IJART- Vol-4, Issue-4, August, 2019 Available online at http://www.ijart.info/
DOI: https://doi.org./10.24163/ijart/2017/4(4):135-145

INTERNATIONAL JOURNAL OF APPLIED RESEARCH AND TECHNOLOGY
ISSN 2519-5115
RESEARCH ARTICLE

Influence of Inter-Row Spacing on The Agronomic Performance of Four Soybean Varieties in Buea, Cameroon

[1]A.F. Lum
[2]R.M. Njilar
[3]E.M. Ndifon
[4]G.F. NJI
[5]N.A. Neba

[1] Department of Agronomic and Applied Molecular Sciences, University of Buea, Cameroon
[5]Institute of Agricultural Research for Development, Barombi Kang, Cameroon

Corresponding author:
A.F. Lum
lumfontem@yahoo.com

Received: May 12, 2019
Revised: August 01, 2019
Published: August 31, 2019

ABSTRACT

A field experiment was conducted in Buea, Cameroon, to determine the effect of inter-row spacing on the growth and yield of four soybean varieties. The inter-row spacings consisted of 50, 60 and 75 cm while the soybean varieties were: TGX 1835-10E, TGX 1987-62F, TGX 2010-11F and TGX 2010-12F. Results revealed that inter-row spacing significantly ($P<0.05$) influenced the performance of the soybean varieties. Three weeks after sowing (WAS), plants sown at an inter-row spacing of 50 cm were taller than those in wider rows. At 6 and 9 WAS, these plants produced more leaves with fewer branches than those in wider rows and at harvest, they had the highest grain yield (11.4 t ha^{-1}). Among the varieties, TGX 2010-12F had the tallest plants (98.4 cm), produced the highest number of leaves (47), number of pods (129) and grain yield (12.6 t ha^{-1}). In conclusion, the soybean varieties should be sown at an inter-row spacing of 50 cm for optimum grain yield production.

Keywords- : Agronomy, Glycine max, legumes, soybean performance

@IJART-2016, All Rights Reserved

DOI: https://doi.org./10.24163/ijart/2017/4(4):135-145

INTRODUCTION

Soybean (*Glycine max* (Linn.) Merril) is an important grain legume based on its production, consumption and economic importance. It is an annual plant that belongs to the family leguminosae and sub family Papilionoideae. The crop is widely distributed in most parts of the world and it has a lot of potentials (Adamu and Amatobi, 2001). It is grown in the cropping systems of most tropical countries and it requires the use of minimal agricultural inputs. It is used for soil fertility improvement and the reduction of *Striga* infestation on farmers' fields (Sanginga *et al*., 2001; Franke *et al*., 2004). In addition to the above, it has several other uses in Cameroon; it is cooked and eaten as a vegetable; it is processed into many food products such as milk, yogurt and flour; it is a good source of protein and household income; it is used in the poultry, pig and fish farming industries as a source of high quality protein feed. The oil is low in cholesterol and has a natural taste with an odour which is almost imperceptible therefore it is considered the ultimate choice of vegetable oil for domestic and industrial food processing (Mpepereki *et al*., 2000).

Some of the factors that affect the productivity of soybean are inadequate planting practices and inappropriate cultivars. Plant population is an important agronomic factor that limits the growth, development and production of crops (Muhammad *et al*., 2002; Rahman and Hossain, 2011). An increase in plant population density could lead to an increase in yield per unit area, within certain limits (Caliskan *et al*., 2007). Low plant population per unit area has been reported to cause poor yields in smallholder farming systems in sub-Saharan Africa (Gomez and Gomez, 1984). Proper spacing ensures adequate ventilation, reduces overcrowding competition among plants and transmission of diseases, facilitates weeding and movement in the farm (Adeniyan and Ayoola, 2007). The required population density for the crop to attain optimum yield is obtained through appropriate spacing and this may vary with the variety under cultivation and the location. For example, the optimum plant density reported for superior soybean yield was 45 plants m^{-2} in Kenya (Misiko *et al*., 2008) and 40 plants m^{-2} in Ethiopia (Worku and Astatkie, 2010).

The choice of variety is therefore a key factor in profitable soybean production. The performance of a variety could vary from one location to another depending on factors such as inter-row spacing, weather and management practices. The objective of this study was to determine the influence of inter-row spacing on the performance of four soybean varieties.

MATERIALS AND METHODS

Site description

A field trial was conducted on-farm in Buea during the 2017 planting season. Buea is in the humid forest agro-ecological zone with a monomodal rainfall distribution pattern. The mean annual temperature is 28 °C and the relative humidity ranges from 80 to 85%. The topography is mountainous; the soil type is basically volcanic and rich in minerals.

EXPERIMENTAL DESIGN AND TREATMENTS

The experiment was set-up as a split-plot arrangement in a randomized complete block design with three replications. The main plots consisted

@IJART-2016, All Rights Reserved

DOI: https://doi.org./10.24163/ijart/2017/4(4):135-145

of the inter-row spacings while the sub-plots were the varieties. There were three inter-row spacings (50, 60 and 75 cm) and four soybean varieties (TGX 1835-10E, TGX 1987-62F, TGX 2010-11F, TGX 2010-12F). The varieties were developed at the International Institute of Tropical Agriculture. The intra-row spacing was 5 cm.

FIELD ESTABLISHMENT AND CROP MAINTENANCE

The land was ploughed and harrowed using a tractor. After two weeks, raised beds were formed on each plot using a hoe. The plots were 3 m × 3 m in size. The seeds of each soybean variety were sown 2 per hill on 17 May 2017 and the seedlings were thinned two weeks after sowing (WAS) to 1 per stand. Weeds were controlled manually using a hoe at 3 and 6 WAS. The contact insecticide Cypercot (active ingredient: Cypermethrine 100 E.C.) was applied using a knapsack sprayer to control insect pests at 3 WAS.

Data collection and analyses

Data for growth and yield parameters were obtained from 10 plants randomly selected from the middle rows of each plot. The data for the following growth parameters were obtained at 3, 6 and 9 WAS: plant height (cm), number of leaves and number of branches; stem girth (cm^2) was determined at 9 WAS. The phenology data obtained were number of days to 50% flowering and number of days to 90% physiological maturity. Yield parameters (number of pods/plant, number of seeds/pod, grain yield (tons ha^{-1}) and 100-seed weight (g)) were estimated at harvest.

Plant height was measured from the surface of the soil to the tip of the main stem using a metre rule. The number of leaves was determined by counting those produced by each sampled plant. The stem girth was measured using a Vernier caliper. The number of branches was determined by counting those on each sampled plant.

The number of days to 50% flowering was obtained by counting the number of days from sowing to when 50% of the plants in each plot bore at least one open flower. The number of days to 90% physiological maturity was determined as the number of days from sowing to when 90% of the plants in each plot were matured.

The number of pods/plant was determined by counting the pods from the sampled plants in each plot. The number of seeds/pod was obtained by counting the seeds in 10 pods selected at random in each plot. Grain yield was determined at harvest, after the dried pods were harvested, threshed and weighed. The 100 seed weight (g) was determined by counting 100 seeds at random from each plot and weighing using a sensitive balance.

The data were subjected to analysis of variance using the SPSS version 21 software. Treatment means were compared using the Least Significant Difference at 5% level of probability.

RESULTS AND DISCUSSION

Growth parameters of soybean varieties

There were no significant (P>0.05) interactions between inter-row spacing and variety for the various growth parameters of soybean.

Plant height

There were significant (P<0.05) differences in plant height among the inter-row spacings (Fig. 1). At 3 WAS, plants sown at an inter-row spacing of 50 cm were taller that those sown at 60 and 75 cm. At 6 and 9 WAS, plants sown at 50 and 60 cm were taller than those sown at 75 cm. These results

@IJART-2016, All Rights Reserved

DOI: https://doi.org./10.24163/ijart/2017/4(4):135-145

indicate that the plants were taller at close than at wide spacing. These results agree with the findings of other researchers who reported an increase in plant height with reduced inter-row spacing (Safo-Kantanka and Lawson, 1980; Jadhav *et al*., 1992; Aydogdu and Acikgoz, 1995).

Plant height differed significantly (P<0.05) among the soybean varieties (Fig. 2). In general, TGX 2010-12F had the tallest plants at the different sampling periods. With the exception of TGX 2010-12F, all the varieties had similar heights at 3 and 6 WAS. The average height of the other three varieties was 14.7 cm at 3 WAS and 31.2 cm at 6 WAS. At 9 WAS, TGX1835-10E had the shortest plants; TGX 1987-62F and TGX 2010-11F had plants with similar heights. The variation in plant height might be due to genetic characteristics of the varieties. Similar results were obtained by Ouattara and Weaver (1994) who observed significant differences among the height of soybean varieties.

Number of leaves

Significant (P<0.05) differences were observed in the number of leaves produced at the different inter-row spacings at 3 WAS (Table 1). Plants sown at 50 and 60 cm inter-row spacings produced more leaves than those sown at 75 cm. These findings indicate that the plants produced more leaves when sown at close than at wide spacing. At 6 and 9 WAS, there was no variation in the number of leaves produced at the different inter-row spacings. The mean number of leaves produced across the spacings was 18.9 leaves at 6 WAS and 41.3 leaves at 9 WAS.

At 3 and 6 WAS, the number of leaves produced was similar across the varieties (Table 1). The mean number of leaves produced by the four varieties was 8.1 leaves at 3 WAS and 18.9 leaves at 6 WAS. The varieties significantly (P<0.05) influenced the number of leaves produced at 9 WAS. The varieties TGX 2010-11F and TGX 2010-12F produced more leaves than TGX 1987-62F and TGX 1835-10E.

Number of branches

Inter-row spacing did not significantly influence the number of branches produced by the plants at 3 WAS (Table 1). The mean number of branches produced across the different spacings was 1.1 branch. At 6 WAS, there were significant (P<0.05) differences in the number of branches produced by the plants at the different inter-row spacings (Table 1). Plants sown at 60 and 75 cm inter-row spacings produced more branches than those sown at 50 cm. These observations indicate that the plants produced more branches at wide than at narrow spacing. At wide inter-row spacing, the plants were able to branch more profusely than at narrow inter-row spacing. Therefore the plants were able to partition more growth resources at wide than at narrow spacing since competition was minimal and this resulted to an increase in the number of branches. Under narrow row spacing, the canopy closed earlier than at wider spacing. This observation is in agreement with the results of previous studies (Safo-Kantanka and Lawson, 1980; Caliskan *et al*., 2007). At 9 WAS, the number of branches produced did not vary across the spacings.

At 3 and 6 WAS all the varieties produced a similar number of branches. The mean number of branches produced by the varieties was 1.1 at 3 WAS and 4.9 at 6 WAS. At 9 WAS, there were significant differences in the number of

@IJART-2016, All Rights Reserved

DOI: https://doi.org./10.24163/ijart/2017/4(4):135-145

branches produced among the varieties. The varieties TGX 2010-12F and TGX 1835-10E produced similar number of branches which was more than that produced by the other two (Table 1). These varieties produced an average of 8.6 branches. The varieties TGX 1987-62F and TGX 2010-11F also produced similar number of branches (mean=7.3 branches). The differences in number of branches produced by the varieties could be due to the variations in their genetic constitution.

Stem girth

Inter-row spacing did not significantly influence the stem girth of soybean plants at 9 WAS (Table 1). The mean stem girth recorded across the different spacings was 1.0 cm^2. There were significant (P<0.05) differences in stem girth among the varieties. The lowest stem girth was recorded for TGX 1835-10E while the highest was recorded for TGX 2010-11F. Varieties TGX 2010-12F and TGX 1987-62F had similar stem girth.

Number of days to 50% flowering

Inter-row spacing did not affect the number of days taken by 50% of the plants to flower (Table 2). Across the different spacings, the mean number of days to 50% flowering was 51.3 days. These observations are similar to those obtained by Salih (1987) and Lum *et al*. (2018) who reported that the number of days to 50% flowering was similar when cowpea, another legume, was sown at different inter-row spacings that represent low and high densities.

The number of days to 50% flowering was significantly affected by the soybean varieties (Table 2). It took variety TGX 1835-10E the least number of days for 50% of the plants to flower (47.1 days). It took varieties TGX 2010-12F and TGX 1987-62F the highest number of days for 50% of the plants to flower (mean=54.5 days). This may be attributed to the genetic characteristics of the soybean varieties.

Number of days to 90% maturity

Inter-row spacing did not influence the number of days to 90% maturity (Table 2). Across the three inter-row spacings, 90% of the plants took 104.2 days to reach physiological maturity. These observations are similar to those reported by Lum *et al*. (2018). The authors reported that inter-row spacing did not significantly influence the number of days taken by 90% of cowpea plants to reach maturity in the same location where this trial was conducted.

The number of days to 90% maturity varied significantly (P<0.05) among the soybean varieties (Table 2). Variety TGX 2010-12F took more time to reach maturity than all other varieties; TGX 1835-10E took the least number of days to reach maturity. In general, varieties TGX 1987-62F and TGX 1835-10E took less time to reach physiological maturity than the other varieties.

Yield parameters of soybean varieties

There were no significant interactions between inter-row spacing and variety for the yield parameters of soybean. Results of the effect of inter-row spacing on the number of pods/plant, number of seeds/pod, grain yield (tons/ha) and 100 seed weight (g) of the soybean varieties are presented on Table 2 and Fig. 3.

Number of pods per plant

The number of pods/plant was significantly (P<0.05) influenced by inter-row spacing and variety (Table 2). The number of pods/plant increased with an increase in the inter-row

@IJART-2016, All Rights Reserved

DOI: https://doi.org./10.24163/ijart/2017/4(4):135-145

spacing. Hence the highest number of pods was recorded at an inter-row spacing of 75 cm while the lowest was obtained at 50 cm. This shows that the number of pods/plant was more at wide than at narrow row spacing. Similar results were obtained by Safo-Kantanka and Lawson (1980). The number of pods/plant varied significantly ($P<0.05$) among the varieties (Table 2). The varieties TGX 2010-12F and TGX 1987-62F had more pods/plant than the others. The lowest number of pods/plant was obtained from TGX 1835-10E.

Number of seeds per pod

Inter-row spacing and variety did not affect the number of seeds/pod. The mean number of seeds/pod across the various spacings was 3.0 seeds while that across the varieties was 2.8 seeds (Table 2).

Grain yield

Inter-row spacing significantly ($P<0.05$) influenced the grain yield of soybean. The grain yield recorded for plants sown at 50 and 60 cm inter-row spacings was more than that obtained at 75 cm (Fig. 3). These results indicate that the grain yield of soybean decreased with an increase in inter-row spacing. This could be attributed to more light interception at narrow row spacing with high plant density than at wide row spacing with low plant density. It is possible that at high plant density, there was more light interception which could have caused a higher growth rate of the soybean. Previous researchers have also reported similar results (Board *et al*., 1992; Ball *et al*., 2000; Kamara *et al*., 2014). Grain yield also varied significantly ($P<0.05$) among the varieties (Fig. 4). The variety TGX2010-12F had the highest grain yield (12.6 t ha^{-1}) compared to the others. All the other varieties had similar grain yield (mean=10 t ha^{-1}).

100-Seed weight

Inter-row spacing did not significantly influence the 100-seed weight of soybean (Table 2). The average 100-seed weight across the various spacings was 20.8 g. The 100-seed weight varied significantly among the varieties. With the exception of TGX 1987-62F, all the varieties had similar 100-seed weight. The lowest 100-seed weight was recorded for TGX 1987-62F.

The results of this study revealed that inter-row spacing significantly influenced the performance of the four soybean varieties evaluated. The varieties responded similarly to inter-row spacing as indicated by the different growth and yield parameters. Soybean sown at 50 cm inter-row spacing produced the tallest plants at 3 WAS and at harvest, they had the highest grain yield. Grain yield at narrow spacing (with high plant density) was more than that at wide spacing (with the lowest plant density) by 21%. Therefore the soybean varieties should be sown at a narrow row spacing of 50 cm for optimum yield production. Among the four varieties, TGX 2010-12F had the tallest plants with the highest number of pods and grain yield.

REFERENCES

Adamu RS, Amatobi CI. (2001). Field evaluation of soybeans genotypes for susceptibility to stinkbug damage at Samaru, Zaria. Tropical Oil Seed Journal **7,** 74–83.

Adeniyan ON, Ayoola OT. (2007). Evaluation of four improved soybean varieties under different planting date in relayed cropping system with maize under soybean/maize/cassava intercrop.

@IJART-2016, All Rights Reserved

DOI: https://doi.org./10.24163/ijart/2017/4(4):135-145

African Journal of Biotechnology **6,** 2220–2224.

Aydogdu L, Acikgoz E. (1995). Effect of seeding rate on seed and hay yield in common vetch (*Vicia sativa* L.). Journal of Agronomy and Crop Science **174,** 181–187.

Ball RA, Purcell LC, Vories ED. (2000). Short-season soybean yield compensation in response to population and water regime. Crop Science **40,** 1070–1078.

Board JE, Kamal M, Harville BG. (1992). Temporal importance of greater light interception to increased yield in narrow row soybean. Agronomy Journal **84,** 575–579.

Caliskan SM, Aslan M, Uremis I, Caliskan ME. (2007). The effect of row spacing on yield and yield components of full season and double cropped soybean. Turkish Journal of Agriculture and Forestry **31,**147–154

Franke AC, Schulz S, Oyewole BD, Bako S. (2004). Incorporating short-season legumes and green manure crops into maize-based systems in the moist Guinea savanna of West Africa. Experimental Agriculture **40,** 463–479.

Gomez KA, Gomez AA. (1984). Statistical procedures for Agricultural Research. 2nd ed. USA: John Wiley and Sons Inc.

Jadhav AS, Chavan GV, Gungrade SA. (1992). Geometry of sesame (*Sesamum indicum* L.) cultivars under rain fed conditions. Indian Journal of Agronomy **37,** 857–858.

Kamara AY, Ewansiha SU, Boahen S, Tofa AI. (2014). Agronomic response of soybean varieties to plant population in the Guinea savannas of Nigeria. Crop Ecology and Physiology **106,** 1051–1059.

Lum AF, Nji FG, Ndifon EM, Neba NA. (2018). Agronomic Performance of four Cowpea (*Vigna unguiculata* L. Walp) varieties under different inter-row spacings in Buea, Cameroon. Journal of Experimental Agriculture International **25,** 1–9.

Misiko M, Tittonell P, Ramisch JJ, Richards P, Giller KE. (2008). Integrating row soybean varieties for soil fertility management in smallholder systems through participatory research: lessons from western Kenya. *Agricultural Systems* **97,** 1–12.

Mpepereki S, Javaheri F, Davis P. (2000). Soybean and sustainable agriculture: Promiscuous soybean in Southern Africa. Field Crops Research **63,** 137–149.

Muhammad AN, Asghar A, Rashid SL, Mudassar M. (2002). Effect of different planting patterns on growth, yield and quality of grain. Pakistan Journal of Life and Social Science **2,** 132–135.

Ouattara S, Weaver DB. (1994). Effect of growth habit on yield and agronomic
characteristics of late-planted soybean. Crop Science **34,** 870–873.

Rahman MM, Hossain MM. (2011). Plant density effects on growth, yield and yield components of two soybean varieties under equidistant planting

@IJART-2016, All Rights Reserved

DOI: https://doi.org/10.24163/ijart/2017/4(4):135-145

arrangement. Asian Journal of Plant Science **10,** 278–286.

Safo-Kantanka O, Lawson NC. (1980). The effect of different row spacings and plant arrangement on soybeans. Canadian Journal of Plant Science **60,** 227–231.

Salih FA. (1987). Effect of nitrogen application and plant population per hill on faba bean (*Vicia faba* L.) yield. FABIS Newsletter **17,** 27–30.

Sanginga N, Okogun J, Vanlauwe B, Dashiell K. (2002). The contribution of nitrogen by promiscuous soybean to maize based cropping in the moist savanna of Nigeria. Plant and Soil **241,** 223–231.

Worku M, Astatkie T. (2010). Row and plant spacing effects on yield and yield components of soybean varieties under the hot humid tropical environment of Ethiopia. Journal of Agronomy and Crop Science **197,** 67–74.

Table 1. Effect of inter-row spacing and variety on the number of leaves, number of branches and stem girth of soybean

	Number of leaves			Number of branches			Stem girth
Treatment	3 WAS	6 WAS	9 WAS	3 WAS	6 WAS	9 WAS	9 WAS
Inter-row spacings							
50	8.2a	18.1a	38.8a	0.9a	4.7b	7.8a	1.0a
60	8.4a	21.1a	41.9a	1.2a	5.4a	8.2a	1.0a
75	7.7b	17.6a	43.1a	1.3a	5.6a	8.9a	1.0a
LSD (5%)	0.4	6.42	9.47	0.73	0.60	4.46	0.13
Varieties							
TGX 1835-10E	8.4a	20.2a	34.9b	1.5a	5.5a	8.9a	0.8c
TGX 1987-62F	8.1a	18.6a	38.9b	0.8a	4.1a	7.4b	1.0b
TGX 2010-11F	7.6a	18.0a	44.2a	0.9a	4.9a	7.2b	1.1a
TGX 2010-12F	8.4a	18.6a	47.1a	1.2a	5.1a	8.2a	1.0b
LSD (5%)	1.12	5.56	10.37	0.72	1.60	1.43	0.11

Means in columns followed by the same letter are not significantly different at 5% level of significance; LSD (5%) = Least Significant Difference at 5% level; WAS = weeks after sowing.

@IJART-2016, All Rights Reserved

DOI: https://doi.org./10.24163/ijart/2017/4(4):135-145

Table 2. Effect of inter-row spacing and variety on the phenological parameters and yield components of soybean

Treatment	Days to 50% flowering	Days to 90% maturity	Number of pods/plant	Number of seeds/pod	100 seed weight (g)
Inter-row spacings					
50	51.2a	103.5a	94.3b	3.0a	20.3a
60	51.4a	104.1a	110.2a	3.0a	21.0a
75	51.6a	105.0a	115.2a	3.0a	21.2a
LSD (5%)	1.29	2.99	21.45	0.03	1.5
Varieties					
TGX 1835-10E	47.1c	85.6d	76.9c	3.0a	20.6a
TGX 2010-11F	49.0b	108.6b	104.0b	3.0a	23.0a
TGX 2010-12F	54.8a	122.2a	129.3a	2.0a	22.8a
TGX 1987-62F	54.2a	104.4c	115.4a	3.0a	16.6b
LSD (5%)	1.11	3.13	24.51	0.24	4.73

Means in columns followed by the same letter are not significantly different at 5% level of significance; LSD (5%) = Least Significant Difference at 5% level.

@IJART-2016, All Rights Reserved

DOI: https://doi.org/10.24163/ijart/2017/4(4):135-145

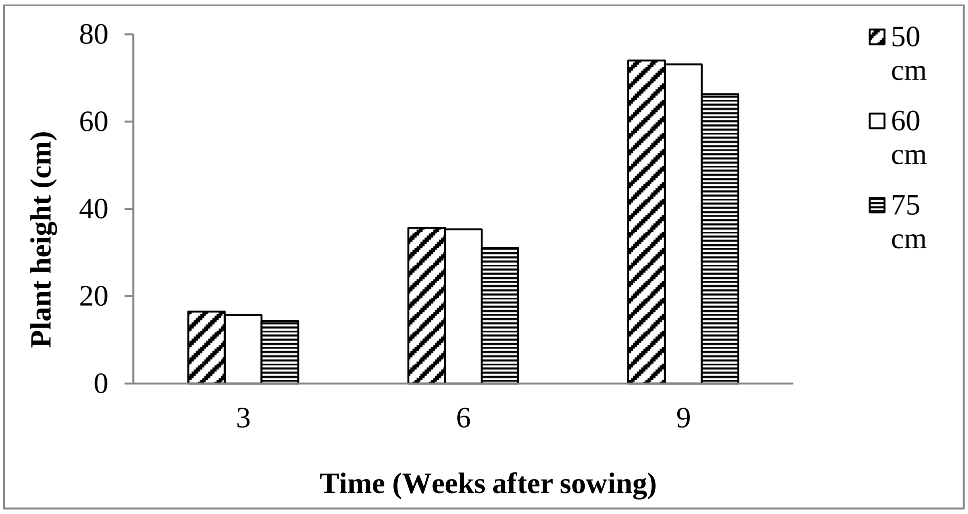

Fig. 1. Influence of inter-row spacing on the height of soybean varieties at 3, 6 and 9 weeks after sowing in Buea, Cameroon

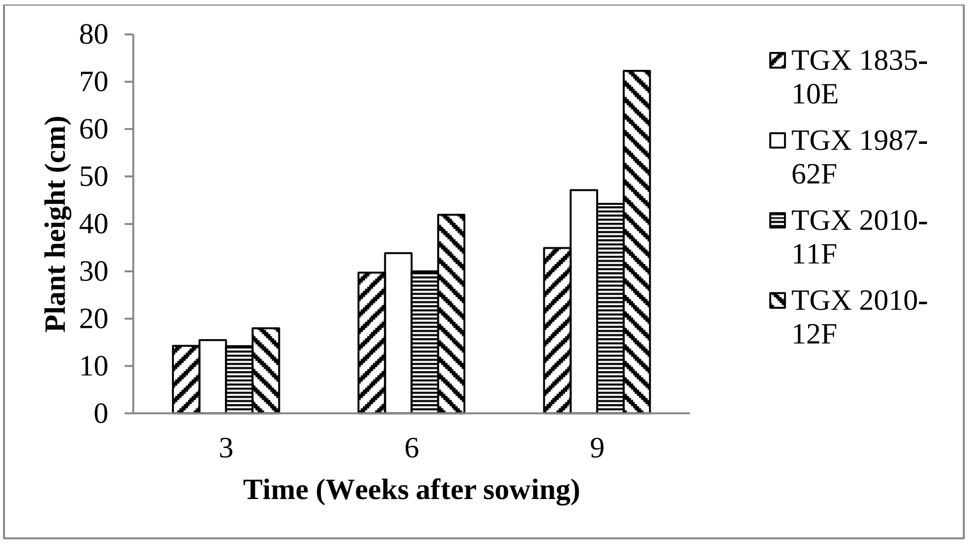

Fig. 2. Height of soybean varieties at 3, 6 and 9 weeks after sowing in Buea, Cameroon

@IJART-2016, All Rights Reserved

DOI: https://doi.org/10.24163/ijart/2017/4(4):135-145

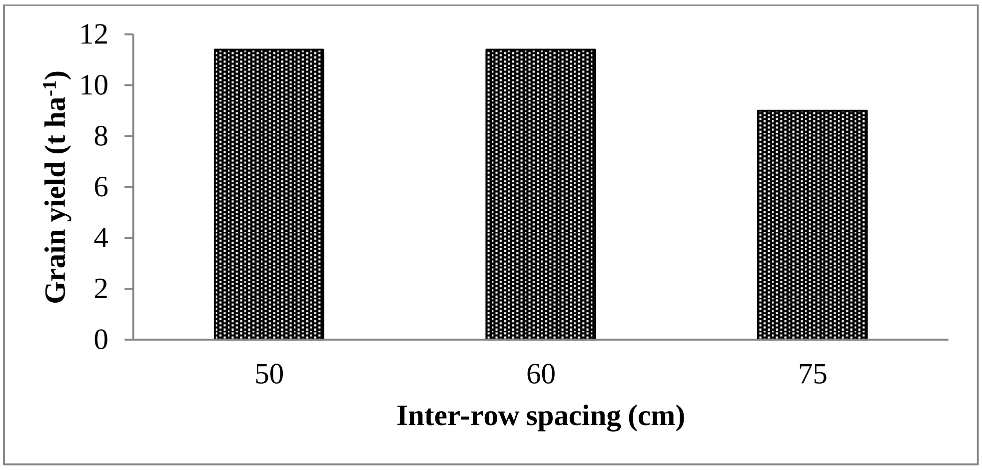

Fig. 3. Influence of inter-row spacing on the grain yield of soybean varieties in Buea, Cameroon

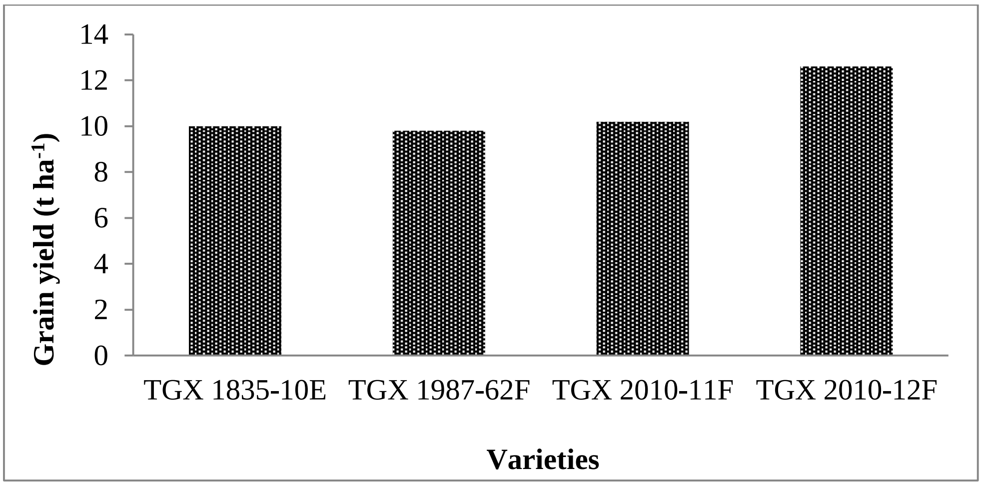

Fig. 4. Grain yield of soybean varieties in Buea, Cameroon

@IJART-2016, All Rights Reserved