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Soybean (*Glycine max*) Yield Loss Due to Weeds at Jimma, Ethiopia

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Abstract: Weeds are a serious and economically more harmful than insects and crop diseases in soybean. Assessment of crop yield and economic losses due to weeds in soybean is an important aspect which helps in designing appropriate management strategies against weeds. A study was conducted at Jimma Agricultural Research Center to estimate the yield loss due to weed competition and determine critical period of weed interference to prevent quantitative and qualitative yield losses in soybean which is paramount for the possibility of developing the management method. Eight treatments including standard checks were used, and arranged in randomized complete block design (RCBD) with three replications. Two hand weeding applied at 25 and 45 days after crop emergence gave maximum yield (20.4 q/ha) and had no significant differences compared with weed free. However, the highest yield loss (60.29%) recorded from the plot received weedy control treatment. This clearly indicates that serious crop weed competition has taken place between the 25 and 45 days after crop emergence to secure high yield in soybean. Generally, weeds contribute 60% yield losses in soybean under Jimma conditions.

Keywords: Loss, Percentage, Crop Emergence, Cultural Practice

1. Introduction

Soybean (*Glycine max* (L.) Merr.) is a grain legume that is high in protein content that provides more than 50% of the world's oil. It can be used directly for food in the home or processed into soy-milk, cooking oil, and animal feed [1]. Among all legume crops soybean is a vital oil seed which is the richest and best quality protein source on a global scale [2]. In Ethiopia, soybean production has been growing rapidly in the last couple of years, and several technologies have been developed by the research institutions (regional and national research institutes in the country, in partnership with other international institutions/universities) and made available for use by soybean producers. To enhance the genetic variability and improve the yield the yield potential of the crop, over 1000 soybean germplasm has been introduced to Ethiopia in the last eight years [3]. Currently, soybean cultivation in Ethiopia covered 83,797.17 hectares of land with 208,676.389 tons of production and the national average yield of 2.49 ton ha^{-1} [4], which is lower than that of the world average productivity 2.79 ton ha^{-1} [5]. In Ethiopia the national average yield is very low as compared to other soybean producing countries due to different yield limiting factories Like: weeds, insect pests, diseases, multi-nutrient deficits, low varietal stability, insufficient fertilization, restricted access to improved soybean seed and poor agronomic practices [6]. Weed interference in soybeans is a major limiting factor for successful soybean production [7], and also are considered the number one problem in all major soybean producing developing countries [8]. Weeds contribute 77.6 -78.50% yield losses under Assosa condition if it left uncontrolled, sometimes compromises the whole crop depending on type of soil, seasons, and intensity of weed infestation [9].

Soybean has been growing in various agro-ecologies of Ethiopia. However, management practices, environmental conditions and weed competition affect soybean [7]. As the result, as different agro ecologies found in Ethiopia the yield loss due to weed might be different from areas to areas, which need yield loss quantification. Such information provides as basis for planning and decision making for successful weed management method.

Therefore, it is important to quantify yield loss due to weed in soybean at Jimma condition. Hence, the objective of the present

work was to estimate the yield loss due to weed, and critical period of crop weed competition in soybean at Jimma area.

2. Materials and Methods

2.1. Description of Study Area

The study was conducted at Jimma Agricultural Research Center (JARC/Melko). JARC is found in Oromiya regional state in Jimma zone, Ethiopia, 360 km to southwest of Addis Ababa. It is located at 07°46''N latitude and 36°47'E longitude with an elevation of 1753 meter above sea level (masl) receiving average annual rainfall of 1572mm. The area experience has mean daily minimum and maximum temperature of 11.6°C and 26.3°C, respectively. The major soil type of the center is chromic nitosol and cambiosol of upland and fluvisol of bottom land [10].

2.2. Treatments and Experimental Design

2.2.1. Crop Cultivation

Spacing between row and soybean plants 60cm and 5cm, respectively. Spacing between experimental block and plots was 1.5 and 1m, respectively. Two seeds of soybean was planted per hole and later thinned to one vigorous seedling per stand. All agronomic practices were done as per the area recommendations by JARC. Different weeding frequencies in different time intervals after crop emergence (six in number) and two checks weed free check and weedy control (positive & negative control) treatments were used. The treatments were arranged in randomized complete block design with four replications.

Table 1. *Description of treatment.*

Treatments	Description of the treatments
One hand weeding at 25 DAE	Hand weeding applied at Early soybean growth stage
Two hand weeding at 25 and 45 DAE	Hand weeding applied at Early and middle soybean growth stage
Two hand weeding at 25 and 55 DAE	Hand weeding applied at Early and late soybean growth stage
Three hand weeding at 25, 40 and 55 DAE	Hand weeding applied at Early, middle and late soybean growth stage
One hand weeding at 50 DAE	Hand weeding applied at late soybean growth stage
Two hand weeding at 45 and 55 DAE	Hand weeding applied at middle and late soybean growth stage
Weed free	Positive control (Weed free) throughout the season
Weedy control	Negative Control

Yield loss (YL) was calculated using the following formula [11];

$$\text{Yield loss (\%)} = \frac{Y1-Y2}{Y1} \times 100$$

Where YL= Yield loss, Y1 and Y2 represent yield of the weed free and other treatments, respectively.

2.2.2. Statistical Analysis

The collected yield data was analyzed using the General Linear Model (GLM) procedures of SAS 9.30 [12]. The significant differences between treatments were separated using Least Significant Difference (LSD) using SAS, 2012.

3. Results and Discussion

Analysis of variance on yield (q/ha) showed highly significant difference between treatments (Table 2). Two hand weeding applied at 25 and 45 days after emergence gave maximum yield (20.4 q/ha), and had no significant differences compared with weed free. Three times HW at 25, 40 and 55. DAE had no significant differences with one hand weeding applied at 25 and 45 days after crop emergence (Table 2). Similarly, significant yield loss observed among treatments. Accordingly, the yield loss estimated due to weed in soybean varied among weeding time (treatments) with 0.00% to% 60.00% (Table 2). Particularly high yield loss was recorded from no weeding (60%) followed by one HW at 50 days DAE (36.8%). this indicated that the critical weeding period for soybean is between 25 and 45 days after emergence. Two HW at 25 and 45 DAE had gave 39.71q/ha times from untreated (no weeding) plot. On the other hand, when weeding was totally ignored yield loss amounted 60% in soybean.

Table 2. *Soybean yield and yield loss percentage at different crop emergence at Jimma, Ethiopia.*

Treatments	Yield (q/ha)	Yield loss (%)
One hand weeding at 25 DAE	15.8b	22.55
Two hand weeding at 25 and 45 DAE	20.4a	0.00
Two hand weeding at 25 and 55 DAE	17.5b	14.24
Three hand weeding at 25, 40 and 55 DAE	15.9b	22.06
One hand weeding at 50 DAE	12.9c	36.8
Two hand weeding at 45 and 55 DAE	16.4b	19.61
Weed free	20.4a	0.00
Weedy control	8.1d	60.29
LSD (5%)	1.8	-
CV (%)	15.1	-

The minimum yield (8.1q/ha) was obtained from no weeding treatment, resulted in 60.29% yield loss. While one hand weeding applied at 50 days after crop emergence gave 12.9q/ha, which is 36.8% yield loss, this suggesting that

delayed weeding of soybean up to 45 days after crop emergence resulting in considerable yield loss under Jimma condition. This clearly indicates that serious crop weed competition has taken place between the 25 and 45 day after crop emergence suggesting that one early weeding at the 25 days after crop emergence is mandatory to secure high yield. Halford *et al.* [13] reported that soybean needs to be kept weed-free from 13 to 44 DAE to avoid greater than 2.5% yield loss. Also another study shows the critical period of weed control (CPWC) in soybean started at 15 days after crop emergence (DACE) and ended at 60 DACE in case of Asosa condition [14]. Although estimates of the critical period for a crop vary from year to year and site to site [13], and depends on management practices and environmental conditions that affect weed competition in soybean [7]. Our findings demonstrate that identifying the critical crop weed competition in soybean is an important point for designing weed management option in soybean at Jimma condition. It is important to take into account such critical weed control period in soybean, which needs to kept weed free from 25 to 45 days after crop emergency to reduce the yield loss.

4. Conclusion and Recommendation

From one year experiment on yield loss estimation in soybean carried out at Jimma Agricultural Research Center. The lowest soybean yield loss (0.00%) due to weeds obtained from, two times hand weeding at 25 and 45 days after emergence treatment as compared to other treatments. Whereas the highest yield loss (60.29%) recorded from the plot received weedy control treatment. In a similar manner, the highest yield (20.4 q/ha) obtained from this treatment which is similar with weed free treatment. From the weeding times undertaken at different days after crop emergency serious crop weed competition (the critical time of weeds removal) in soybean has been determined between the 25 and 45 days after crop emergence under Jimma condition, which, suggesting that an early weeding (the beginning of weed removing) is at 25 day after crop emergence and ends at 45 days after emergence is mandatory to secure high yield in soybean. On the other hand, the study result also revealed that when weeding was totally ignored yield loss amounted 60% in soybean.

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