

Influence of Seeding Pattern on Weed Cover and Yield of Soybean [*Glycine max* (L.) Merr] in a Southern Guinea Savannah of Nigeria

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ABSTRACT

Understanding the best seeding pattern and distance is very important in reducing weed-crop competition. This study was conducted at the University of Ilorin Teaching & Research Farm Bolorunduro (008° 27' 23.9" N and 004° 39' 42.9" E) located in a southern Guinea savannah, Nigeria to determine the effect seeding patterns on weed infestation and performance of five soybean varieties. The trial was laid as a randomized complete block design with a split-plot arrangement and replicated 3 times. The treatment comprised of five varieties (TGX 1951-3F, TGX 1988-5F, TGX 1448-2E, TGX 1987-62F, TGX 1987-10F) as main plots while three sowing patterns (drilling, 2 rows per ridge and 1 row per ridge) as sub plots. Sowing was done on flat at a planting spacing of 75 cm x 20 cm for the rows patterns and 75 cm between rows for the drilling pattern. Data on soybean yield and yield components, weed biomass and weed cover score were collected at stipulated intervals and subjected to analysis of variance at $p \leq 0.05$. Gross margin was estimated to determine the profitability of the soybean production. Results showed that there was no significant difference across varieties for all parameters estimated except grain yield. TGX1951-3F had significantly higher yield (9.89 t/ha) than other varieties that yielded between 4.24 - 6.78 t/ha. The drilling sowing pattern suppressed 55.5 % of the weed spectrum while the row sowing pattern suppressed between 34.3 - 42.9 %. Single row sowing pattern yielded 7.18 t/ha which was 20.6 % and 8.22 % greater than double rows (5.70 t/ha) and drilled (6.59 t/ha). The single row sowing pattern had the highest profit (₦ 590,250.00), better benefit-cost ratio, 8.16 and the lowest production efficiency (12.26 %). Therefore, the study concludes that, sowing soybean at 75cm x 25cm using single row per ridge increase weed suppression ability of soybean, give significant yield and good economic returns in southern Guinea savannah of Nigeria.

Key words: Seeding Pattern, Weed Profitability

INTRODUCTION

Cultural practices like alternating planting distance and seeding rate could affect the ability of a crop to compete with weeds for nutrients and these may likely affect weed suppression ability and crop yield (Grichar et al., 2004). While increase in seeding rate of a crop might lead to high plant canopy closure (Nice et al., 2001) which will affect weed management. Therefore selection of varieties with traits that favour rapid canopy development should be encouraged (Bussan et al., 1997) for efficient weed control.

Soybean seeded at high populations may have a competitive advantage over weeds because of fast canopy development. De Bruin and Pedersen (2009) reported a complete weed suppression at very high crop populations, Nice

et al. (2001) opined that high soybean populations (676,000 plants/ha) with reduced plant spacing reduced weed density and growth while Tharp and Kells (2001) found that increasing maize population from 60,000 to 73,000 plants/ha reduced dominant weeds biomass and increased maize yield.

Understanding the best seeding pattern and distance is very important in minimizing weed competition. Dalley et al. (2004) reported an adjusted drill and row spacing has one of the important agronomic practices for increasing yield of a row crop and reducing the competition with weeds. In soybean production, narrow row spacing is known to minimize weed growth by closing crop canopy earlier than wider row spacing and narrow row spacing was found to increase light interception (Knezevic et al.,

2003).

The economic benefit of higher seeding rates to enhance weed suppression in soybean cultivation should be considered because increased cost of seeds may exceed the benefits in weed suppression (Nice et al., 2001). Therefore, this study was designed to determine the effect seeding patterns on weed infestation and performance of five soybean varieties in a southern Guinea savannah.

MATERIALS AND METHODS

Experiment was conducted at the University of Ilorin Teaching & Research Farm located at Bolorunduro (008° 27' 23.9" N and 004° 39' 42.9" E) in the southern Guinea savannah agro-ecology of Nigeria and is 307 m above sea level. The area is characterized by a bimodal rainfall pattern with peaks in June and September and a dry spell between mid-July and August. The average annual rainfall of the area is 1,250–1500 mm and a mean temperature range of 25–28.9°C.

The trial was laid as a randomized complete block design with a split-plot arrangement and replicated 3 times. The treatment comprised of five varieties (TGX 1951-3F, TGX 1988-5F, TGX 1448-2E, TGX 1987-62F, TGX1987-10F) as main plots while three planting patterns (drilling, 2 rows per ridge and 1 row per ridge) as sub plots. The field was ploughed and harrowed in July of both seasons and planting was done on flat at a planting spacing of 75 cm x 20 cm for the rows patterns and 75 cm between rows for the drilling pattern in a sub-plot of 54m².

A pre-emergence application of Pendimethalin at 2.5kg ai/ha was applied immediately after planting using a CP3 knapsacks sprayer filter with a polyjet nozzle with a delivery rate of 250L/ha and supplementary hand hoeing at 5 weeks after planting (WAP).

The following data were estimated using a net plot of 4m²: plant stand at 4WAP, 8WAP, and 12WAP; plant height at 2WAP, 4WAP, 6WAP and 8WAP; number of leaves and branches at 3WAP, 5WAP, 7WAP, and 9WAP; weed cover score (using a scale 0-10, 0 = perfect weed cover while 10 = no weed cover) at 4WAP, 6WAP, 8WAP, 10WAP, and 12WAP; and dry

weed biomass at 4WAP, 8WAP, and 12WAP.

Data collected during and after harvests were includes: pods per plot; seeds per pod; seeds per plant; weight of 500 seed per plot; and grain weight. All data collected were subjected to analysis of variance (ANOVA) using Genstat Statistical package at $p \leq 0.05$.

The data obtained on the cost of farm inputs and revenues from the output of soybean were analysed using addition, mean and percentages. Gross margin was used to determine the profitability of the soybean production. The assumption was that, the farmers are rural dwellers that inherited the farmland and depend only on hoes, cutlasses and hiring of tractor for tillage operations. Those farm tools had negligible depreciation and so were ignored in the computation of costs of production. Gross Margin was obtained by deducting total cost from total revenue. Efficiency of soybean enterprise was calculated by dividing total cost by total revenue and multiplying by 100. The benefit-cost ratio was obtained by dividing benefit by cost.

RESULTS AND DISCUSSION

Soybean Growth

The differences in plant stands of soybean across varieties was significant ($p \leq 0.05$) whereas drilling seeding pattern had significantly higher soybean stands per plot while 2 rows per ridge and single row plots had similar number of plant stand per plots (Table 1). The interactions between seeding pattern and soybean varieties were significant at all periods of assessment. At 12WAP, TGx1988-5F, TGx1951-3F and TGx1987-10F had significantly ($p \leq 0.05$) higher plant stands at drilled, 2 rows per ridge and single row plots, respectively (Fig.1). Across the seeding patterns, drilled seeded plots had the tallest plants in all sampling periods while the row seeded plots had similar plant height (Table 2). According to Chauhan and Opena (2013), soybeans grown at closed spacing have an ability to increase in height due to light competition while the plants will physiologically struggle for light in drilling pattern of planting because the position of adjacent plants allows competition due to the high population density leading to increase in height for survival. Number of leaves across

seeding pattern was not significant except at 5WAP (Table 3). The result revealed that, row sown soybean plants had more leaves (31-32 leaves) than drilled seeded plants with 28 leaves at 9WAP.

WEED COVER

Weed cover score at 10 and 12WAP showed that TGx1448-2E plots had relatively high weed cover score 58.2% and 71.5%, respectively, followed by TGx1987-62F and TGx1988-5F (Table 4). Conversely, seeding pattern significantly affected weed cover except at 4WAP. The drilled seeded plots had significantly lower weed cover score (44.5%) followed by 2 rows plots (57.1%) while single row plots (65.5%) had significantly higher weed cover score. TGx1951-3F plots had relatively low weed biomass (78.24 g/m²) while TGx1448-2F plots had high weed biomass, 166.28 g/m² (Table 5). The drilled seeded significantly suppressed weed biomass production, at all periods of assessment, the biomass obtained was 50% significantly lower compared single row seeded pattern. The row seeded patterns differed significantly from each other in weed biomass production except at 4 WAP where 52.72 g/m² and 54.41 g/m² were obtained at single row plant and double rows plots, respectively. The greatest influence that narrow row spacings have in soybeans is in the reduction in the amount of light that reaches the soil surface (Kurt et al., 2017) and in the reduction in the amount of time that it takes for soybean to reach full canopy closure (Gulluoglu et al., 2016). In this study, there could be less radiation at the soil surface in drilling and double row compared to single row patterns of sowing which accounted for about 50% reduction in weed biomass at all the periods of assessments in the drilling pattern of planting except at 4WAP. Dalley et al. (2004) reported greater light interception in narrow compared to wide-row sown soybean throughout most of the growing season.

Soybean Yields

Grain yield and 500 seeds weight differed significantly across varieties (Table 6). TGx1951-3F had high significant grain yield (9.84 t/ha) followed by (6.78 t/ha) obtained from TGx19888-5F while TGx1448-2E yielded the lowest grain yield of (4.24 t/ha). In similar

manner, significant grain yield was obtained from 1row per ridge plots which had 7.18 t/ha followed by drilled plots (6.59 t/ha) than 5.70 t/ha obtained from 2 rows plots. Interaction between varieties and planting pattern was significant (Table 7). TGx1951-3F either on single row or 2 rows per ridge plots gave significantly higher yield ranging between (10.47 – 12.39t/ha). The double rows sowing pattern had 20.61% higher grain yield than single row sowing pattern and 13.51% higher than drilling pattern while drilled pattern had 8.22 % higher yield than single row plots. Studies have shown that soybeans grown in double rows expressed increase yield of and higher than those grown in single rows, if all growth factors, especially soil and soil moisture, are not a limiting factor (Bruns, 2011a; 2011b) while Gulluoglu et al., (2016) reported that, soybean planted on double row planting pattern (63 plants /m²) gave higher yield than single rows (35 plants /m²). The results of Kurt et al., (2017) stated that double rows on peanuts can increase pod yields 15.79 - 17.86% compared to single rows. Also, the results of Mascagni et al., (2008) reported that planting soybeans with double rows planting patterns can increase seed yield by 12.6 and 13.1% compared to single row. Other results suggest that planting soybeans with double row planting patterns can increase soybean yield by 17% compared to single row (Grichar, 2007). Although, the results of research conducted by Rahman et al., (2011) showed that soybean yields increased with increasing crop density and highest yields were obtained in populations of 80-100 plants/m² depending on varieties and seasons which also goes in contrary to this present finding where single row planting pattern had the highest grain yield. The economic estimate (Table 8) based on the soybean sole cropping and the result indicates that, the total production cost is ? 81,150.00- ? 101,450.00. The profit per hectare ranged from ? 452,260.00 to ? 580,750.00 while the benefit-cost ratio was estimated at 5.46, 6.81 and 8.16 for drilling, double rows/ridge and single row/ridge sowing pattern of soybean, respectively which implies that for every Naira invested on soybean production generated revenue of ? 5.46- ? 8.16. The production efficiency shows that 12-

18% of all revenue generated from soybean went into cost of production depending on the seeded pattern adopted.

CONCLUSION

The drilling sowing pattern suppressed 55.5 % of the weed spectrum while the 2 rows per ridge sowing pattern 34.3 % and single row per ridge at 42.9 % of weeds suppressed. Variety TGx1951-3F had the highest grain yield (9.89 t/ha) than other varieties that yielded between 4.24 - 6.78 t/ha. Single row sowing pattern

yielded 7.18 t/ha which was 20.6 % and 8.22 % greater than double rows (5.70 t/ha) and drilled (6.59 t/ha). The single row sowing pattern had the highest profit (₦ 590,250.00), better benefit-cost ratio, 8.16 and the lowest production efficiency (12.26 %). Therefore, the study concludes that, sowing soybean at 75 cm x 25 cm using single row per ridge increase weed suppression ability of soybean, give significant yield and good economic returns in southern Guinea savannah of Nigeria

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Table 1: Effect of Planting pattern and varietal difference on stand count per plot (4m²) of soybean

Variety (Var.)	Stand Count (4m ²)		
	4WAP	8WAP	12WAP
TGx1951-3F	198	195	195
TGx1988-5F	250	238	231
TGx1448-2E	140	139	138
TGx1987-62F	213	213	211
TGx1987-10F	155	151	151
Sed	38.30	38.40	40.18
Planting Pattern (PP)			
Drilling	428	427	422
2rows per ridge	90	84	84
1row per ridge	56	50	50
Sed	27.03**	26.19**	27.40**
Interaction			
Var. × PP	*	*	*

WAP= weeks after planting

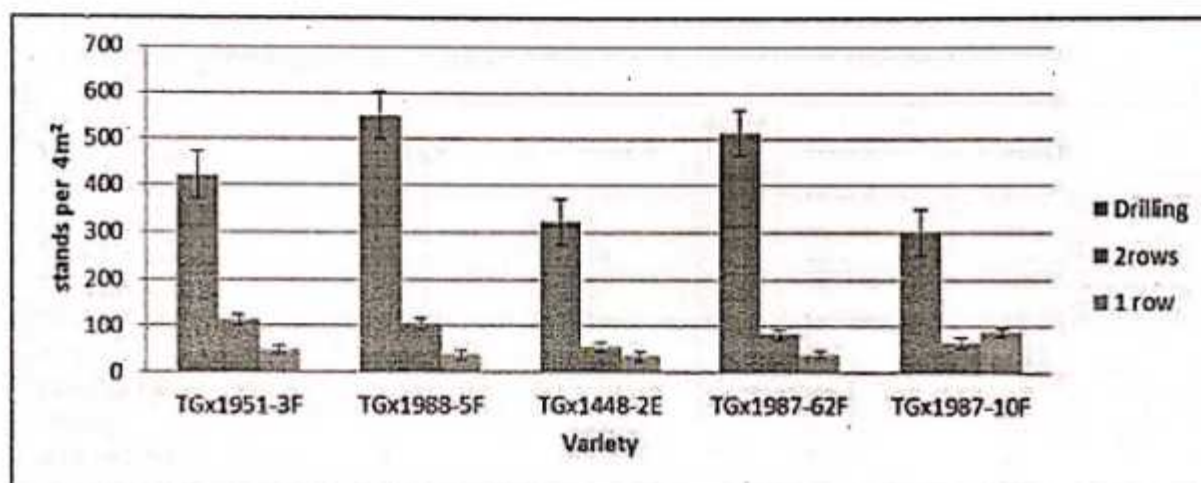


Figure 1: Interaction between planting pattern and soybean varieties on stand count of soybean at 12 weeks after planting

Table 2: Effect of Planting pattern and varietal difference on plant height soybean

Variety (Var.)	Plant Height (cm)			
	2WAP	4WAP	6WAP	8WAP
TGx1951-3F	10.61	16.19	26.11	35.58
TGx1988-5F	9.18	15.10	21.51	30.75
TGx1448-2E	9.28	12.62	17.85	26.12
TGx1987-62F	9.10	15.44	20.00	28.25
TGx1987-10F	8.75	14.51	18.39	25.82
Sed	0.33*	0.74**	0.93**	1.24**
Planting Pattern (PP)				
Drilling	10.34	17.47	22.26	32.60
2rows per ridge	9.06	13.69	20.61	28.87
1row per ridge	8.75	13.17	19.44	26.45
Sed	0.27*	0.48**	0.68**	1.05**
Interaction				
Var. × PP	NS	NS	NS	*

WAP= weeks after planting

Table 3: Effect of Planting pattern and varietal difference on number of leaves of soybean

Variety (Var.)	Number of Leaves/Plant			
	3WAP	5WAP	7WAP	9WAP
TGx1951-3F	7	15	20	36
TGx1988-5F	7	15	18	22
TGx1448-2E	6	14	17	31
TGx1987-62F	6	14	16	30
TGx1987-10F	6	13	16	32
Sed	0.44	0.66*	1.07*	3.67
Planting Pattern (PP)				
Drilling	7	13	17	28
2rows per ridge	6	15	17	31
1row per ridge	6	14	18	32
Sed	0.43	0.39*	0.84	2.11
Interaction				
Var. × PP	NS	*	*	NS

WAP= weeks after planting

Table 4: Effect of Planting pattern and varietal difference on weed cover on soybean field

Variety (Var.)	Weed Cover Score (%)			
	4WAP	8WAP	10WAP	12WAP
TGx1951-3F	15.0	26.3	42.8	46.6
TGx1988-5F	12.8	30.6	45.1	55.7
TGx1448-2E	14.6	34.3	58.2	71.5
TGx1987-62F	8.4	25.8	50.8	55.9
TGx1987-10F	8.9	22.3	40.4	48.7
Sed	4.28	8.79	7.31	7.60
Planting Pattern (PP)				
Drilling	7.5	18.3	36.7	44.5
2rows per ridge	12.1	27.6	48.3	57.1
1row per ridge	16.2	37.7	57.4	65.5
Sed	3.42	6.32*	5.81*	5.85*
Interaction				
Var. × PP	NS	NS	NS	NS

WAP= weeks after planting

Table 5: Effect of Planting pattern and varietal difference on fresh weed biomass on soybean field

Variety (Var.)	Weed Biomass (g/m ²)		
	4WAP	8WAP	12WAP
TGx1951-3F	33.08	64.28	78.24
TGx1988-5F	57.18	111.12	136.35
TGx1448-2E	44.03	87.03	166.28
TGx1987-62F	49.12	96.03	140.19
TGx1987-10F	36.01	84.04	156.27
Sed	18.58	32.94	40.13
Planting Pattern (PP)			
Drilling	25.32	51.16	98.65
2rows per ridge	54.41	98.27	143.27
1row per ridge	52.72	115.25	165.63
Sed	8.39	5.18*	9.32*
Interaction			
Var. × PP	NS	NS	NS

WAP=weeks after planting

Table 6: Effect of Planting pattern and varietal difference on yield and yield components of soybean

Variety (Var.)	Pods/plant	Seeds/plant	Seeds/pod	500seeds weight (g)	Grain yield (t/ha)
TGx1951-3F	23	61	3	48.00	9.84
TGx1988-5F	16	40	2	34.56	6.78
TGx1448-2E	23	62	3	48.67	4.24
TGx1987-62F	28	84	3	47.78	5.80
TGx1987-10F	21	52	3	44.00	5.79
Sed	3.25	9.86*	0.30	0.59**	1.08**
Planting Pattern (PP)					
Drilling	20	52	3	44.67	6.59
2rows per ridge	22	58	3	44.00	5.70
1row per ridge	26	70	3	45.13	7.18
Sed	4.01	11.73	0.15	0.68	0.80
Interaction					
Var. × PP	NS	NS	NS	NS	*

Table 7: Interaction between planting pattern and soybean varieties on grain yield of soybean

	Drilling	Planting Pattern 2rows per ridge	1row per ridge
TGx1951-3F	6.68	10.47	12.39
TGx1988-5F	6.05	6.24	8.04
TGx1448-2E	4.16	4.24	4.32
TGx1987-62F	6.93	5.61	4.87
TGx1987-10F	5.35	5.75	4.87
Sed		1.81	

Table 8: Economic analysis of cultivating soybean in southern Guinea savannah of Nigeria

Planting Patterns	Yield (kg/ha)	Price (₦/kg)	Production Costs per hectare					Output t	Profit			
			Seeds	Tillage	Inputs	Other	Total		₦	US\$	BCR	PE (%)
Drilling	5538	100	30,45	20,00	13,00	38,00	101,45	553,80	452,26	1,246.5	5.46	18.3
			0	0	0	0	0	0	0	5		2
2rows/ridge	6172	100	19,60	20,00	13,00	38,00	90,600	617,20	526,60	1,451.4	6.81	14.6
e			0	0	0	0		0	0	5		8
1row/ridge	6619	100	10,15	20,00	13,00	38,00	81,150	661,90	580,75	1,600.7	8.16	12.2
			0	0	0	0		0	0	0		6

US\$:₦ = 1: 362.81