EFFECTS OF WEED CONTROL METHOD ON GROWTH AND YIELD OF SOYBEAN (*Glycine max* (L.) Merrill) IN MINNA, NIGER STATE.

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ABSTRACT
Field experiment was carried out at the teaching and research farm of the Federal University of Technology, GidanKwano,Minna, Niger state during the 2021 cropping season. The field experiment was conducted to evaluate the effect of weed control methods on growth and yield of soybean. The experiment was laid out in a Randomized Complete Block Design (RCBD) consisting of Ten (10) treatments and replicated three (3) times. The treatments were Soybean, Hoe weeding at 3 weeks(W3), Hoe weeding at 3 and 6th week (W3,6), Hoe weeding at 3,6 and 9th week (W3,6,9), No weeding (W0), Pre-emergence Herbicides at rate 1.5kg a.i/ha(H1.5), Pre-emergence Herbicides at rate 2.0kg a.i/ha(H2.0), Pre-emergence Herbicides at rate 1.5kg a.i/ha + Hoe weeding at 6 weeks (H1.5+W6), Pre-emergence Herbicides at rate 1.5kg a.i/ha + Hoe weeding at 6 and 9weeks (H1.5+W6,9), Pre-emergence Herbicides at rate 2.0kg a.i/ha + Hoe weeding at 6 weeks (H2.0+W6), Pre-emergence Herbicides at rate 2.0kg a.i/ha + Hoe weeding at 6 and 9weeks (H2.0+W6,9).Data collected were weed cover score, weed dry weight (Kg), plant height (cm), Days to 50 % flowering, number of pods per treatments, and grain yield (Kg/plot). Results obtained from this experiment shows that treatment withpendimethalinPre-emergence Herbicides at rate 2.0kg a.i/ha + Hoe weeding at 6 and 9weeks (H2.0+W6,9) gives ($p<0.05$) the lowest weed cover score and weed dry weight, taller plants heights, higher number of pods which translated into higher grain yield for the treatment. The use of Pre-emergence Herbicides at rate 2.0kg a.i/ha + Hoe weeding at 6 and 9weeks (H2.0+W6,9) could be recommended for better growth and yield of soybean.

Key words: Soybean, Hoeweeding, Herbicide, Weed control

INTRODUCTION

Soybean (*Glycine max* L.) is an important economic legume crop throughout the world. It is one of the most popular crops cultivated by smallholder farmers in sub-Sahara Africa (SSA) because of its multiple uses, such as a cheap source of protein and oil for human diet, feed for livestock and aquaculture, and biofuel for industry (Joubert and Jooste, 2013).Soybean provides 43.3% protein and 19.5% oil, which makes it a "miracle bean". Soybean is indigenous to China and was introduced to India in the 1950s (Appunu*et.al*, 2007). Soybean is a high nutritional value legume,

and its beans contain up to 30 % of proteins. They provide all the essential amino acids except methionine. Soybean is also used as a protein supplement for animal feed (Clive, 2010).There is increasing demand for food that needs to be sustainably produced. Among different options to fulfill this huge demand for food, soybean plays an important role as one of the major crops worldwide, accounting for more than half of the global demand for oil and vegetable protein (Oerke andDehne, 2004, Faostat, 2019).The presence of weeds in soybean crops can cause competition between the plant and the weeds. Not only for the nutrient, but they also compete with the crop for sunlight and water, resulting in abnormal growth of crops which contributed to a failure to reveal their potential. Allelopathy in weeds are also thought to be one obstacle for crops by delaying or preventing seed germination and reducing seedling growth (Appunu*et.al*, 2007), (Clive, 2010). Among the factors responsible for poor yields of soybean in Nigeria and other soybean-producing countries in SSA, weed infestation is the most deleterious one, causing an average yield reduction of 37%, whereas other pests and diseases account for 22% yield reduction (Oerke and Dehne, 2004). In Nigeria, between 77% and 90% reduction in potential soybean yield, attributable to weed infestation, was reported from different zones (Imoloame, 2014). Weed control in soybean in the humid tropics is, however, always a challenge. Soybean is a weak competitor against fast-growing weeds, and infestation of soybean field by weeds, such as *Imperatacylindrica, Rottboelliacochinchinensis, Cynodondactylon, Tridaxprocumbens, Euphorbia heterophylla,* and many others could lead to total yield loss if not properly controlled (Imoloame, 2014; Daramola, et al. 2018). . Weeding with hand hoes is the predominant management technique used by farmers in Nigeria. However, this method is tedious, inefficient and extremely expensive (Adigun and Lagoke, 2003; Imoloame, 2014). Besides the high cost, availability of labor for weeding is uncertain, especially during critical periods of weed control, resulting in delayed weeding, or weeding after the crops have suffered irreversible damage from weeds (Adigun, 2005; Chikoye,*et al.* 2007). Herbicide use, on the other hand, is expensive and does not provide season-long weed control (Adigun *et al*., 2020). In addition, smallholder farmers lack the technical know-how for correct herbicide application. Although the use of herbicides for weed control is effective and efficient, phytotoxicity and environmental problems that might be induced when herbicides are wrongly applied have made the use of post-emergence herbicides less desirable for smallholder farmers in SSA (Labrada, 2003)

MATERIALS AND METHODS

Field experiment was conducted in 2021 cropping season at the Teaching and Research Farm of the Federal University of Technology, Minna (latitude 90371 N and longitude 60331 E), which is located in Nigeria's Southern Guinea Savanna ecological zone.Minna is climate is sub-humid tropical, with a long-term mean rainfall of around 1284mm and a mono-modal rainfall pattern. The area has a distinct dry season that lasts roughly 5 months, from November to March. The average maximum temperature remains high throughout the year at around 32^{o}C (fluctuates from 35^{o}C to 37^{o}C, notably between March and June), while relative humidity ranges between 40% and 80%. The soils of Minnaare generally Alfisols.

The experiment was laid out in a Randomized Complete Block Design (RCBD) consisting of Ten (10) treatments and replicated three (3) times. The treatments were Soybean, Hoe weeding at 3 weeks(W3), Hoe weeding at 3 and 6th week (W3,6), Hoe weeding at 3,6 and 9th week (W3,6,9), No weeding (W0), Pre-emergence Herbicides at rate 1.5kg a.i/ha(H1.5), Pre-emergence Herbicides at rate 2.0kg a.i/ha(H2.0), Pre-emergence Herbicides at rate 1.5kg a.i/ha + Hoe weeding at 6 weeks (H1.5+W6), Pre-emergence Herbicides at rate 1.5kg a.i/ha + Hoe weeding at 6 and 9weeks (H1.5+W6,9), Pre-emergence Herbicides at rate 2.0kg a.i/ha + Hoe weeding at 6 weeks (H2.0+W6), Pre-emergence Herbicides at rate 2.0kg a.i/ha + Hoe weeding at 6 and 9weeks (H2.0+W6,9).Data collected were weed cover score, weed dry weight (Kg), plant height (cm), Days to 50 % flowering, number of pods per treatments, and grain yield (Kg/plot).The experimental site was manually cleared of the existing vegetation and ridges were made manually with hoe, seeds were directly sown at two seeds per hole at 25cm by 75cm intra and inter-row spacing respectively Seedlings were thinned down to two stands per hill at 4 weeks after sowing**.** Manual weeding was carried out based on the prescribed treatments of the experiment and fertilizer was applied at the rate of 20 kg N, 80 kg P2O5 and 40 kg K_2O at 3 WAS. Data were collected on weed cover score, weed dry weight, plants heights, number of pods and grain yield.The weed cover score was taken from each plot on visual rating of 1-6, where, 1= Clean plot, 2= Moderately clean plot, 3= Fairly clean plot, 4= Moderately weedy plot, 5= Fairly weedy plot and 6=Weedy plot. The weed dry weight was determined by taking fresh weed samples from each net plot prior to each weeding at 3, 6, and 9 WAS, oven drying until a consistent weight was obtained, and then weighing them to determine the dry matter content.The plant height was measured using a tape rule from the soil level to the tip of the flag leaf at 3, 6, and 9 WAS.Numbers of pod per treatment were manually counted.The grain yield from each plot according to the treatments was taken after threshing and winnowing and weighed using a weighing balance.Data collected were subjected to analysis of variance (ANOVA) using Statistical Analysis System (SAS, 2016) to test significance of treatments effects. The means were compared using Duncan's Multiple Range Test at 5% probability level.

RESULT AND DISCUSSION

Effect of weed control method on weed cover score and weed dry weight.

The effect of weed control method on weed cover score were significantly ($p<0.05$) different throughout the sampling period (Table 1). All the treatments recorded lowest weed cover score compared to the highest score observed in treatment T_4= No weeding (control) at 3weeks after sowing (WAS). Similar observation was seen at 6 WAS, where treatments T_3= Hoe weeding at 3, 6 and 9 WAS, T_8= Pre-emergence Herbicides at rate 1.5kg a.i/ha + Hoe weeding at 6 and 9WAS andT_{10}= Pre-emergence Herbicides at rate 2.0kg a.i/ha + Hoe weeding at 6 and 9WAS recorded lowest weed cover score. Compared to other treatments at 9 WAS(Table 1).Weed dry weight showed same trend with weed cover score. The lowest weed cover score and weed dry

weight observed could be as a result of no weeding. Therefore, weedy check plots allowed weeds to grow to maturity thus, which result in higher dry weight. This result supports findings of Peer *et al* (2013) findings that herbicides were effective at higher rates when applied alone, but were more effective when combined with one hoe weeding, and that the initial achievement of limiting weed growth by the herbicides is maintained because hand weeding eliminates the fresh flush of weeds that may regenerate due to herbicide persistence loss.The combined weed control approach provided early canopy closure, which further reduced late sprouting weeds.

Table 1: Effect of weed control method on weed cover score and weed dry weight.

	Weed Cover Score			Weed Dry Weight		
	3WAS	6 WAS	9WAS	3 WAS	6WAS	9WAS
T_1=W_3	1.00^{b}	3.00^{b}	4.67^{b}	0.02^{b}	0.04^{ab}	0.05^{bc}
T_2=$W_{3,6}$	1.00^{b}	1.00^{d}	2.33^{de}	0.02^{b}	0.02^{de}	0.04^{ed}
T_3= $W_{3,6,9}$	1.00^{b}	1.00^{d}	1.00^{e}	0.02^{b}	0.02^{efg}	0.01^{g}
T_4=W_0	3.00^{a}	4.00^{a}	6.00^{a}	0.05^{a}	0.06^{a}	0.07^{a}
T_5=$H_{1.5}$	1.00^{b}	3.00^{b}	4.33^{bc}	0.02^{b}	0.04^{ab}	0.05^{ab}
T_6=$H_{2.0}$	1.00^{b}	2.00^{c}	4.00^{bc}	0.02^{b}	0.03^{cd}	0.05^{ab}
T_7=$H_{1.5}$+W_6	1.00^{b}	1.00^{d}	2.00^{de}	0.01^{b}	0.01^{gh}	0.02^{ef}
T_8=$H_{1.5}$+$W_{6,9}$	1.00^{b}	1.00^{d}	1.00^{e}	0.02^{b}	0.01^{h}	0.01^{g}
T_9=$H_{2.0}$+W_6	1.00^{b}	1.00^{d}	2.00^{de}	0.02^{b}	0.02^{ef}	0.03^{def}
T_{10}=$H_{2.0}$+$W_{6,9}$	1.00^{b}	1.00^{d}	1.00^{e}	0.01^{b}	0.01^{h}	0.01^{g}
SE ±	0.12	0.18	0.22	0.02^{b}	0.02	0.03

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

NOTE: WAS: Week after sowing, PRE;: Pre-emergence

T_1= Hoe weeding at 3 weeks(W_3)

T_2= Hoe weeding at 3 and 6th week ($W_{3,6}$)

T_3= Hoe weeding at 3,6 and 9th week ($W_{3,6,9}$)

T_4= No weeding (W_0)
T_5= Pre-emergence Herbicides at rate 1.5kg a.i/ha ($H_{1.5}$)
T_6= Pre-emergence Herbicides at rate 2.0kg a.i/ha ($H_{2.0}$)
T_7= Pre-emergence Herbicides at rate 1.5kg a.i/ha + Hoe weeding at 6 weeks ($H_{1.5}$+W_6)
T_8= 'Pre-emergence Herbicides at rate 1.5kg a.i/ha + Hoe weeding at 6 and 9weeks ($H_{1.5}$+$W_{6,9}$)
T_9= Pre-emergence Herbicides at rate 2.0kg a.i/ha + Hoe weeding at 6 weeks ($H_{2.0}$+W_6)
T_{10}= Pre-emergence Herbicides at rate 2.0kg a.i/ha + Hoe weeding at 6 and 9weeks ($H_{2.0}$+$W_{6,9}$).

Effect of weed control methods on plant height.

Plant height were significantly ($p< 0.05$) different throughout the sampling periods (Table 2). Treatments.T_7= Pre-emergence Herbicides at rate 1.5kg a.i/ha + Hoe weeding at 6 weeks, T_8= Pre-emergence Herbicides at rate 1.5kg a.i/ha + Hoe weeding at 6 and 9weeks, T_9= Pre-emergence Herbicides at rate 2.0kg a.i/ha + Hoe weeding at 6 weeks andT_{10}= Pre-emergence Herbicides at rate 2.0kg a.i/ha + Hoe weeding at 6 and 9weeks statistically recorded higher plant height compared to the lower seen in T_4= No weeding (control) and other treatments. This is because weeds at these treatments could not well established and were not aggressive enough in their competitive ability to cause any adverse effect on crop growth and productivity, and could not cause serious depression on growth and yield of the crop. According to IITA (2005), a well-planned weed management strategy can reduce the negative effects weeds have on crop development and performance treatments (Table 2).

Means with the same letter(s) in a column are not significantly different according to

Table 2: Effect of weed control method on plant height (cm).

Treatment	Plant Height (cm) 3 WAS	6WAS	9 WAS
T1=W3	19.70^{ab}	28.63^{ab}	34.60^{ab}
T2=W3,6	19.80^{ab}	27.50^{ab}	33.70^{ab}
T3= W3,6,9	19.95^{ab}	28.40^{ab}	34.60^{ab}
T4=W0	19.10^{b}	21.00^{b}	27.20^{b}
T5=H1.5	20.50^{ab}	27.10^{ab}	33.30^{ab}
T6=H2.0	20.65^{ab}	28.33^{ab}	34.56^{ab}
T7=H1.5+W6	22.50^{a}	30.70^{a}	38.00^{a}
T8=H1.5+W6,9	22.65^{a}	31.20^{a}	39.20^{a}
T9=H2.0+W6	25.72^{a}	33.00^{a}	40.50^{a}
T10=H2.0+W6,9	26.00^{a}	34.65^{a}	41.00^{a}
SE±	0.15	0.29	0.58

Duncan Multiple Range Test (DMRT) at 5% probability level.

WAS: Week after sowing
T1= Hoe weeding at 3 weeks(W3)
T2= Hoe weeding at 3 and 6th week (W3,6)
T3= Hoe weeding at 3,6 and 9th week (W3,6,9)
T4= No weeding (W0)
T5= Pre-emergence Herbicides at rate 1.5kg a.i/ha (H1.5)
T6= Pre-emergence Herbicides at rate 2.0kg a.i/ha (H2.0)
T7= Pre-emergence Herbicides at rate 1.5kg a.i/ha + Hoe weeding at 6 weeks (H1.5+W6)
T8= Pre-emergence Herbicides at rate 1.5kg a.i/ha + Hoe weeding at 6 and 9weeks (H1.5+W6,9)
T9= Pre-emergence Herbicides at rate 2.0kg a.i/ha + Hoe weeding at 6 weeks (H2.0+W6)
T10= Pre-emergence Herbicides at rate 2.0kg a.i/ha + Hoe weeding at 6 and 9weeks (H2.0+W6,9).

Effect of weed control methods on number of pod per plot and grain yield

The effect of weed control method on number of pod per plot were significantly ($p< 0.05$) different (Table 3). The result showed thattreatments T_8= Pre-emergence Herbicides at rate 1.5kg a.i/ha + Hoe weeding at 6 and 9weeks recorded the highest number of pods, but statistically similar with the result obtained fromT_{10}= Pre-emergence Herbicides at rate 2.0kg a.i/ha + Hoe weeding at 6 and 9weeksthough at par with the result obtained from T_7 and T_9.
T_4= No weeding (control) recorded the lowest number of pods.
(Table 3).
The increased number of pods per plot as observed on the treatments might be due to increase in the number of branches due to low weed interference and higher plant height, resulting in a larger number of pods. This is consistent with the findings of Eric R. Gallandt (2015), who reported that efficient weed control decreases weed density, increases crop early establishment and resource absorption, and reduces the competitive impacts of weeds on crops.
Grain yield were show variations among treatments such thatTreatments T_3= Hoe weeding at 3, 6 and 9th weeksignificantly recorded the highest grain yield, but statistically similar with the result obtained from T_7= Pre-emergence Herbicides at rate 1.5kg a.i/ha + Hoe weeding at 6 weeks, T_8= Pre-emergence Herbicides at rate 1.5kg a.i/ha + Hoe weeding at 6 and 9weeks, T_9= Pre-emergence Herbicides at rate 2.0kg a.i/ha + Hoe weeding at 6 weeks and T_{10}= Pre-emergence Herbicides at rate 2.0kg a.i/ha + Hoe weeding at 6 and 9weeks recorded highest grain yield compared to T_4= No weeding (control) (Table 3).This might be due to the treatment's capacity to reduce competition between the plant and the weed, which translated into improved growth and yield. According to Vollmann*et al*., (2010), decreasing weed competition in soybean lowers the unfavorable effect that will occur if weed is not controlled.

Table 3: Effect of weed control methods on number of pod and grain yield (kg/plot)

Treatments	Number of Pod/Plot	Grain yield (kg/plot)
T1=W3	297.00^{cd}	0.33^{cd}
T2=W3,6	356.33^{c}	0.50^{b}
T3= W3,6,9	400.00^{b}	0.56^{a}
T4=W0	162.33^{e}	0.18^{e}
T5=H1.5	243.00^{d}	0.31^{de}
T6=H2.0	286.00^{d}	0.32^{cd}
T7=H1.5+W6	420.00^{ab}	0.56^{a}
T8=H1.5+W6,9	445.00^{a}	0.60^{a}
T9=H2.0+W6	429.33^{ab}	0.58^{a}
T10=H2.0+W6,9	460.00^{a}	0.65^{a}
SE	14.50	0.02

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

WAS: Week after sowing
T1= Hoe weeding at 3 weeks(W3)
T2= Hoe weeding at 3 and 6th week (W3,6)
T3= Hoe weeding at 3,6 and 9th week (W3,6,9)
T4= No weeding (W0)
T5= Pre-emergence Herbicides at rate 1.5kg a.i/ha (H1.5)
T6= Pre-emergence Herbicides at rate 2.0kg a.i/ha (H2.0)
T7= Pre-emergence Herbicides at rate 1.5kg a.i/ha + Hoe weeding at 6 weeks (H1.5+W6)
T8= Pre-emergence Herbicides at rate 1.5kg a.i/ha + Hoe weeding at 6 and 9weeks (H1.5+W6,9)
T9= Pre-emergence Herbicides at rate 2.0kg a.i/ha + Hoe weeding at 6 weeks (H2.0+W6)
T10= Pre-emergence Herbicides at rate 2.0kg a.i/ha + Hoe weeding at 6 and 9weeks (H2.0+W6,9).

CONCLUSION

All the treatments used in this study play a greater role in weed control. Treatments with integrated application of pre-emergence pendimethalineherbicides at rate 2.0kg a.i/ha followed by 2-Hoe weeding during the 6 and 9th week of crop growth provides the best performance on soybean growth and yield. As a result, the treatment might be considered to be an effective weed management method for weed control in soybean.

RECOMMENDATION

The use of integrated methods of weed control using Pre-emergence herbicides combined with two hoe weeding could be recommended for better soybean growth and yield.

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