VOL. 12, NO. 4, APRIL 2017 ISSN 1990-6145
ARPN Journal of Agricultural and Biological Science

www.arpnjournals.com

THE CRITICAL PERIOD FOR WEED COMPETATION IN SOYBEAN *Glycine max* (L.) Merr. UNDER IRAQI IRRIGATED AREAS

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ABSTRACT

Afield experiment was conducted during season 2012 to determine the Critical Period for Weed Competition in soybean crop growing under irrigated areas in Iraq to prevent unacceptable losses in yield. This period, expressed according to the growing periods of the soybean crop. The experiment included keeping plots free of weed at 1, 2, 3, 4, 5, 6, 7 and 8 weeks after emergence of soybean by removing weeds manually. Then, allowed weeds to grow after these periods until the end of the growing season. Results showed through the seasonal study that this period was during the fifth week after emergence depends on acceptable yield losses 3-5% in comparison of yield of free weed plots. Yield Losses of soybean resulting from weed competition along the growing season were 29.04%. Accordingly, this study recommends that weed control must continue until the fifth week after emergence and not to delay it for this period by using mechanical control methods or by using herbicides, which still effective against weeds until this period to avoid unacceptable loss of the economic yield and minimizing the negative impact of weeds environmentally and economically.

Keywords: critical period for weed control (CPWC), soybean, unacceptable yield losses.

INTRODUCTION

Weed competition is considered as the most problems facing in an agricultural system due to reducing the yield of economic crops quantitatively and qualitatively. As well as, reducing the value of agricultural lands (Hossain *et al*. 2010). Weeds compete with the economic crops on the essential requirements of growth mainly; water and nutrients (Appleby, 2005; Hartzler, 2007). Generally, losses caused by weed competition estimated by 34% of the total losses which caused by all agricultural pests. These losses reached to around 3.8 billion dollars per year (Boutin*et al*. 2014). Although the chemical weed control (Synthetic herbicides) deemed as the most efficient methods used in weed control, occasionally their uses are not feasible as a result of unsuitable applying time, such as sprayed in the late stages of the weed's life. So, determining the critical period for weed competition isvery necessary and essential to help the economic crop to escape from the real weed competition, which adversely affects the efficiency of its production. Furthermore, rationing the use of synthetic herbicides due to their negative effects, environmentally and economically (Almarie*et al.* 2016). As well as, determining of this period is useful in the programs of integrated weed management. Previously, many studies conducted to determine the critical period for weed competition, which is symbolized by (CPWC). It's defined by Nadeem *et al*., (2013) as a certain period in the life cycle of the crop, must be free from a weed. Or its minimum-weed -free period from agriculture or emerge and necessary to prevent unacceptable yield losses (Mahmoodi and Rahimi, 2009). Also, CPWC defined by Graham and Ian, (2008) as the period of the crop which removing weeds were necessary. Each crop has a certain period of its life be critical towards weed competition. This period is different depending on the crop species and growing conditions. There are several ways to determine this period, some investigations determined this period, depending on the stages of plant growth. For example, this period was determined in Bean crop to be from second true leaf until flowering stage (Van *et al.*1993).As well as, this period has indicated according to the growing time (days & weeks) after germination or emergence into the period where no economic losses in yield (Frenda *et al*. 2013). This period in maize was during the fifth week after germination (Uremis *et al*. 2009). Also, this period in Mungbean was from 10 And 20 days after emergence (Rahman, 2012).

Soybean crop*Glycine max* (L.) Merr. Is an important legume crop grown basically for its seeds which used in many industries, mainly for human consumption and as a poultry; fish and animal feed (Masuda& Goldsmith, 2009). Soybean seeds featured by high content of oil and protein. This making Soybean outperforms compared with other crops in terms of a high content of protein and oil seeds. As well as, soybean seeds contain from many essential amino acids, unsaturated fatty acids and vitamins (Banaszkiewicz, 2011). Furthermore, Soybean oil can be used as an alternative biodiesel engine with little or no modifications (Muneeswaran & Thansekhar, 2015).

Currently, Soybean crop is widely grown in Iraq due to its multiple uses and possibilityof growing inhigh efficiencyunder irrigated agricultural areas. No studies were dedicated to determine the critical period for weed control regarding this crop under irrigated lands, especially, this crop considering sensitive to the weed competition. Moreover, losses resulting from competition not defined clearly. Therefore, the aim of this study is to determine the critical period for weed competition and also to evaluate negative impact of weed competition in this crop and expected losses resulting from weed competition.

MATERIALS AND METHODS

Experimental

During the season of 2012, a field experiment was carried out on the right bank of the Euphrates River in the city of Ramadi in Anbar Province – Iraq, to study the critical weed period of the soybean crop. An experimental field was arranged and divided into plots (3m×4m). The experiment was conducted in accordance with (R.C.B.D) design with three replicates, each replicate contain 10 treatments including preventing weed to grow for 1, 2, 3, 4, 5, 6, 7 and 8 weeks after emergence of soybean as well as the treatments of weedy and free of weed along growing season. Soybean crop (Var. Giza 35) was planted in rows, the distance between rows was 70cm and between holes at the same row was 25cm. Three seeds were sown in each hole, and then thinned to one when crop seedlings arrived to the second true leaf (Triangle leaf). Watering and fertilization were applied as recommended (Salvagiotti *etal.* 2008). Removing weeds in different periods tested was conducted manually. When soybean plants reached to the end of the flowering stage, weed density was calculated by taking the average of throwing wooden frame (1m×1m) three times randomly in each plot. Then, weeds were cut near from the soil surface and dried using electrical oven at 48°C until weight stability, in order to calculate weed dry matter. Upon soybean maturity, 10 plants of the crop from the middle plot area were harvested to calculate the number of branches per plant, number of pods per plant, weight of 100 seeds (g) and total yield as Ton/ hectare.

Data analysis

Data collected were subjected to analysis of variance using SASS software version9.0.Means were separated using least significant difference LSD ($P \leq 0.05$).

RESULTS

Results of weed density (plant/m^2) and their dry matter (g/$m^{2)}$ were shown in (Figure-1). As can be seen, weed removal periods were significantly different as compared with controls (Weedy). Also, the significant differences were observed from these periods in between each other, wherein the decreasing of weed density was related to the increasing of removal periods.

Removal weed for four weeks was the crucial stage, when the rate of decline weed density reached to 84.49% in comparison with controls (Weedy), while the treatment of removing for three weeks after emergence recorded only 55.24%. Effecting of weed removal periods on dry matter g/m^2 were similar to where coming in weed density. A significant reduction was observed in all periods tested. The treatment of removing till the four weeks also considered a transformative stage when the huge inhibition of weed dry matter began from this stage and recorded suppressing rate 90.04% compared with the controls. The statistical analysis presented in (Table-1) showed the soybean yield and its components affected by weed removal periods. A significant superior of branch per plant was achieved by increasing removal periods.

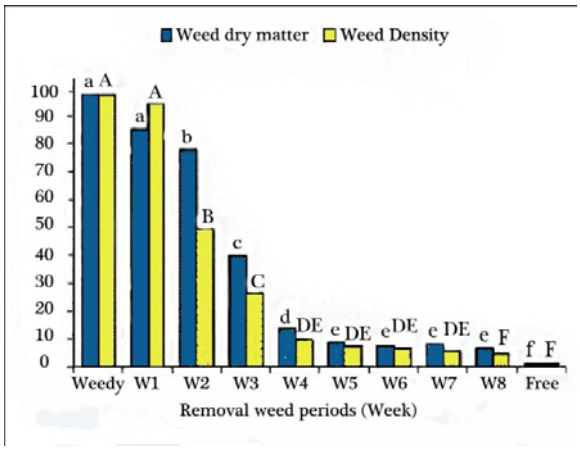

Figure -1. Effect of weed removal periods on weed density and dry matter of growing in soybean field.

* Density and dry matter of weeds in weedy treatments calculated as 100%.
* Capital letters; means differences in weed density, weed/m^2.
* Small letters; means differences in weed dry matter g/m^2.

The increasing of soybean branches continued significantly between weed removal treatments until the five weeks of removing, and then no significant increasing was caused. In addition to this, the longest removal periods (five weeks and beyond) came with the same significance level with the treatment of free weed.

The total pods per plant also affected by weed removal period as shown in (Table-1). Removing weeds through the first week after emergence did not show any improvement of the total plant pods.

Table-1. Effect of weed removal period on yield and its components in soybean crop.

Removal weeks	Branch/ plant	Pod/plant	Weight of 100 seeds	Total yield Ton/ha^{-1}
Weedy	5.30 e	120.72 c	11.04 d	1.82 d
1 week	5.61 d	123.17 c	11.10 d	1.94 cd
2 weeks	6.32 c	130.10 b	11.67 c	2.05 c
3 weeks	6.46 bc	131.30 b	11.68 c	2.23 b
4 weeks	6.68 b	131.35 b	11.81 bc	2.35 b
5weeks	7.03 a	136.79 a	12.10 ab	2.50 a
6 weeks	7.07 a	138.33 a	12.36 a	2.51 a
7 weeks	7.08 a	139.10 a	12.40 a	2.54 a
8 weeks	7.10 a	139.44 a	12.38 a	2.55 a
Free weed	7.12 a	139.53 a	12.45 a	2.56 a

*Means followed by the same letters in the same column are not significantly different at the 5% level of the LSD multiple range test.

The significant supremacy was begun from the second week, which did not differ from the nearest period, third and fourth week. Moreover, in case of the longer periods (five weeks and beyond), they came with the best results and did not differ from each other, the losses percent of this period, compared with free weed treatment were 1.97, 0.86, 0.31 and 0.07% for the five, six, seven and eight weeks after emergence respectively. Application of removal periods greatly increased weight of 100 seeds in all periods tested except removing weeds for one week which did not differ significantly with controls. No differences in weight of 100 were detected with the rising of weed removal periods during the longer periods, beginning from the five weeks to the eight weeks after emergence. Furthermore, these treatments did not differ with the treatment of free weed.

Regarding the total yield of soybean crops, it is also affected by removal weed periods. The effect on yield was positive, the yield was increased gradually until reaching the longer removal periods to be at the same level of significance with free weed treatment periods (five weeks and beyond). The losses percent of the longer periods compared with free weed treatment were 1.75, 1.36, 0.78 and 0.39% for the five, six, seven and eight weeks after emergence respectively. Also the increasing rate in yield in these periods in comparison of weedy treatment was 27.2, 27.8, 28.4 and 28.7% respectively.

DISCUSSIONS

The current study indicated, although the presence of weed seed in soil, the low percentage of weeds germinated after longer removal periods (five weeks and beyond) as compared with the shortest, especially in the emergence stage of soybean. That can explain, the germination of the economic crops stimulated the germination of the weed seeds as a result of the biochemical interaction between each other which is known as a commensalism (Benech *et al*. 2000).

Our findings in agreement with findings of (Smitchger *et al*. 2012; Stagnari *et al*. 2011) which emphasized that the density and dry weight of weeds inversely proportional to the increase of removal periods. It has been seen that the absence of weeds in the early stages of crop growth led to getting an economic crop to the available growth requirements perfectly. Allowing weeds to grow naturally without control will rival the economic crops of the essential growth requirements.

Hence, caused reduction of the final yield to the lowest rate, especially many species of weeds considered more efficient than economic crops to get these requirements.

All yield components that tested in the current study were affected by removal periods. Improving of the yield components will affect positively on the final yield. These results are in conformity with the findings of (Charles & Taylor, 2007; Knezevic & Datta, 2015), stated that the removal of weeds, definitely in the early stages of growth of leguminous crops led to a significant increase in economic yield. In this regard, Hossain *et al.,* (2010) was mentioned that the weight of 100 seeds is considered the most character related to the yields in legume crops and any effect it will adversely effect on the final yield.

Table-2. Losses percent (%) of the yield its components compared with free weed yield.

Removal weeks	Branch/ plant	Pod/plant	Weight of 100 seeds	Total yield Ton/ha^{-1}
Weedy	25.51	13.48	11.33	29.04
1 week	21.15	11.72	10.80	24.37
2 weeks	11.17	6.76	6.22	19.88
3 weeks	9.21	5.90	6.14	13.26
4 weeks	6.11	5.86	5.14	8.38
5weeks	1.19	1.97	2.77	1.75
6 weeks	0.63	0.86	0.72	1.36
7 weeks	0.42	0.31	0.40	0.78
8 weeks	0.14	0.07	0.56	0.39

According to previous studies, the acceptable loss in soybean yield compared with treatment of free weeds ranging from 3-5% (Hartzler, 2007). Based on this, critical period of weed competition in soybean crop of the current study was determined during the weed removal period for five weeks after emergence (Table-2 & Figure-3).

Previously, this period was determined by to be lasting up to the fourth node growth stage (V4) (El-Gizawy *et al*. 2012). Our result came in lane with this investigation in which this stage considering approximately 30 days after emergence.

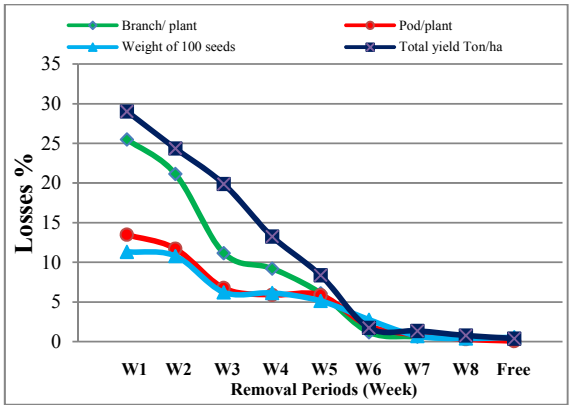

Figure-2. Losses percent of yield and its components effecting by weed removal periods.

Losses in final yield of soybean resulting from weed competition of the long growing season were 29.04%. The yield losses estimated in the current study were coming less than yield losses estimated in earlier studies (El-Gizawy *et al*.2012), wherein the losses were ranged 34.4 to 37.6 % for both study seasons respectively. However, this study was conducted in dry season when water is considered a determining growth factor; especially the soybean is sensitive crop to water stress.

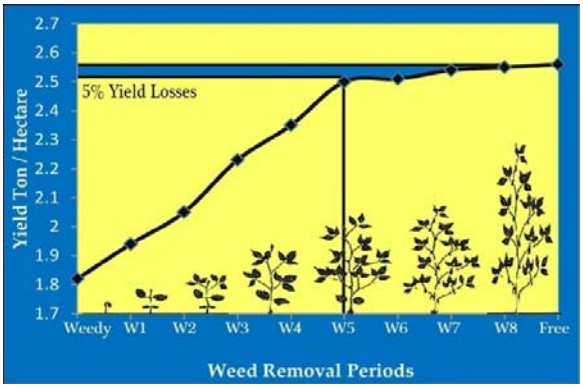

Figure-3. The critical period for weed control in Soybean crop.

CONCLUSIONS

a) The results showed that the critical period for weed control in Soybean crop was determined to be during the five weeks after emergence.

b) Determining the critical weed period is able to reduce theweed competition to the lowest level and allowing optimum utilization of available growth ingredients.

c) Preventing weed to grow in early growth stages by using mechanical methods or applying herbicides that remaining active until this period to avoid unacceptable losses in yield.

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