).

Seed yield reduced with the increasing duration of weed infestation in both years. The significant seed yield difference between weed-free control and weedy 1 WAE treatment showed that weeding must be started right after emergence and continued till to 11 WAE. Recommended time of weed removal was between 9 and 38 days after emergence[4,16,17]. Among different studies, differences in weed removal time were resulted from the differences in weed species, their densities and different environmental conditions. Seed yield was significantly and positively correlated with branch number/plant, node number/plant, pod number/plant and seed number/plant (Table 2). Any increase in one of these yield components increases seed yield of double-cropped soybean.

In the current study, weed crop competition started with germination of the crop and continued up to the maturity. Among treatments, seed yield reduction varied between 14-73% in 2002 and between 5 and 74% in 2003. Seed yield reduction in weed-infested plots was mainly resulted from the reduction in pod and seed number/plant. As the duration of weed infestation was extended seed yield loss remarkably increased in both years. To reduce seed yield loss in an acceptable level, weeding should be started at crop emergence and continued till to maturity. To maintain desired weed control level in the context of current study requires development of weed control techniques which are suitable for IWM.

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