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Research paper

Evaluation of Different Rows Spacing on Linseed (*Linum usitatissimum*) Yield in River Nile State, Sudan

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ABSTRACT

The Linum species is a crop now grown all over the world for the oil extracted from the seeds and for its fibers. This study aimed to verify the yield of linseed for supporting the potentiality of flax cultivation to be introduced in the cropping system as cash crop in the River Nile State. The experiments were conducted at Hudeiba Research Station Farm, River Nile State during the seasons 2015/16 and 2016/17 to determine the optimum row spacing for linseed crop through its effects on plant growth and seed yield, the 10, 20, 30 and 40cm rows spacing were tested in randomize complete block design with four replicates. The results showed that, the mean of the two seasons of plant height; number of flowers; number of capsules and weight of thousand seeds, were not significantly affected by the different rows spacing, where there were a significant difference in the means of the number of branches and yield. The 30 cm spacing resulted in higher seed yield in the two seasons.

Keywords: Row spacing, linseed, yield, River Nile State.

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تقييم مسافات مختلفة بين السطور على إنتاجية بذور الكتان بولاية نهر النيل، السودان

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محطة ابحاث الحديبة، هيئة البحوث الزراعية

أجريت هذه الدراسة بمزرعة محطة بحوث الحديبة بولاية نهر النيل خلال الموسميين 2016/15 و 2017/16، بهدف تحديد أثر المسافة بين الصفوف على إنتاجية نبات بذور الكتان، كانت المسافة بين الصفوف التي تم دراستها 10، 20، 30 و 40 سم في تصميم المربعات كاملة العشوائية بأربع مكررات. أظهرت النتائج عدم وجود فروقات معنوية لمتوسط الموسميين لطول النبات وعدد الأزهار وعدد القرون ووزن الألف حبة بالنسبة للمسافات بين الصفوف تحت الدراسة، بينما اظهر متوسط الموسميين لعدد الأفرع والإنتاجية فروقات معنوية، وأعطت المسافة 30 سم أعلى إنتاجية خلال الموسميين.

Introduction

The *Linum species* is an annual crop cultivated at least since 5000 BC, probably first by the ancient Mesopotamians and later by the Egyptians who wrapped their mummies in linen cloth. The Romans spread flax cultivation to Northern Europe; the plant is grown now all over the world for the oil extracted from the seeds (linseed) and for its fibers (flax), which are made into linen and other cloths. The linseed is the third largest natural fiber crop and one of the five major oil crops in the world, the total world area planted with linseed about 3 million hectares (FAOSTAT, 2016).

In addition, the seeds are widely used medicinally; their constituents include 30-40% of oil (linseed oil) with esters of linoleic acid, linolenic acid, stearic acid and oleic acid; also, mucilage, proteins, a cyanogenic glycoside (linamarin) and enzymes. Whole or crushed seeds are reliable means of relieving constipation. Crushed seeds mixed with water as a paste are used to make hot poultices to relieve pain and to heal septic wounds, skin rashes and ulcers. The extracted oil is used in the pharmaceutical industry to make liniments for burns and rheumatic pain. The oil is also important in the manufacture of paints, soap and printers ink.

Stevenson and Wright (1996) studied the effect of seeding rate and 9, 18 and 27cm row spacing on flax yields and weed interference, they found that the rows tested did not affect flax yield and had minor effects on weed yields when weeds were not controlled. Acko and Trdan (2008) examined influence of 8.5, 17 and 34cm row spacing on the yield of two flax cultivars, they obtained average yield of flax seed from both cultivars produced at row spacing of 8.5 cm (1.34 t/ha) and 34 cm (1.01 t/ha), the average yield of the seeds obtained from the 17 cm row spacing was significantly the highest (1.52 t/ha). Also Halzapfe *et al.* (2015) tested 25, 31, 36, 41 and 61cm for optimum flax row spacing; they found that the seed yield was affected by row spacing and yield declined linearly with row spacing, flax grown at 25cm yielded significantly higher than other row spacing. In Sudan, information regarding the production of flax is not available. So it is unfortunate that the flax worth is never brought out to the forefront of any level of research to promote the crop for local consumption or export. The present research was conducted to verify the yield of linseed for supporting the potentiality of flax cultivation to be introduced in the cropping system as cash crop in River Nile State. Therefore, the objective of this research was to study the performance of the crop under River Nile State environment, to determine the optimum row spacing for better crop establishment and yield.

Materials and Methods

An experiment was conducted during the winter seasons 2015/16 and 2016/17 in the experimental farm of Hudeiba Research Station, located in the River Nile State, at latitude 17˚.34″.N and longitude 23˚.56″.E. with altitude of 351 meter above sea level. The climate is characterized by cool and short (100-110) days during winter season. The main plot 4x5 m in size was divided into rows 10, 20, 30 and 40 cm between rows. The rows spacing treatment executed in randomized complete block design with four replications. Each plot divided into rows for each treatment by using markersand a seed rate of 60kg/ha was used, the seed was calibrated for each 4x5m plot size corresponding to rows spacing. Urea fertilizer was added in amount of 240 grams per plot (120 kg/ha) after one month from planting as recommended by Shareif *et al.* (2005). Ten plants per treatment were randomly tagged for measurement of plant height; number of branches and leaves/plant at 50% flowering for vegetative stage, and number of flowers/plants sixty days after planting; number of pods/plant at harvesting date and yield for reproductive growth and maturity stages parameters. A net area of $15m^2$ for each treatment was harvest and after 10 days from harvest, pods were ground by hands and seeds were separated then weighed to assess yield in kg/ha. The data were statistically analyzed using MstatC computer software.

Results and Discussion

Vegetative growth

Results in Table (1) showed that the planting spacing under test has no significantly affected plant height in both seasons but the longest mean plant height for the two seasons (60.3cm) resulted from 30 cm spacing. Mean number of branches per plant for the two seasons was significantly affected by rows spacing, 30cm spacing gave a greater number of branches, coincided with highest plant with the same spacing in the two seasons. These results agreed with the findings of Muhammed and Madiha (2005) who showed that the number of branches parameter is significantly affected by row spacing.

Table 1: Effect of different rows spacing on some vegetative growth traits of linseed during seasons 2015/16 and 2016/17

Row spacing	Plant height (cm)		Mean	Branches/plant		Mean
	2015/16	2016/17		2015/16	2016/17	
10 cm	62.0	52.7	57.7	17.6c	14.1	15.8
20 cm	63.7	51.6	57.6	20.2b	14.4	17.3
30 cm	65.2	55.4	60.3	25.2a	16.5	20.9
40 cm	63.3	52.9	58.1	25.2a	16.1	20.6
C.V.%	4.01	7.9	5.9	8.05	8.4	8.3
SE±	1.28^{ns}	2.09 ^{ns}	1.23ns	0.89**	0.4 ^{ns}	0.5***

* = significant, ** highly significant and ns =not significant

Reproductive growth and seed yield

From the results of the two seasons, it can be observed that there were no significant differences in the number of flowers and pods/plant under the different row spacing (Table 2), but the mean of flowers and pods/plant of 30cm row spacing for the two seasons was the highest.

Table 2: Effect of different rows spacing on some reproductive growth traits of linseed during 2015/16 and 2016/17 seasons

Row spacing	Flowers/plant		Mean	pods/plant		Mean
	2015/16	2016/17		2015/16	2016/17	
10 cm	46.5	42.3	44.4	42.6	10 cm	46.5
20 cm	33.2	52.3	42.8	30.5	20 cm	33.2
30 cm	39.7	58.5	49.1	36.2	30 cm	39.7
40 cm	32.1	43.6	37.8	30.0	40 cm	32.1
C.V.%	33.5	10.6	22.3	32.9	C.V.%	33.5
SE±	6.3 ^{ns}	2.6***	3.4^{ns}	5.7^{ns}	SE±	6.3 ^{ns}

* = significant, ** highly significant and ns =not significant

The thousand seeds weight was not significantly affected by rows spacing in both seasons (Table 3). The seed yield for each season for all rows spacing was not significantly different, the mean seed yield for the two seasons was significantly affected by rows spacing treatments, with highest seed yield resulted from 30cm row spacing. Similar results were obtained by Muhammed and Madiha (2005) who concluded that row spacing significantly affects yield and yield components.

Table 3: Effect of different rows spacing on yield of linseed during 2015/16- 2016/17 seasons

Row spacing	1000 Seed weight (g)		Mean	Yield (kg/ha)		Mean
	2015/16	2016/17		2015/16	2016/17	
10 cm	3.7	3.4	3.6	962.8	802.8	882.6
20 cm	3.7	3.5	3.6	1016.0	950.5	983.2
30 cm	3.7	3.4	3.5	1054.4	1083.8	1069.1
40 cm	3.6	3.3	3.4	996.0	910.7	983.4
C.V.%	3.3	4.2	3.7	11.3	13.7	12.5
SE±	0.06^{ns}	0.7^{ns}	0.05^{ns}	56.9^{ns}	64.3^{ns}	42.9^{*}

* = significant and ns =not significant

Conclusion

With the objectives of higher and more stable yield of linseed under River Nile State environment, four different rows spacing were applied. Results revealed that the 30 cm row spacing gave the highest yield compared to other spacings.

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