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Full Length Research Paper

Assessment of four intra – rows spacing on grains yield and its components of soybean (*Glycine max*) under rainfed conditions, Blue Nile State, Sudan.

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The research works was conducted for two consecutive seasons (2014/15 and 2015/16), at Damazin Research Station Farm, Blue Nile State, Sudan. The objective of this study was to assess the effect of intra - rows spacing on grains yield and yield components of soybean under rainfed conditions. The experimental materials consisted of one soybean released cultivar (Sudan-2) and four intra rows spacing (5cm, 10cm, 15cm and 20cm). The experiments were sown in 21.7.2014 and 24.7.2015. Treatments were replicated three times and laid out in a randomized complete block design. Data collected on days to 50% flowering, plant height (cm), height to first pod (cm), number of pods / plant, number of grains / pod, Dry weight ton/ha, 100- grains weight (g) and grains yield ton/ha. The combine analysis of the effect of intra rows spacing on soybean grains yield revealed that the intra row spacing of 20cm recorded 1.8 ton/ha as the highest values of grains yield. But means of grains yield of all intra rows spacing were not deeply various.

Keywords: grains, soybean, *Glycine max*.

INTRODUCTION

Soybean *Glycine max* (L) Merrill is a legume crop with high protein content (40%) and high-quality oil (20%). It provides approximately 60% of vegetable protein and 30% of vegetable oil in the world. In season 2015/2016, soybean was grown on 119.74 million hectares worldwide with a total production of 313.26 million metric tons, and productivity average of 2.62 metric tons/ha. The major countries of soybean production are USA, Brazil,

Argentina, China, Paraguay, India and Canada (USDA, 2016).

Soybean was first introduced to the Sudan in 1910 by the colonial Garden (Shurtleff and Aoyagi 2009). Further introductions in the country were made in 1912. In 1949 soybean was introduced into South-West Sudan to prevent the severe malnutrition that exists among infants, children, pregnant and lactating women. Research on soybean in Sudan started as early as 1930. Soybean varieties were tested at Gezira Research Station, Wad Medani, central Sudan, between 1973 and 1977 (Salih 1977). An intensive research in developing improved soybean varieties suitable

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for irrigated and rainfed farming began in 1975 by Agricultural Research Corporation (ARC), in collaboration with International Soybean (INTSOY) varietal testing program, USA (Ageeb and Khalifa 1979). International Soybean Variety Evaluation Experiment (ISVEX) trials were conducted at Wad Medani, Abu Naama and Kadugli during 1977-1984. Results of field trials indicated that Sudan has great potential for growing soybeans as irrigated and rainfed crop. In 1982 Sudanese-Egyptian Integration Agricultural Scheme initiated a 2-year commercial soybean production project in Blue Nile State, Damazin. The area planted with soybeans is 2100 ha. Most of the early introduced soybean varieties were sensitive to photo-periods and high temperature resulting in poor vegetative growth, shorter plant height and height to first pod, making mechanical harvesting impossible. Soybean varieties introduced from USA and International Institute of Tropical Agriculture (IITA), Nigeria were tested at multi-locations over many years. The results of variety and on-farm trials show that grain yields of over 2.5 ton/ha could be obtained under irrigated conditions. Recently, the ongoing soybean research program at the Agricultural Research Corporation (ARC) is currently focusing on developing improved soybeans varieties and suitable agronomic practices (Ibrahim 2011), which resulted two released soybean cultivars, Sudan-1 and Sudan-2 for both rainfed and irrigated system.

Although Sudan has great potential for growing soybeans, unavailability of improved varieties, processing and utilization technology, guaranteed markets and lack of technical knowhow were the main constraints hindering commercialization and expansion of soybean production during this period. Domestic demand for soybean oil and meal is currently growing rapidly due to shortage in edible oils and increase and expansion in the poultry industry in Sudan. In addition, soybean is considered one of the most promising crops which could be introduced into rainfed and irrigated areas to increase human nutrition and improve soil fertility. A key factor for successful introduction and promotion of commercial soybean production in irrigated and rain fed farming is implementation of broad-based research to develop improved variety and suitable agronomic practices. Plant spacing is an important factor in determining growth, development and grain yield of soybean. In this study the research work was conducted for two consecutive seasons (2014/15 and 2015/16), at Damazin Research Station Farm. The objective of this study was to assess the effect of intra - rows spacing on grain yield and yield components of soybean under rainfed conditions.

MATERIALS AND METHODS

The research works was conducted for two consecutive seasons (2014/15 and 2015/16), at Damazin Research

Station Farm, to the south of Sudan (Lat. 11° 47' N, long. 31° 21' E, 492 m asl), in cracking heavy clay soil. The chemical analysis result of the top soil (0 – 20) and the sub soil (20 – 40 cm) of the site was described in table 1. The experimental materials consisted of one soybean released cultivar (Sudan-2) and four intra rows spacing (5cm, 10cm, 15cm and 20cm). The experiments were sown in 21.7.2014 and 24.7.2015. Treatments were replicated three times and laid out in a randomized complete block design. A total plot area was 14.4m². The soil of the experiment was ploughed with wide level disc. Seed were sown in rows 0.6m apart and intra rows spacing of 5cm, 10cm, 15cm and 20cm. Plants were thinned to one, two, three and four plants for 5cm, 10cm, 15cm and 20cm intra-row spacing, respectively after two weeks from emergence. Fertilizers, herbicides and pesticides were not used. Data collected on days to 50% flowering, plant height (cm), height to first pod (cm), number of pods / plant, number of grains / pod, Dry weight ton/ha, 100- grains weight (g) and grains yield ton/ha. Gen Stat Discovery Edition (Buysse *et al.*, 2004) was used for statistical analysis. A total amount of rain fall received during the rainy seasons of 2014 and 2015 were 506.7mm and 529.4mm.respectively (Table7). Theoretical and actual plant population (thousand ha⁻¹) was presented in table 2.

RESULTS

Analysis of variance of grains yield components was presented in tables 3, 4 and 5. Combine analysis for grains yield was presented in table 6. Highly significant differences ($P \leq 0.001$) in both seasons were observed for plant height (cm), whereas dry weight kg/ha recorded highly significant difference ($P \leq 0.001$) in season one. However, significant difference ($P \leq 0.05$) in season one was recorded for height to first pod (cm). Number of pods/plant showed significant differences ($P \leq 0.05$) over the two seasons. Whereas, days to 50% flowering and number of grains /pod recorded non-significant differences during the two seasons, which means no response of these traits for different intra rows spacing. While 100-grains weight exhibited significant difference ($P \leq 0.05$) in season one.

For plant height 20cm spacing gave the highest mean of 43.5cm. Height to first pod recorded highest mean of 11.7cm with 5cm spacing. Days to 50% flowering listed an equal means for all intra rows spacing. The highest mean of number of pods / plant was 57.8 given with 20cm spacing. Means of number of grains / pod were appeared to be equal for all spacing. Dry weight showed similar values of means for all intra rows spacing. 100-grains weight gave the highest value of means 10.8g with the spacing 10cm and 15cm.

The combine analysis of the effect of intra rows spacing on grains yield (Table 6) revealed that the intra row

Table1. The soil chemical analysis result of Damazin Research Station Farm:

Analysis result	Value
pH (1:5 H ₂ O)	7.0 – 7.3
Total N	0.042 – 0.044 %
Available P	3.9 – 3.9 mg/kg
Exchangeable K	0.63 – 0.59 cmol/kg
O.C.	0.593 – 0.598 %
C/N ratio	14 -13, respectively

Table2. Theoretical and actual plant population thousand ha⁻¹:

Intra-row spacing	Theoretical plant population	actual plant population		
		Season one	Season two	Mean
5	333333	189814.3	166203.3	178008.8
10	333333	228462.7	152684.7	190573.7
15	333333	194620.0	162268.0	178444.0
20	333333	203703.0	155555.0	179629.0

Table3. Effect of intra-row spacing on Plant height (cm), Height to first pod (cm) and Day to 50% flowering of soybean over two seasons (2014/15 - 2015/16) at Damazin Research Station Farm:

Intra-row spacing	Plant height			Height to first pod			Day to 50% flowering		
	Season one	Season two	Mean	Season one	Season two	Mean	Season one	Season two	Mean
5	40.0	39.7	39.8	9.0	14.3	11.7	56.7	55.3	56.0
10	45.3	37.0	41.2	6.3	12.7	9.5	56.0	55.3	55.7
15	36.7	43.7	40.2	6.7	12.3	9.5	56.3	55.7	56.0
20	47.3	39.7	43.5	7.3	13.0	10.2	57.7	55.3	56.5
Mean	42.3	40.0		7.3	13.1		56.7	55.4	
Statistics									
Sig. level	***	***		*	NS		NS	NS	
SE±	1.3	0.5		0.4	-		-	-	
CV%	4	2		7.5	7		2	2	

*** Very Highly significant difference, * significant difference, NS no significant difference.

Table 4. Effect of intra-row spacing on number of pods plant⁻¹ and grains pod⁻¹ of soya bean over two seasons (2014/15 - 2015/16) at Damazin Research Station Farm:

Intra-row spacing	Number of pods plant ⁻¹			Number of grains pod ⁻¹		
	Season one	Season two	Mean	Season one	Season two	Mean
5	65.0	49.3	57.2	2.3	2.3	2.3
10	50.3	50.3	50.3	2.7	2.7	2.7
15	52.7	60.7	56.7	2.0	2.3	2.2
20	67.0	48.7	57.8	2.0	2.7	2.3
Mean	58.8	52.3	55.5	2.3	2.5	2.4
Statistics						
Sig. level	*	*		NS	NS	
SE±	2.9	2.5		-	-	
CV%	6.2	6		16.6	26	

*** Very Highly significant difference, * significant difference, NS no significant difference.

Table 5. Effect of intra-row spacing on Dry weight (g) and 100- grains weight (g) of soybean over two seasons (2014/15 - 2015/16) at Damazin Research Station Farm:

Intra-row spacing	Dry weight (g)			100 grains weight (g)		
	Season one	Season two	Mean	Season one	Season two	Mean
5	2361.1	1967.6	2164.3	12.0	9.1	10.5
10	2777.8	1736.1	2256.9	11.8	9.7	10.8
15	2113.2	2199.1	2156.1	11.8	9.8	10.8
20	2476.8	1851.8	2164.3	11.8	8.8	10.3
Mean	2432.2	1938.7	2185.4	11.9	9.3	10.6
Statistics						
Sig. level	***	NS		NS	*	
SE±	42	-		-	0.3	
CV%	2	19		3.8	4	

*** Very Highly significant difference, * significant difference, NS no significant difference

Table 6. Effect of intra-row spacing on grains yield tons ha⁻¹ of soybean over two seasons (2014/15 - 2015/16) and combine analysis at Damazin Research Station Farm:

Intra-row spacing	Season one	Season two	Combine analysis
5	1.9	1.1	1.5
10	1.8	1.0	1.4
15	1.7	1.5	1.6
20	2.4	1.2	1.8
Mean	2.0	1.2	1.6
Statistics			
Sig. level	***	***	***
SE±	0.05	0.03	0.03
CV%	3.1	3.1	4

*** Very Highly significant difference, * significant difference, NS no significant difference.

Table7. Rainfall data (mm) as 10 days total at Damazin Research Station Farm during seasons 2014/15 and 2015/16:

Season 2014/2015					
Days	July	August	Sep.	Oct.	Nov.
1-10	0	50.1	59.6	34	0
11-20	25.5	53.3	59.2	32	0
21-31	25	119	30	19	0
Total/month	50.5	222.4	148.8	85	0
Total/year	506.7mm				
Season 2015/2016					
Days	July	August	Sep.	Oct.	Nov.
1-10	21	60	103	0	0
11-20	0	108	38.4	16	0
21-31	106	69	8.2	0	0
Total/month	127	237	149	16	0
Total/year	529mm				

spacing of 20cm recorded 1.8 ton/ha as the highest values of grains yield. But means of grains yield of all intra rows spacing were not deeply various.

CONCLUSION

The research work found that no deep significant differences and no obvious effect on grains yield and yield components between tested ridges intra rows spacing 5cm, 10cm, 15cm and 20cm x 60cm. This provides more chances and options for soybean planting methods (machinery or manually). The intra row spacing 20cm is useful especially for small holders whom depend on physical effort for sowing seed in the soil under rainfed conditions in Blue Nile State, Sudan. The study suggested the intra row spacing 5cm between plants x 60cm between ridges for machinery soybean cultivation and the intra row 20cm between plants x 60cm between ridges for small holders (hands workers) under rainfed conditions in Blue Nile State, Sudan.

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