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The Response of Pigeon pea (Cajanus cajanL.) Millsp) Variety Baladi Grain Yield to Different Sowing Methods under Gezira Scheme Conditions

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Abstract

A field experiment were conducted to determine the optimum sowing methods for pigeon pea varieties namely Baladi. The experiments was conducted for two seasons (2019/20 and 2020/21) at Gezira Research Station Farm. four sowing methods were tested; ridge at 80 cm apart with single row (T1), bed at 120 cm apart with two rows (T2), bed at 120 cm apart with three rows (T3) and bed at 160 cm apart with two rows (T4). The treatments were arranged in a randomized complete block design with four replications. Data on implements working parameters, plant performance and yield was collected. The sowing method T2 resulted in significantly ($p \leq 0.05$) highest yield (1623 kg/ha), the highest marginal rate of return (2595.6 %) and it was economically profitable.

Keywords: The Response, Pigeon pea(Cajanus cajanL.) Millsp), Gezira Scheme conditions.

Introduction

Selecting sowing method for a certain crop in irrigated sector is not an easy task, as there are many interrelated factors governing and involving in this operation. One of These factors is land configuration method. The land configuration method has to be compatible with subsequent farm operations such as irrigation and machinery movement. In fact, land configuration for sowing crops helps in maximizing rainfall infiltration, minimizing total runoff and facilitates drainage. This reduces the soil related problems and improves the crop growth and yield (Ramesh *et al.*, 2020). Several authors mentioned that the raised seed bed is used to drain out excessive rain water during heavy rain storm and to store rain water in furrow for enriching soil moisture thus sustain the crop during dry spells (Jha *et al*., 2014; Dhakad, 2016; Singh *et al*., 2018;Gupta *et al*.,2018; Dhakad *et al*., 2020). So that the crop can perform better under excess as well as deficit water conditions. In general, the historical method of land configuration for sowing crops, in the Gezira irrigated scheme, is ridge-furrow system at 80 cm apart. The crops are sown in a single row on the top of the ridges. However, recently some farmers in the scheme practiced a new land configuration system (raisedbed–furrow) for sowing crops by using ditcher implement. The crop is sown in row at the top of both sides of the bayou. The ditcher edifies somewhat wider and deeper furrows compared to that established by ridger. Pigeon pea (*Cajanus cajan* (L.) Millsp) is widely cultivated in tropics and subtropics (Mallikarjuna *et al*., 2011; Sarkar *et al*., 2018). It ranks number six as most important grain legume crop globally (Mula and Saxena, 2010; Varshney *et al*.,2011). It contents 20% to 22% protein, 1.2% fat, 65% carbohydrate and 3.8% ash (FAO 1982;

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Bhattacharjee *et al*.,2013). It is a crop of long tap-root and efficient in fixing nitrogen in field (Junior *et al*., 2011; Fernandes *et al*.,2012; Pandit *et al*., 2015). In the past few decades, farmers in the Gezira scheme have grown pigeon pea in the borders of their farms. However, in recent years and due to its high market value this crop is grown in sizable area. In the Sudan, some researchers have considered this crop in their research work to maximize its productivity. The conducted research work had resulted in approval of an early maturing pigeon pea variety (Khair, 2000). In addition, the optimum sowing date has been determined (Elhassan and Ahmed, 2019). Furthermore, the suitable intra-row spacing has been determined (Ahmed and Elhassan, 2020). Generally, in Sudan and specifically in the irrigated schemes, there is no information about sowing method of pigeon pea. Therefore, the objective of this study was to determine the optimum sowing methods for pigeon pea varieties namely Baladi under Gezira scheme conditions.

Material and Methods

A field experiment was conducted on pigeon pea crop variety Baladi. The field experiment were executed at Gezira Research Station Farm, Wad Medani, Sudan for two consecutive summer seasons (2019/2020 and 2020/2021). The farm lies at the intersection of Latitude 14º 24\ N, Longitude 33º 29\ E and at an Altitude of 407 mASL. The soil is Vertisols (heavy cracking clay), with high clay content, very low in organic carbon, low in N content and medium in available phosphorus. The pH ranged from 7.5 to 8.2. The rainy season start in May reached its peak in July and August and ends in late October. The total rainfall in the first was 419.7 mm and it was 322.1 mm in the second season. During the growing season, the minimum and the maximum temperatures for the first season ranged between (15.5 - 25.7 Co) and (32.6 – 43.5 Co), respectively and for the second season ranged between (12.9 – 25.0 Cº) and (31.4 – 42.3 Cº), respectively. These climatic data were obtained from the Gezira Agro-meteorological Station. Four treatments of sowing method were tested which were;

1. Ridge at 80cm apart (T1).
2. Bed at 120 cm apart with two rows (T2).
3. Bed at 120 cm apart with three rows (T3).
4. Bed at 160 cm apart (T4).

The tested treatments were carried out in two steps. The first step was to configure the land by two different implements (ridger implement by using different spaced between its units and ditcher implement).The treatment T1 was carried out by using ridger implement with four-units to make ridge-furrow system at 80 cm apart. However, the treatments T2 and T3 were done using ridger implement with three-units spaced at 120 cm apart. Meanwhile, the treatment T4 was carried out by using ditcher implement spaced at 160 cm. The second step was seeding pattern (single, two or three rows). The second step was carried out manually according to the recommended intra-row spacing for each pigeon pea variety. These four treatments were arranged in a

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randomized complete block design with four replications. The plot size was 64 m^2. The experiment was sown by Baladi variety in the second half of August for both seasons. The seeds were planted in holes at 30 cm apart putting 4 to 5 seeds in each hole and then thinned to two plants per hole. Phosphorus fertilizer in form of Dap at a rate of 43 Kg P_2O_5/ha was applied at sowing. Nitrogen fertilizer in form of Urea at a rate of 21.5 kg N/ha was applied three weeks after sowing. All plots were kept free from weeds throughout the growing seasons. The crop parameters such as plant height (cm), plant density per square meter, number of fruiting branches per plant, number of pod per plant, 100 seed weight (g)and grain yield (kg/ha) were measured. The collected data was statistically analyzed by using the GenStat statistical package software. The analysis of variance (ANOVA) and Duncan Multiple Range Test (DMRT) procedures were used to compare and to detect differences between the treatments. Moreover, economic analysis including partial budget and marginal rate of return (MRR) were used as described by (CIMMYT, 1988) to evaluate and compare the profitability of the tested treatments. The average cost of the operations and harvesting as well as pigeon pea price were obtained at the prevailing costs and prices from pigeon pea growers. The total cost that vary is the summation of operation and harvesting costs.

Results and Discussion

Effect of sowing methods on yield and growth performance:

The statistical analysis in the first seasons (2019/2020) showed that there were no significant differences between the tested sowing methods in plant height, fruiting branch per plant and pod per plant (Table 1). These results inferred that all of the tested sowing methods have similar effect on these parameters in the first season. However, the results showed high significant difference ($p \leq 0.01$) in number of plant per m^2 and grain yield. The sowing methods T2,T3 and T4 resulted in significantly higher numbers of plant per m^2 compared to the sowing method T1 as shown in Table 1. The effect of sowing methods on grain yield followed the same trend as in plant per m^2. Moreover, the results of 100 seeds weight in the first season showed significant different ($p \leq 0.05$), the sowing method T1 gave the least 100 seeds weight. Table 2. shows the results of the second season (2020/2021). The statistical analysis showed there were no significant differences between the tested sowing methods in plant height, in number of fruiting branch per plant and pods per plant. However, high significant difference ($p \leq 0.01$) was found in number of plant per m^2, where the sowing methods T2, T3 and T4 gave significantly higher number of plant per m^2 (Table 2) compared to sowing method T1. The result of number of plant per m^2 in the second season followed the same trend as in the first season. The results showed that there were significant differences ($p \leq 0.05$) between the sowing methods in 100 seeds weight and grain yield (Table 2). The sowing method T2 obtained the highest grain yield (1507 kg/ha) and the sowing method T1 gave the lowest grain yield (1208 kg/ha). However, statistically no difference between the sowing methods T2, T3 and

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T4 in grain yield this mean that these treatments have similar effect on grain yield; at the same time no difference between the sowing methods T1 and T3 in grain yield too. On the other hand, combined analysis for the grain yield in both season showed that there were significant differences ($p \leq 0.05$) between the sowing methods (Table 2. The results of combined analysis followed the same trend as in the second season. The sowing method T2 obtained the highest combined grain yield (1623 kg/ha) and the sowing method T1obtained the lowest grain yield (1264 kg/ha). However, statistically no difference in combined grain yield between the sowing methods T1 and T3 this mean that these sowing methods have similar effect on grain yield; at the same time no difference between the sowing methods T2, T3 and T4 in combined grain yield too.

Table 1. Effect of sowing methods on yield and yield components of pigeon pea Baladi variety in the first season (2019/2020)

Treatments	Plant height, cm	Fruiting branches/plant	Pods/ plant	plant/m^2	100 seed weight (g)	Yield (kg/ha)
T1	125.9	7.6	93.2	7 b	9.7 b	1320 b
T2	127.2	8.8	96.6	12 a	10.5 a	1740 a
T3	132.4	7.3	105.3	13 a	10.5 a	1699 a
T4	129.6	9.6	116.4	10 a	10.6 a	1566 a
SE (±)	3.22	0.716	18.03	0.79	0.196	54.5
Sig. level	Ns	Ns	Ns	**	*	**
C. V. (%)	5.0	17.2	35.1	15.0	3.8	6.9

*and **=significant at 0.05and 0.01 levels, respectively, NS= not significant.
Means in the same column followed by the same letter are not significantly different according to DMRT.

Table 2. Effect of sowing method on yield and yield components of pigeon pea Baladi variety in the second season (2020/2021)

Treatment	Plant height, cm	Fruiting branches/plant	Pods/ plant	plant/ m^2	100 S W (g)	Yield (kg/ha)	Yield combined (kg/ha)
T1	117.6	6.4	76.7	7 b	9.2 b	1208 b	1264 b
T2	119.3	5.5	54.4	10 a	10.4 a	1507 a	1623 a
T3	120.8	6.9	75.9	12 a	10.0 a	1278 ab	1488 ab
T4	120.1	6.1	61.8	10 a	10.4 a	1499 a	1533 a
SE (±)	3.92	0.521	7.06	0.616	0.249	71.1	36.8
Sig. level	Ns	Ns	Ns	**	*	*	*
C. V. (%)	5.7	14.5	18.2	11.1	4.3	9.0	7.0

*and **=significant at 0.05and 0.01 levels, respectively, NS= not significant.
Means in the same column followed by the same letter are not significantly different according to DMRT.

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Economic Analysis

The results of the partial budget analysis for pigeon pea Baladi variety experiment showed that the sowing methodsT2 achieved the highest cost that vary (32655.9 SDG/ha) and the highest net return (321158.1 SDG/ha) compared to the other sowing methods (Table 3). Table 4 shows the marginal analysis and the calculated MRR% for the tested sowing methods. The sowing method T2, gave the highest marginal rate of return (MRR %) which was 2595.6 %. This mean that for every one SDG invested in producing pigeon pea Baladi variety by using T2 as a sowing method will return back about 26 SDG. These results indicated that the sowing methodT2 was economically the most superior sowing method. The sowing method T2 obtained the highest grain yield and the highest net return and it was economically profitable.

Table 3. Partial budget analysis for pigeon pea Baladi variety

Treatment	Grain yield (kg/ha) combined	Gross return (SDG/ha)	Cost that vary (SDG/ha)	Net return (SDG/ha)
T1	1264	275552	25475.4	250076.6
T2	1623	353814	32655.9	321158.1
T3	1488	324384	30109.1	294274.9
T4	1533	334194	31928.0	302266.0

Table 4. Marginal analysis for pigeon pea Baladi variety

Treatment	Cost that vary (SDG/ha)	Net return (SDG/ha)	MC	MR	MRR%
T1	25475.4	31928.0			
T3	30109.1	294274.9	4633.8	44198.2	953.8
T4	31928.0	302266.0	1818.9	7991.1	439.3
T2	32655.9	321158.1	727.8	18892.2	2595.6

Conclusion

The sowing method T2 for pigeon pea Baladi variety resulted in the highest grain yield, the highest net return, the highest marginal rate of return (MRR %) and it was economically profitable.

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