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EFFECT OF PLANT SPACING AND WEEDING FREQUENCY ON THE GROWTH AND YIELD OF SOYBEAN AT JALINGO, TARABA STATE

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Abstract
Soybean is very sensitive to early weed competition, weed infestation in soybean field may reduce yield by 40-45 percent depending on the intensity, nature and duration of weed competition. The study was undertaken to evaluate the effect of plant spacing and weeding frequency on the growth and yield of soybean under field condition at the Teaching and Research Farm of the Taraba state College of Agriculture, Jalingo (lat. 8°45" N and long. 11°25"E.),during the 2011 and 2012 wet seasons. The research was laid out in a Randomized Complete Block Design with three replicates. The plant spacing were (50×10cm, 50×15cm, 50×20cm, 75×10cm and 75×15cm) and the weeding frequency were 0 weeding (control), once, twice and thrice at 2 weeks interval. The results obtained revealed that all weeded plots (W_1, W_2,W_3) had significantly taller plant than unweeded plots in both years. Weeding twice (W_2) recorded the highest mean value of 25.05cm which was significantly taller than weeding once (W_1) with mean value of 22.28cm. W_2 and W_3 had significantly longer pods than W_0 in 2012. W_3 produced the highest number of leaves per plant, not different from W_2 in the both years. The highest number of pods per plant in S_1 was significantly more than what was obtained in S_5 with a mean of 12.70 and 12.17. The highest mean value of 4.09g for seed yield per plant was recorded by the closest plant spacing (S_1) which was higher than the widest spacing (S_5) with 3.99g. Planting at closer spacing, with twice weeding frequency would be an effective approach for higher yield of soybean in the area.

Key words: Soybean, Weeding frequencies, Plant spacing

Introduction

Soybean (*Glycine max*. L.) is a leguminous vegetable of the pea family that grows in tropical, subtropical, and temperate areas. It occupies an important position among the grain legumes due to its worldwide economic importance (Ayeni, 1994; Dugje *et al*., 2009). It is estimated that more than 216 million tons of soybean were produced worldwide, of which 1.5 million were from Africa in 2007 (Dugje *et al*., 2009). Soybean consists of more than 36% protein, 30% carbohydrates, and excellent amounts of dietary fiber, vitamins, and minerals (Dugje *et al*., 2009). The crop is use in milk production, oil processing, livestock feeds, medical, industrial and human consumption (Adedoyin *et al*., 1998). Soybean is important in the household nutrition due to its high protein content and affordability. It consists of 20% oil, which makes it the most important crop for producing edible oil (Matthews-Njoku, 2005; Dugje *et al*., 2009).

Ajobo and Akinyemi (2007) reported that consumption of soybean has been found to prevent various diseases such as cancer, diabetes and menopausal problems. Interest in soybean production in Africa has increased considerably over the past few decades. This could be attributed to a number of factors viz increased utilization of most commercially grown pulse as supplement in livestock feed (Uguru, 1996). Nigeria soybean outputs are about 480,000 MT in 2010/2011 and are produced on smallholder farms averaging not more than one hectare or 2.47 acres (GAIN, 2011). Taraba state soybean production has increased from 2.84 tonnes in 1999 to 63.05 tonnes in 2005, averaging 22.24 tonnes following Kaduna state 101.21 tonnes and Benue state with 166.82 tonnes (AMREC, 2007). Like most other crops, the total output of the soya crop is invariably influenced by the farmer's environment, the genetic potential of the planting material and the farmer's management capacity (AMREC, 2007). Uncontrolled weed growth has been observed to be responsible for 53-60% losses in legumes (FAO, 2006). Soybean is very sensitive to early weed competition, weed infestation in soybean

field may reduce yield by 40-45 percent depending on the intensity, nature and duration of weed competition (Chhidda *et al*., 2006).

The most critical period of weed competition in soybean is the early stage of growth, three to six weeks after sowing (Sodangi *et al*., 2007). A properly timed weed control program can minimize the effects of weeds on soybean (Dugje *et al*., 2009). Rezvani *et al*. (2012) stated that the influence of the number of weeding required to achieve minimum weed competition in soybean is still poorly understood. Hand weeding which consists of hand pulling, hand slashing and hoeing is the most popular method of weed control because it is a single process and farm sizes are small (Lavabre *et al*.,1991). Santos (2010) reported that proper spacing ensures adequate ventilation, reduces competition among plants for space and nutrients, and reduces transmission of diseases, facilitates weeding and movement in the farm and also reduces overcrowding and, therefore allow interception of radiation by plant canopies. Shamsi and Kobraee (2011) stated that among various agronomic factors limiting soybean yield, planting pattern is considered of great importance.

Yield is influenced by inter and intra plant competition and there are considerable scope for increasing the yield by adjusting plant population to an optimum level (Nwokwu, 2011). Information about this crop in terms of agronomic practices such as planting density, yield, pests and production levels is limited in the study area because it is produced at subsistence level by rural farmers. The present study attempts to evaluate the effect of varying intra row and inter row spacing and frequency of weeding on the growth and yield of soybean.

Materials and Method

The experiment was conducted at the Teaching and Research Farm of the Taraba State College of Agriculture, Jalingo (lat. 8°45" N and long. 11°25"E.), during the 2011 and 2012 wet season. Soil samples were collected using screw auger to 0-15cm depth. Organic carbon and available N, P and K were analyzed. The soil was well drained loamy soil with a pH of 5.6, annual rainfall of 1000-1500mm, with average elevation of 351m above sea level and average temperature of 35°C.

Table 1 shows the major weeds found at the experimental site before land preparation and those found during the various weeding periods.

Table 1: Major weeds found at the experiment site before ploughing and during weeding

Weeds species	Family	Life span
Cynodon dactylon L	*Poceae*	Annual
Andropogon gayanus	*Poceae*	Annual
Digitaria gayana	*Poceae*	Annual
Cenchrus biworus	*Poceae*	Annual
Cyperus esculentus	*Cyperaceae*	Perennial
Cyperus rotundus	*Cyperaceae*	Perennial
Amaranthus spinosis	*Amaranthaceae*	Perennial
Commelina diffusa L	*Commelinaceae*	Perennial
Tridax procumbens L	*Asteraceace*	Perennial
Euphorbia leterophylla	*Euphobiaceae*	Annual
Vernonia ambugua	*Asteraceae*	Perennial
Spermacoe verticillata	*Rubiaceae*	Annual

The research was laid out in a Randomized Complete Block Design with split plot arrangement with three replications, each plot measured 4m×4m. The plant spacing were (50×10cm, 50× 15cm, 50× 20cm, 75×10cm, 75×15cm) and the weeding frequency were no weeding (control), weeding at 2 weeks after planting (WAP), weeding at 2,4 WAP, and weeding at 2,4,6 WAP. Ten plant from each plot were randomly selected, tagged and used for data collection. The parameters measured were plant height, number of leaves per plant, days to emergence, days to flowering, days to podding, number of pods per plant, pod length, pod weight per plant, pod weight per plot and seed yield per plant. Data collected were subjected to analysis of variance (ANOVA) and Duncan Multiple Range Test (DMRT) was used for comparing means at P= 0.05.

Results and Discussion

The effect of plant spacing on days to emergence and plant height (Table 2) was not significant in both 2011 and 2012. Plant height of soybean was significantly influenced by weeding frequency. All weeded plots (W_1, W_2, and W_3) had significantly taller plant than unweeded plots in both years. Weeding twice (W_2) recorded the highest mean value of 25.05cm which was significantly taller than weeding once (W_1) with mean value of 22.28cm. Weeding increased plant height. This might be

due to less competition with weeds for light, nutrient and other growth factors, where weed competition was high in no weeded plots and thus plant height was reduced. This is in agreement with Baloch *et al.* (2002), Bedry (2007), El. Naim *et al.* (2011) and Mohammad *et al*. (2014). Misangu *et al.* (2007) stated that taller plants produce more pods emanating from more branching that in turn results to increased yield in Bambara groundnut.

Table 2: Effect of plant spacing and weeding frequency on Days to emergence and plant height of soybean

Treatment	2011		2012		Mean	
	Days to emergence	Plant height (cm)	Days to emergence	Plant height (cm)	Days to emergence	Plant height (cm)
Spacing						
S_1 (50×10cm)	3.97a	25.23a	4.00a	24.13a	3.99	24.68
S_2 (50× 15cm)	4.00a	24.87a	4.06a	25.70a	4.03	25.29
S_3 (50× 20cm)	4.23a	24.40a	4.06a	23.97a	4.15	24.19
S_4 (75×10cm)	3.87a	23.53a	4.57a	23.73a	4.22	23.63
S_5 (75×15cm)	4.03a	25.77a	3.67a	24.70a	3.85	25.24
SE ±	1.04	2.72	0.61	1.93		
Weeding frequency						
W_0 (0 Weeding)	3.67a	16.43c	4.00a	16.20b	3.84	16.32
W_1 (2 WAP)	3.67a	21.23b	4.00a	23.33a	3.84	22.28
W_2 (2,4 WAP)	3.67a	25.23a	4.33a	24.87a	4.00	25.05
W_3 (2,4,6 WAP)	3.67a	24.13ab	3.67a	25.70a	3.67	24.92
SE ±	1.67	2.88	2.15	2.99		
CV %	25.87	10.98	15.06	7.88		

Values followed by the same letter at each column are not significantly different at P = 0.05

Number of leaves per plant (Table 3) was not significantly different among the spacing for 2011 and 2012. The result in (Table 3) shows that significant difference exist on number of leaver per plant as a result of variation in weeding frequency. W_3 produced the highest number of leaves per plant, not different from W_2 in the both years (2011 and 2012). The least number of leaves per plant was recorded by W_0 in the experiments. This revealed that increasing weeding frequency increased the number of leaves per plant in soybean. Effect of plant spacing on days to flowering showed no significant influence among the treatments in both 2011 and 2012. However, Masum Akond *et al.* (2013) reported significant effect in days to flowering between soybean plants grown in closer and wider row space. Similarly, weeding frequency recorded no significant difference for days to flowering in both years.

Table 3: Effect of plant spacing and weeding frequency on number of leaves and days to flowering of soybean

Treatment	2011		2012		Mean	
	Number of leaves	Days to flowering	Number of leaves	Days to flowering	Number of leaves	Days to flowering
Spacing						
S_1 (50×10cm)	26.63a	42.87a	27.67a	41.27a	27.15	42.07
S_2 (50× 15cm)	27.17a	42.80a	28.00a	42.13a	27.59	42.47
S_3 (50× 20cm)	28.77a	42.20a	27.53a	41.57a	28.15	41.89
S_4 (75×10cm)	26.30a	44.27a	28.10a	41.86a	27.20	43.07
S_5 (75×15cm)	27.70a	43.40a	31.43a	40.50a	29.57	41.95
SE ±	1.43	1.92	3.77	1.46		
Weeding frequency						
W_0 (0 Weeding)	21.33b	42.00a	20.00b	41.50a	20.67	41.75
W_1 (2 WAP)	24.00ab	42.03a	24.67a	41.36a	24.34	41.70
W_2 (2,4 WAP)	26.67a	41.86a	27.00a	41.23a	26.84	41.55
W_3 (2,4,6 WAP)	27.33a	40.80a	27.67a	41.00a	27.50	40.90
SE ±	3.64	1.55	3.00	1.08		
CV %	5.24	3.73	13.21	2.64		

Values followed by the same letter at each column are not significantly different at P = 0.05

Days to podding was not significantly affected by plant spacing (Table 4). The weeding frequency (Table 4) had no significant effect on days to podding for both years.

Table 4: Effect of plant spacing and weeding frequency on Days to podding and pod length of soybean

Treatment	2011		2012		Mean	
	Days to podding	Pod lengt (cm)	Days to podding	Pod length (cm)	Days to podding	Pod length (cm)
Spacing						
S_1 (50×10cm)	74.67a	6.60a	72.77a	6.90a	73.72	6.75
S_2 (50× 15cm)	73.07a	6.27a	73.50a	6.83a	73.29	6.55
S_3 (50× 20cm)	75.07a	6.47a	72.47a	6.67a	73.77	6.57
S_4 (75×10cm)	74.00a	6.23a	73.63a	5.83a	73.82	6.03
S_5 (75×15cm)	76.10a	5.10a	73.03a	5.93a	74.57	5.52
SE ±	2.84	1.13	1.49	1.07		
Weeding frequency						
W_0 (0 Weeding)	70.67a	5.20bc	74.33a	4.67b	72.50	4.94
W_1 (2 WAP)	73.33a	6.60ab	72.33a	6.27ab	72.83	6.44
W_2 (2,4 WAP)	73.33a	3.90c	71.00a	6.83a	72.17	5.37
W_3 (2,4,6 WAP)	72.00a	6.67a	71.33a	7.07a	71.67	6.87
SE ±	4.17	1.44	3.53	1.92		
CV %	3.81	18.58	2.03	16.64		

Values followed by the same letter at each column are not significantly different at P = 0.05

Pod length in 2011 and 2012 (Table 4) showed no significant difference between the plant spacing. This finding confirmed previous studies by Aslam *et al.* (1993) and Gricher (2007) where they reported that pod length did not show any measurable effect between various plant spacing. Weeding frequency had significant influenced on pod length, weeding thrice (W_3) produced significantly longer pods than weeding twice (W_1) and no weeding (W_0) in 2011, also W_2 and W_3 had significantly longer pods than W_0 in 2012.

The effect of spacing on number of pods per plant was significant among the treatments. The highest number of pods per plant (Table 5) in S_1 was significantly more than what was obtained in S_5 in both 2011 and 2012 with a mean of 12.70(S_1) and 12.17(S_5).

Table 5: Effect of plant spacing and weeding frequency on number of pod per plant and pod weight per plant of soybean

Treatment	2011		2012		Mean	
	Number of pod per plant	Pod weight per plant (g)	Number of pod per plant	Pod weight per plant (g)	Number of pod per plant	Pod weight per plant (g)
Spacing						
S_1 (50×10cm)	11.70a	3.03ab	13.70ab	4.90a	12.70	3.97
S_2 (50× 15cm)	10..97ab	3.83a	13.16b	4.30a	12.07	4.07
S_3 (50× 20cm)	9.83ab	3.50a	14.23ab	4.43a	12.03	3.97
S_4 (75×10cm)	10.30ab	2.60b	13.70ab	4.09a	12.00	3.35
S_5 (75×15cm)	9.60b	2.40b	14.73a	4.63a	12.17	3.52
SE ±	1.00	0.43	0.69	0.67		
Weeding frequency						
W_0 (0 Weeding)	3.33b	2.80c	6.00c	3.03c	4.67	2.92
W_1 (2 WAP)	10.67a	3.41abc	11.33b	3.73b	11.00	3.57
W_2 (2,4 WAP)	12.67a	3.68a	13.33a	4.40a	13.00	4.04
W_3 (2,4,6 WAP)	12.33a	3.50ab	13.67a	4.00ab	13.00	3.75
SE ±	2.76	0.41	1.55	0.39		
CV %	9.56	10.84	4.99	8.61		

Values followed by the same letter at each column are not significantly different at P = 0.05

Increasing plant density increased significantly the number of pods per plant. The current finding is consistent with Mohammed *et al*. (1984), Boquet (1990), Abbas *et al.* (1994) and Shamsi and Kobraee (2011). Where they reported that number of pods per plant declined with decreasing plant density. They concluded that number of pods per plant increased with corresponding increase in plant density.

Similarly, number of pods per plant (Table 5) was significantly influenced by weed frequency. Weeding twice (W_2) and thrice (W_3) recorded significantly higher number of pods per plant than the other treatments as observed in 2011 and 2012 with mean of 13.00 each. The higher number of pods per plant obtained in 2012 than 2011(Table 5) may be most likely due to climatic effects.

For pod weight per plant (Table 5), plant spacing had significant effects among the treatments. In 2011, soybean in S_2 and S_3 plots were significantly heavier than S_4 and S_5 plots. In 2012, no significant differences in pod weight as influenced by spacing. High weeded plots (W_2,W_3) recorded significantly heavier pod when compared to W_0 in 2011 and 2012. In 2012, high weeding frequencies (W_2, W_3) significantly increased pod weight than one weeding (W_1) and no weeding (W_0). This finding revealed that increasing number of hoeing can increased pod weight per plant. Pod weight per plot of soybean (Table 6) was not influenced by plant spacing in both years.

Table 6: Effect of plant spacing and weeding frequency on pod weight per plot and seed yield per plant of soybean

Treatment	2011		2012		Mean	
	Pod weight per plot (kg)	Seed yield per plant (g)	Pod weight per plot (kg)	Seed yield Per plant (g)	Pod weight per plot (kg)	Seed weight per plant (g)
Spacing						
S_1 (50×10cm)	5.00a	3.87ab	7.57a	4.30a	6.29	4.09
S_2 (50× 15cm)	3.700a	3.33c	7.03a	3.30c	5.37	3.32
S_3 (50× 20cm)	3.43a	3.53bc	5.83a	3.70b	4.63	3.62
S_4 (75×10cm)	3.87a	3.57bc	6.00a	3.90b	4.94	3.74
S_5 (75×15cm)	4.33a	4.20a	7.10a	3.77b	5.72	3.99
SE ±	1.12	053	2.48	0.37		
Weeding frequency						
W_0 (0 Weeding)	0.77c	1.00bc	0.83c	1.63b	0.80	1.32
W_1 (2 WAP)	2.07bc	2.37b	2.30bc	2.47ab	2.19	2.42
W_2 (2,4 WAP)	5.00ab	3.87ab	3.70b	3.33a	4.35	3.60
W_3 (2,4,6 WAP)	7.56a	4.30a	7.03a	3.30a	7.30	3.80
SE ±	3.93	1.47	2.46	1.32		
CV %	27.70	15.93	37.02	11.15		

Values followed by the same letter at each column are not significantly different at P = 0.05

The weeding frequency was significant for pod weight per plant (Table 6) in both years. The weed free (W_3) plots produced the heaviest weight in the both years with a mean of 7.30kg, while the least pod weight was observed in the non- weeded (W_0) plots with a mean of 0.80kg.

The results for seed yield per plant (Table 6) shows inconsistent results between 2011 and 2012. In 2011, the highest yield per plant recorded by widest spacing (S_5) was significantly higher than in all other except S_1. Similar results were obtained by Mohammed *et al.* (1984), Chauhan and Opera (2013). They reported that seed yield was highest at the widest spacing. The 2012 results showed that the closest spacing (S_1) produced the highest seed yield per plant which was significantly higher than the rest of the treatments. Previous works by De Bruin and Padersen (2008) and Masum Akond *et al.* (2013) documented that higher seed yield was produced from soybean planted in narrower than in wider spacing. However, the highest mean value of 4.09g for seed yield per plant was recorded by the closest plant spacing (S_1) which was higher than the widest spacing (S_5) with 3.99g.

Seed yield was influenced by weeding frequency in both years. Plot weeded thrice (W_3) produced the highest seed yield, in 2011 which was significantly higher than seed yield of W_0 and W_1. Treatment W_2 and W_3 had seed yield significantly higher than W_0 in 2012. Rezvani *et al*. (2012) confirmed that grain yield in soybean can be increased by increasing the number of hoeing.

Conclusion

There were significant differences on yield of soybean as influenced by plant spacing and weeding frequencies. Close plant spacing

and increasing weeding frequency increased various growth and yield attributes. It can however be concluded that for higher yield of soybean in the area, closer spacing of 50x10cm with weeding twice are recommended.

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