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RESEARCH ARTICLE

CRITICAL PERIOD OF WEED INTERFERENCE ON SOYBEAN (GLYCINE MAX (L) MERRILL)

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ABSTRACT

Weeds are one of the important factors affecting agriculture production, weeds and inadequate weed control and management pose a detrimental factor affecting crop production. The experiment was conducted at the Teaching and Research Farm of Federal University Technology, Minna, Nigeria, to determine the effectiveness of different weeding regime and critical period of weed interference in the growth and yield of soyabean. The treatments were laid out in a Randomized Complete Block Design (RCBD) and replicated three times. There are ten treatments consisting of weed infested and weed-free as follows T_1= soybean + weeding for 2 weeks, T_2= soybean + weeding for 4 weeks, T_3= soybean + weeding for 6 weeks, T_4= soybean + weeding for 8 weeks, T_5= soybean + weedy for 2 weeks, T_6= soybean + weedy for 4 weeks ,T_7= soybean + weedy for 6 weeks, T_8= soybean + weedy for 8 weeks, T_9= soybean + weed-free plot till end and T_{10}= soybean + no weeding till end. Data were collected on weed cover score, weed dry weight, plant height, pod weight and grain yield. The Data were subjected to analysis of variance using SAS, software version 9, 2002. The results showed that soyabean with weed-free plot for 4, 6 8 and weed-free throughout significantly $P<0.05$ suppressed weed and increases yield by 70 % compared to other treatments The use of early maturing variety of soybean in addition to weed-free plot throughout the growth stage and weed-free for 8 weeks could be recommended in controlling weed interference in soybean for better soybean growth and yield.

KEYWORDS

Soybean, Critical Period, Weeding Regime and Weed Interference.

1. INTRODUCTION

Soybean is originally a native of China before its introduction across the globe; it was believed to have been introduced to Africa in the 19th century by Chinese traders (IITA, 2014). Soybean was introduced to Nigeria in the year 1908 (Shortleaf and Aoyagi 2009). A lot of soybeans is produced in Nigeria for diverse domestic usage and it is a good source of vegetable oil in the international market, it is a vegetable protein source that account for more than half of the world's seeded oil (FAO, 2015). Soybean is cultivated mainly for its seed, and for the fact that it is fairly easy to cultivate compared to other crops and it is also a source of vegetable protein which accounts for more than 50% of the world seeded oil (FAO, 2015). Soybean is a productive oil crop and constitutes an important component of smallholder cropping systems, with considerable potential for enhancing household food and nutrition security in SSA (Joubert and Jooste 2013).

Soybean meal has recently been used extensively in the poultry industry in South Sahara Africa. The soy plant belongs to member of a family of plants that has the ability to draw nitrogen from the air, impart it into the soil through its roots thus enriching poor soils (Herdt, 2006). A group researchers summarized the importance of soybean to include a source of excellent vegetable oil, as source of soil fertility enhancement and a source of parasitic weed (*Striga hermonthica*) control (Dugje et al., 2009). Losses caused by weeds in Soybean are both direct and indirect. Direct losses include reduction in crop yield by interfering with its growth. This is due to competition for nutrients, light and space, indirect losses associated with weeds include damage by other pest that use weeds as alternate host and hinders harvest operation, thus increasing operational cost, waste of time and manpower (FAO, 2009).

Competition from weeds is the most important of all biological factors that affects all agricultural crop productivity. This occurs mainly because weeds use up the resources that would have been consumed by the plant for growth. Practices that (a) reduce the density of weed (b) maximize occupation of space or uptake of resources by the crop or (c) establish an early-season size advantage of the crop over the weeds will minimize the competitive effects of weeds on crops (Eric, 2015). Competition between weeds and crops is expressed by altered growth and development of both species. Weed management is the process of reducing the quantity of weeds and their growth to the point where they cause no economic damage to the crop. The ultimate objective of weed management is to eliminate or reduce the negative impacts of weeds on crops. Perennial and most annual weeds are a nuisance in the early phases of soybean development. Weeds can be reduced in their impact with a well-timed weed management program.

Weed management in soybean can be done manually, chemically, or both (IITA, 2005). The critical period of weed control (CPWC) is that period in the growth cycle during which weeds must be controlled to prevent yield losses (Knezevic et al., 2003). Therefore, the period at which weed poses a threat to the soybean must be monitored. The critical period of weed control in soybean has been found to before the onset of soybean reproductive growth stage after which rapid soybean loss occurred because of the competitive ability of crops and weeds is heavily dependent

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on the environment conditions (Knezevic et al., 2002). Two hand hoeing are recommended for effective weed control in soybean (Galal, 2004; Singh and Jolly, 2004). Traditional manual weeding is the most commonly used method of weed control in Nigeria. This method however is, time consuming, labor – intensive, strenuous and overall expensive (Joshua and Gworgwor, 2000; Adigun and Lagoke, 2003). In this study, the effectiveness of different weeding regime and critical period of weed interference in the growth and yield of soybean was determined.

2. MATERIALS AND METHODS

The field experiment was conducted during the rainy season of at the Teaching and Research Farm of Federal University of Technology, Minna (latitude $9^0 37^1$ N and longitude $6^0 33^1$ E) located in the Southern Guinea Savanna ecological zone of Nigeria. The climate of Minna is sub-humid tropical, characterized with a long term mean rainfall of about 1284mm and a mono-modal pattern of rainfall. The rainy season begins in April and ends early October with peaks in September. The area has a distinct dry season of about 5 months duration occurring from November to March. The mean maximum temperature remains high throughout the year at about 32^oc (ranges from 35^oc to 37^oc particularly during March and through June, while the relative humidity span between 40% and 80%.

The soils of Minna are generally Alfisols. The experiment comprised weed-infested and weed-free plots consisting of ten treatments laid out in a Randomized Complete Block Design (RCBD) and replicated three times. The seeds were directly sown at two seeds per hole at 25cm x 75cm, seedlings were thinned down to two per at 4 weeks after sowing (WAS). Manual weeding was carried out based on the prescribed treatments of the experiment. Fertilizer was applied at the rate of 120 kg N, 60 kg P_2O_5 and 60 kg K_2O. A basal dose of 60 kg N ha 60 kg P_2O_5 ha-1 and 60 kg k_2O ha-1 was applied using the side placement method of fertilizer application at 3 WAS of NPK 15:15:15 as source. Data were collected on the following: Weed dry weight using a 50 cm quadrant to take fresh weed samples from each net plot prior to each weeding operation at 6, 8 and 10 WAS and oven dried at 70 ^{0}c till a constant weight was achieved and weighed to obtain dry matter content.

Weed cover score, taken from each plot on visual rating of 1-6, which is used to determine the critical period of weed interference (that is, the degree of damage severity) where, 1) Clean plot 2) Moderately clean plot 3) Fairly clean plot 4) Moderately weedy plot 5) Fairly weedy plot 6) Weedy plot. Plant heightusing a tape rule from the soil level to the tip of the last leaf from eight randomly tagged plants. Pod weight was taken after manually harvesting the pods after turns brown (straw color about 3-4 months) and further sun dried to a constant weight and weighed for each treatment. Grain Yield was taken after threshing and winnowing and then weighed using a weighing balance. Data collected were subjected to analysis of variance (ANOVA) using Statistical Analysis System (SAS) procedure, version 9, 2002 model to test significance of treatments effects. The means were compared using Duncan's Multiple Range Test at 5% probability level.

3. RESULTS

3.1 Effect of Weed Interference on Weed Cover Score and Weed Dry Weight of Soyabeans

The effect of weed interference on weed cover score were significantly ($p < 0.05$) different in all the observation period. At 4 WAS, treatments with soybean + weed-free plot, soybean + weed-free for 6 weeks, soybean + weed-free for 8 weeks and soybean + weed-free for 4 weeks recorded (1.00, 1.33, 1.33 and 1.67 respectively) lowest weed cover score compared to other treatments. While at 6 and 8 WAS, treatments with soybean + weed-free plot, soybean + weed-free for 6 weeks and soybean + weed-free for 8 weeks recorded lowest weed cover score compared to the highest weed cover score in the other treatments. The effect of weed interference on weed dry weight showed same trend with weed cover score.

Table 1: Effect of Weed Interference on Weed Cover Score and Weed Dry Weight of Soyabean

	Weed Cover Score			Weed Dry Weight (kg)		
Treatment	4 WAS	6 WAS	8WAS	6 WAS	8 WAS	10 WAS
T_1=SWF_2	4.33^b	5.67^a	6.00^a	0.03^d	0.03^d	0.03^d
T_2=SWF_4	1.67^c	4.00^b	5.67^a	0.02^e	0.02^e	0.02^e
T_3= SWF_6	1.33^c	1.33^c	2.67^d	0.01^e	0.01^f	0.03^{de}
T_4=SWF_8	1.33^c	1.33^c	1.33^e	0.01^e	0.01^f	0.01^g
T_5=SW_2	4.33^b	5.67^a	6.00^a	0.03^c	0.03^{cd}	0.04^b
T_6=SW_4	5.67^a	5.33^a	5.00^b	0.03^{bc}	0.03^c	0.04^c
T_7=SW_6	5.33^{ab}	5.67^a	4.00^c	0.03^{bc}	0.03^d	0.02^e
T_8=SW_8	5.33^{ab}	6.00^a	6.00^a	0.04^b	0.05^b	0.01^f
T_9=SWF_{-END}	1.00^c	1.00^c	1.00^e	0.01^e	0.01^f	0.01^g
T_{10}=SW_{-END}	5.67^a	6.00^a	6.00^a	0.05^a	0.05^a	0.05^a
SE±	0.3	0.2	0.1	1.39	1.64	1.78

Means with the same letter(s) in a column are not significantly different according to Duncan Multiple Range Test (DMRT) at 5% level of probability.

WAS: Week after sowing

T_1= (SWF_2) = soybean + weeding for 2 weeks

T_2= (SWF_4) = soybean + weeding for 4 weeks

T_3= (SWF_6) = soybean + weeding for 6 weeks

T_4= (SWF_8) = soybean + weeding for 8 weeks

T_5= (SW_2) = soybean + weedy for weeks

T_6= (SW_4) = soybean + weedy for 4 weeks

T_7= (SW_6) = soybean + weedy for 6 weeks

T_8= (SW_8) = soybean + weedy for 8 weeks

T_9= (SWF_{-END}) = soybean + weed-free plot till end

T_{10}= (SW_{-END}) = soybean + no weeding till end

3.2 Effect of Weed Interference on Plant Height of Soyabeans

Weed interference on plant height showed significant ($p < 0.05$) difference (Table 2). Treatments with soybean + weed-free plot recorded (22.93cm) highest plant height followed by treatments with soybean + weed-free for 8 weeks and soybean + weed-free for 6 weeks (21.29cm and 20.44cm respectively) compared to lowest plant height seen in soyabean + weed-infested plots (control) and weed-infested for 6 weeks (12.33 cm and 13.23 cm) at 4 WAS (Table 2). Week 6 and 8 showed similar trend as 4 week (Table 2).

Table 2: Effect of Weed Interference on Plant Height of Soyabean.

Treatment	Plant Height (cm)		
	4 WAS	6WAS	8 WAS
T_1=SWF_2	17.99^{cd}	41.91^b	71.67^{cd}
T_2=SWF_4	18.72^{bcd}	48.50^a	74.74^c
T_3= SWF_6	20.44^{abc}	49.20^a	79.00^b
T_4=SWF_8	21.29^{ab}	51.90^a	80.35^b
T_5=SW_2	18.05^{cd}	40.77^b	67.87^d
T_6=SW_4	16.47^{de}	37.88^b	63.92^e
T_7=SW_6	13.23^f	40.80^b	61.52^e
T_8=SW_8	14.61^{ef}	39.91^b	60.67^e
T_9=SWF_{-END}	22.93^a	54.65^a	86.77^a
T_{10}=SW_{-END}	12.33^f	38.51^b	61.30^e
SE±	0.83	2.11	1.12

Means with the same letter(s) in a column are not significantly different according to Duncan Multiple Range Test (DMRT) at 5% level of probability. WAS: Week after sowing

T_1= (SWF_2) = soybean + weeding for 2 weeks

T_2= (SWF_4) = soybean + weeding for 4 weeks

T_3= (SWF_6) = soybean + weeding for 6 weeks

T_4= (SWF_8) = soybean + weeding for 8 weeks

T_5= (SW_2) = soybean + weedy for weeks

T_6= (SW_4) = soybean + weedy for 4 weeks

T_7= (SW_6) = soybean + weedy for 6 weeks

T_8= (SW_8) = soybean + weedy for 8 weeks

T_9= ($SWF\text{- }_{END}$) = soybean + weed-free plot till end

T_{10}= ($SW\text{- }_{END}$) = soybean + no weeding till end

Weed interference on pod weight were significantly ($p< 0.05$) different (Table 3). Treatment with soybean + weed-free plot recorded (2.57kg) the highest pod weight followed by treatments with soybean + weed-free for 8 weeks and soybean + weed-free for 6 weeks (2.01kg and 1.80kg respectively) compared to the lowest pod weight recorded in soyabean + weed-infested plot (control), soyabean + weed-infested for 8 weeksand soybean + weed-infested for 6 weeks (0.29kg, 0.67kg and 0.98kg respectively).

Table 3: Effect of Weed Interference on Pod Weight.

Treatment	Pod Weight (kg/plot) Mean
T_1=SWF_2	1.41^{cd}
T_2=SWF_4	1.55^{cd}
T_3= SWF_6	1.80^{bc}
T_4=SWF_8	2.01^{b}
T_5=SW_2	1.42^{cd}
T_6=SW_4	1.20^{dc}
T_7=SW_6	0.98^{ef}
T_8=SW_8	0.67^{f}
T_9=SWF_{-END}	2.57^{a}
T_{10}=SW_{-END}	0.29^{g}
SE ±	0.12

Means with the same letter(s) in a column are not significantly different according to Duncan Multiple Range Test (DMRT) a 5% level of probability. WAS: Week after sowing.

T_1= (SWF_2) = soybean + weeding for 2 weeks

T_2= (SWF_4) = soybean + weeding for 4 weeks

T_3= (SWF_6) = soybean + weeding for 6 weeks

T_4= (SWF_8) = soybean + weeding for 8 weeks

T_5= (SW_2) = soybean + weedy for weeks

T_6= (SW_4) = soybean + weedy for 4 weeks

T_7= (SW_6) = soybean + weedy for 6 weeks

T_8= (SW_8) = soybean + weedy for 8 weeks

T_9= ($SWF\text{- }_{END}$) = soybean + weed-free plot till end

T_{10}= ($SW\text{- }_{END}$) = soybean + no weeding till end

100 grain weight were significantly ($p< 0.05$) different with treatments with soybean + weed-free plot recorded (0.03kg) the highest 100 grain weight (Table 4) followed by soybean + weed-free for 8weeks (0.02kg) compared to the lowest 100grain weight seen in other treatments (Table 4.) Weed interference on grain yield also showed similar trend with 100 grain weight. Treatment with soybean + weed-free plot significantly $p<0.05$ recorded (2.11kg) the highest grain yield compared to the lowest (0.18kg) seen in soyabean + weed-infested plot (control) (Table 4).

Table 4: Effect of Weed Interference on 100g Grain Weight and Grain Yield (Kg/Plot).

Treatments	100 Grain Weight (kg/plot)	Grain Yield (kg/plot)
T_1=SWF_2	0.01^{abc}	1.12^{cd}
T_2=SWF_4	0.01^{cd}	1.26^{cd}
T_3= SWF_6	0.01^{abc}	1.49^{bc}
T_4=SWF_8	0.02^{ab}	1.73^{b}
T_5=SW_2	0.01^{bc}	1.08^{de}
T_6=SW_4	0.01^{cde}	0.88^{ef}
T_7=SW_6	0.01^{de}	0.67^{fg}
T_8=SW_8	0.01^{cde}	0.37^{gh}
T_9=SWF_{-END}	0.03^{a}	2.11^{a}
T_{10}=SW_{-END}	0.01^{e}	0.18^{h}
SE ±	0.00	0.10

Means with the same letter(s) in a column are not significantly different according to Duncan Multiple Range Test (DMRT) at 5% level of probability. WAS: Week after sowing

T_1= (SWF_2) = soybean + weeding for 2 weeks

T_2= (SWF_4) = soybean + weeding for 4 weeks

T_3= (SWF_6) = soybean + weeding for 6 weeks

T_4= (SWF_8) = soybean + weeding for 8 weeks

T_5= (SW_2) = soybean + weedy for weeks

T_6= (SW_4) = soybean + weedy for 4 weeks

T_7= (SW_6) = soybean + weedy for 6 weeks

T_8= (SW_8) = soybean + weedy for 8 weeks

T_9= ($SWF\text{- }_{END}$) = soybean + weed-free plot till end

T_{10}= ($SW\text{- }_{END}$) = soybean + no weeding till end

4. Discussion

In this study, the effectiveness of treatments with soybean + weed-free plot, soybean + weed-free for 8 weeks, soybean + weed-free for 6 weeks, soybean + weed-free for 4 weeks were seen on weed and plant growth of soyabean. These treatments reduced weed presence and population which in turn reduces the detrimental effect of weed on the growth of soyabean at that peculiar time. This concept is in concordance with the work of who reported that controlling weed within a specified time frame reduces the emergence of weed and weed cover score (Seem et al., 2003). The lowest weed dry observed in treatments could be as a result of the effectiveness of the treatments to lower the presence and population of weed on the plots hence the lower dry weight.

This is in accordance that controlling the presence of weed, reduces their presence on the field (Buhler and Hartzler, 2004). The higher plant height observed in these treatments could be as a result of the ability of the treatment to reduce the presence of weed on the field, thereby reducing weed-crop competition on the plant which translated into taller plant heights. This is in accordance with IITA that properly timed weed control schedule could minimize the detrimental effects weed has on the growth and performance of a crop (IITA, 2005). The higher pod weight per plot observed on these treatments with soybean could be as a result of better height, higher number of pod and better pod length hence higher pod weight. This is in accordance with that the critical period of weed control (CPWC) is that period in the crop growth cycle during which weeds must be controlled to prevent yield losses (Eric, 2005; Knezevic et al., 2002).

These treatments good performance as higher 100 grain weight observed could be due to the ability of the treatment to lower the competition between the plant and weed which translated into better growth and yield. This is in accordance with that reducing the competition with weed in soybean reduces the adverse effect that will occur if weed is not controlled (Vollmann et al., 2010). The higher grain yield observed could be as a result of earlier good performance in weed cover score, taller plant heights, which all contributed in attaining a better yield. This is in accordance with that longer competition between crops and weed could lead to lower yield but a timely and properly carried out weed management will increase the crop yield (Seem et al., 2003). Decreasing the period of weed interference on crop growth will result in a higher crop yield compared to when the period of weed interference on crop growth is longer thereby leading to loss in crop yield. Jannink reported that weed interference is the main factor that causes soybean grain yield reduction, this is because at an early stage of growth, soybean is a poor competitor with fast growing weeds and if not controlled they (i.e. weeds) may outgrow the crop (Jannink, 2000; Sodangi et al., 2007).

5. Conclusion

This investigation revealed that treatments with soybean + weed-free plot, soybean + weed-free for 8 weeks, soybean + weed-free for 6 weeks, soybean + weed-free for 4 weeks had effect on critical period of weed interference, therefore it could be concluded that these treatments could be an effective weed management strategy in controlling weed in soybean. Further studies are suggested to clarify the best among these treatments

Recommendation

The use of early maturing variety of soybean in addition to weed-free plot throughout the growth stage and weed-free for 8 weeks could be recommended in controlling the critical period of weed interference in soybean for better soybean growth and yield.

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