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RESPONSE OF FLAX TO SOIL LEVELING, PLANTING METHODS AND SEEDING RATES.

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ABSTRACT

Two field experiments were carried out during 2000/2001 and 2001/2002 seasons at Gemmeiza Agricultural Research Station, El-Gharbia Governorate to study the effect of two methods of soil leveling (Traditional, accurate and Laser methods), five planting methods (manual, spreading, mechanical, drilling sowing, band sowing and zegzag band sowing) and three seeding rates (60, 70 and 80 kg seed/fed) on yield, yield components and technological characteristics of Sakha I flax variety.

The results of the present investigation indicated that:

Laser land leveling (L2) had significant increase than traditional leveling (L1) in plant height, technical length, straw yield/fed, fiber yield/plan, fiber yield/fed, fiber length, fiber percentage and fiber fineness. While the traditional; leveling method record a significant increase than laser leveling in stem diameter, straw yield/plant number of capsules/plant, 1000 seed weight, seed yield/plant, seed yield/fed. On the other hand seed oil percentage did not significantly affect by leveling method. Zegzag band sowing surpassed the other planting methods in straw yield/fed, fiber yield/plant, fiber yield/fed, fiber length, fiber percentage, fiber fineness, number of capsules/plant, 1000 seed weight, seed yield/plant, seed yield/fed, and seed oil percentage in both seasons. More over it surpassed the others planting methods in plant height and technical length in the first season only. While drilling sowing planting method surpassed the others in stem diameter, and straw yield/plant in both seasons. Increasing seeding rates from 60 to 70 and 80 kg seed/fed increased plant height, technical length, straw yield/fed, fiber yield/fed, fiber length, fiber percentage and fiber fineness.

The interaction between leveling methods and planting methods was significantly affected on stem diameter, straw yield/fed, fiber/fed, fiber fineness, number of capsules/plant, seed yield/plant and seed yield/fed. Whereas the interaction between leveling methods and seeding rates significant effects on plant height, technical length, stem diameter, straw yield/fed, fiber/plant, fiber yield/fed and fiber fineness. While the interaction between planting methods and seeding rates was significantly affected plant height, technical length, straw yield/fed, fiber yield/fed, fiber length, fiber percentage and fiber fineness. On the other hand the interaction between leveling methods, planting methods and seeding rates did not reach level of significant in all characters studied.

In general, it can be stated that raising flax fiber yield can be achieved by using laser leveling with Zegzag band sowing and sowing flax with 80 kg/fed, seeding rate.

INTRODUCTION

Flax (*Linum usitatissimum L*.) is one of the ancient grown crops in several regions of the world for both fibers and seeds production. It is known in Egypt as a dual purpose field crop. It is grown for both seeds and fibers. It is the most important fiber crop, other than cotton, while it comes fourth after cotton, soybean and peanut with regard to oil seed production. Now, it is one of the most important economic crops in Egypt, where it is plays an effective role in the national economy due to its importance in expiration and many local industries. Recently, the acreage allotted to flax in Egypt is about 30000 feddans in season 2002/2003.

Flax yield like all agricultural crops depends to a great extent on many factors such as improving soil structure of seed bed, using a conbinent method of planting and suitable seeding rate. Regarding the influence of soil structure Hinz (1978) and Hassan (1991) stated that precision land leveling using controlled equipment's increase crop yield not less than 20%. Abdel Maksoud *et al*. (1993) found that laser leveling techniques becomes very important in Egyptian agriculture for saving irrigation water and increase crop yields. In addition, they found that laser leveling increase yield by 20%. El–Ansary and El-Haddad (1995) found that laser leveling increased grain yield by 22.38% and straw yield by 26.31% in case of mechanical seeding and manual broadcasting respectively. With respect to the effect of planting methods El- Sahrigi and Abo–Habaga (1993) reported that the bandwidth and band sowing method increased the crop yield in comparison with the drill method. Abo–Habaga (1994) reported that the drill machine without furrow opener increased the percentage of utilized area for sowing with 33.73% (at conventional method was 19.55%). With respect to the effect of planting methods Zahera Atia (1978), used 4 spacing treatments between rows. The 5 cm space gave the highest fiber percentage and the longest fibers. While the maximum fiber fineness resulted from 20, 15 and 10 cm spacing between rows. With regard to seeding rate Momtaz *et al*. (1981) used 8 plant densities (250, 500, 750, 1000, 1250, 1500, 1750 and 2000) plants /m^2 of flax Giza 5. The 2000 plants / m^2 density gave the highest mean fiber length, fiber fineness and fiber strength. Similar results were reported by El–Farouk *et al*. (1982). El–Shimy *et al*. (1993) and El-Kady *et al*. (1988) who found that there was a decrease in fiber yield / plant and fiber percentage as seeding rates increased, while fiber yield/ fed. And fineness increased.

The main objective of this research was to study the effect of leveling and planting methods and seeding rates on the quality and quantity of flax yield and its components in addition to fiber quality.

MATERIALS AND METHODS

Two field experiments were carried out at El-Gemmiza Agricultural Research Station El–Gharbia Governorate, Egypt during the two successive seasons, 2000/2001 and 2001/2002.

A split split plot design with three replicates was used. The main plots were devoted to the two leveling methods (Traditional leveling (L_1) and Laser leveling (L_2) The sub plots were allocated to the following planting methods:

- Traditional spreading (handling method) (P1)
- Mechanical spreading by using fertilizer spreader (P2)
- Drilling sowing by seed drills (P3)
- Band sowing by using seed drills after removed its furrow openers and provided it with flat distributor (P4)
- Zigzag band sowing by using seed drill after removed its furrow openers and adding a simple mechanism to provide seed tube with reciprocating motion for distributing seeds in zigzag stripes (P5)

The sub sub plots were devoted to the following seeding rates (60, 70 and 80 kg seeds/fed.). Each sub-sub plot was 4 m long and 3 m wide (1/100 fed.). The soil of the experimental site was clay loam. The mechanical and chemical analysis of soil are given in table (1). The previous crop was Zea Maiz in both seasons. The experimental field area was well prepared. Calcium super phosphate (15.5 % P_2O_5) was applied to all the rate of 100 kg/fed. Flax seed Sakha 1 variety were sown on 10 November in both seasons. Sowing irrigation was done at the next day of sowing. Other irrigations were performed approximately at 25 day intervals. All recommended cultural practices for growing flax except the studied factors were carried out as usual.

Table 1: The physical properties of the experimental soil.

Fine sand	Coarse sand	silt	clay	Clay rat	Soil texture
14.64	0.68	40.83	43.85	0.75	Clay loam

Experimental measurements:

The following measurements arranged as follow**:**

1- **The germination ratio (g):** two weeks after sowing and irrigation. The germination ratio was calculated by the following formula:

$$g = p / d$$

Where: p = average seeding number per (1 m^2).
d = average number of delivered seeds per 1 m^2. The (d) value calculated during the seed drill calibration.

2- **Planting distribution around the row center:** after germination (two weeks after sowing and irrigation) the number of plants through asides of the row center lines were counted to determine the seed dispersion.

3- **Yield components:** at full maturity ten plants were taken at random from each sub plot to estimate the following characters: total plant height (cm), technical stem length (cm), main stem diameter (mm), number of capsules/plant, seed index (weight of 1000 seeds (g)), straw yield/plant (g), seed yield/plant (g) and fiber yield/plant (g).

4- **Yield:** seed yield and straw yield were recorded on a whole of sub sub plot basis converted to fed. equivalent to estimate the following characters: straw yield/fed (ton), seed yield/fed (kg) and fiber yield/fed (ton) (determine from the straw yield from 1 m2 after retting and extraction of fiber and converted to kg/fed.

5- Quality characters:

- Fiber length (cm).
- Fiber percentage: according to the following formula:
  Fiber (%) = (Fiber yield / Straw yield) $\times$ 100
- Fiber finenes (Nm): according to the formula given by Radwan and Momtaz (1966).

$$Nm = N . L / G$$

Where: Nm = metrical number.

N = number of fibers (20 fibers of 10 cm each)
L = length of fibers (mm)
G = weight of fibers (mg).

*** Oil percentage**: was determined by Soxhlet apparatus according to Horwitz *et al* (1965).

6- Statistical analysis:

Snedecor and Cochran (1982) mean, were compared at 0.05 level of probability using the LSD.

RESULTS AND DISSCUTIONS

1- The Germination Ratio (G)

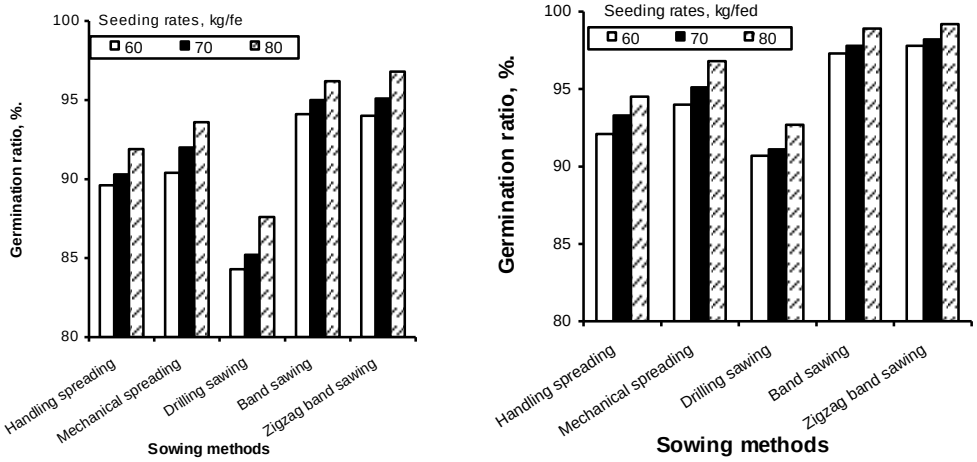
The results in table (2) revealed that the germination ratio was significantly affected by leveling method. Laser land-leveling surpassed the traditional one. It may be due to best distribution of seeds and good distribution of water irrigation. Table (2) show also that germination ratio was significantly affected by planting method. Zigzag band sowing surpassed the other methods, it may due to the best distribution of seeds. The highest value of germination ratio (99.2 %) was obtained from Laser leveling method and Zegzag band sowing when the seeding rate was 80 kg/fed, while the lowest germination ratio (84.3 %) was obtained from traditional leveling at drilling sowing method and sowing with 60 kg/fed as shown in Fig. (1).

Table 2: The effect of leveling methods, planting methods and seeding rates on germination ratio.

Leveling method (L)	Seeding rates Kg/fed (S)	Planting method (P)					Mean
		Handling spreading	Mechanical spreading	Drilling sawing	Band sawing	Zigzag band sawing	
		Germination ratio					
Traditional	60	89.6	90.4	84.3	94.1	94.0	90.5
	70	90.3	92.0	85.2	95.0	95.1	91.5
	80	91.9	93.6	87.6	96.2	96.8	93.2
Mean		90.6	92.0	85.6	95.1	95.3	91.7
Laser	60	92.1	94.0	90.7	97.3	97.8	94.4
	70	93.3	95.1	91.1	97.8	98.2	95.1
	80	94.5	96.8	92.7	98.9	99.2	96.4
Mean		93.3	95.3	91.4	98.0	98.4	95.3

L : leveling method, S : Seeding rates, P : planting method

Comparison	L	S	P	L × S	L × P	P × S	L × S × P
F. Test	**	**	**	**	**	NS	NS
LSD	0.027	0.14	0.31	0.19	0.34	----	----



A: Traditional leveling **B: Laser leveling**

Comparison	L	S	P	L × S	L × P	P × S	L × S × P
LSD	0.027	0.14	0.31	0.19	0.34	----	----

Fig. 1: The effect of leveling methods, planting methods and seeding rates on germination ratio.

2- Plant distribution around the row center:

At using normal drill, the maximum of seeds scattering was found in the first one cm of each side around the seeds dropping line. At Zigzag band sowing the seeds were distributed on the utilized growing

area. Fig. (2) shows the percentage of flax planting around the row centerline for different sowing methods.

It can be seen from Fig. (2) that the best seed distribution around the row center was obtained by using zigzag stripe sowing at laser leveling method. This may be due to the influence of zigzag planting on increasing the seed distribution area.

3- Effect of leveling methods (L):

Data in tables 3. 4 and 5 showed that plant height, technical length, straw yield/fed, fiber yield/plant, fiber yield/fed, fiber length, fiber percentage and fiber fineness were significantly affected by leveling methods. Laser leveling methods (L2) followed by traditional leveling method (L1). It may be due to semilar results were obtained by Hassan (1991), Abdel Maksoud *et al*. (1993) and El-Ansary *et al*. (1995).

Data showed that the traditional leveling method (L1) significantly exceeded in both seasons Laser leveling method in stem diameter, straw yield/plant, number of capsules/plant, 1000 seed weight, seed yield/plant and seed yield/fed. Similar results were obtained by Hinz (1978).

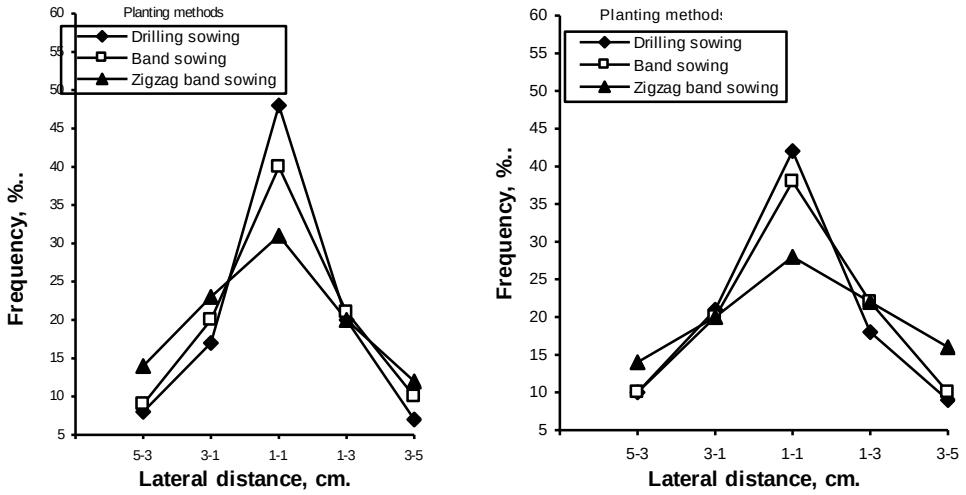


Fig. 2: Planting distribution around the row centerline for all treatments at seeding rate of 80 kg/fed.

4- Effect of planting methods (P):

Plant height, technical length, straw yield/fed, fiber yield/plant, fiber yield/fed, fiber length and fiber fineness in both seasons were significantly increased by using Zigzag band sowing (P5) followed by band sowing (P4), handling spreading, mechanical spreading and drilling sowing, respectively. Stem diameter, straw yield/plant, number of capsules/plant, 1000 seed weight, seed yield/plant and seed yield/fed gave the highest values using drilling sowing (P3) in two season compared with the other planting methods (Tables 3, 4 and 5). Abo-Habage (1994) and El-Sahrigi and Abo-Habaga (1993) come to similar results.

5- Effect of seeding rates (S):

Results of the two seasons (tables 3 and 4) declared that increasing seeding rates from 60 to 70 and 80 kg seeds/fed increased plant height, technical length, straw yield/fed, fiber yield/plant, fiber yield/fed, fiber length and fiber fineness. This trend might be due to the high competition and consequently flax plants tended to elongate searching for light. Moreover, higher seeding rate produced the thinner flax plants and gave finest fibers. These results agree with those of El-Gazzar (1990), El-Shimy *et al*. (1993), Kineber *et al*. (1997) and Mosalem *et al.* (1999).

Data in tables (3 and 5) also showed that stem diameter, number of capsules/plant and seed yield/plant gave the highest values when sowing flax with 60 kg/fed in both seasons. These results are mainly due to the increase in competition among growing plants at dense population for water, light and nutrients. This competition leads in turn in a marked reduction in stem diameter, number of capsules/plant and seed yield/plant.

These results are in harmony with those obtained by Salama (1988), Mostafa (1990), El-Shimy *et al*. (1993), Kineber *et al.* (1997), Masalam *et al*. (1999) and El-Gawish (2000).

Seeding rates had insignificant effects on fiber percentage, 1000 – seed weight, seed yield / fed and seed oil percentage. These results are in agreement with these obtained by Mostafa (1990) and El-Gawish (2000).

Table 6: Effect of interaction between leveling methods on yield components.

	L	2000 / 2001					LSD	2000 / 2001					LSD
		P_1	P_2	P_3	P_4	P_5		P_1	P_2	P_3	P_4	P_5	
Stem diameter (mm)	L_1	1.58	1.62	1.63	1.52	1.48	0.008	1.50	1.59	1.56	1.48	1.40	0.01
	L_2	1.42	1.47	1.49	1.38	1.34	0.009	1.35	1.39	1.40	1.33	1.28	0.01
Straw yield/fed (Ton)	L_1	3.018	2.943	2.918	3.119	3.183	0.011	3.001	2.939	2.90	3.06	3.11	0.017
	L_2	3.126	3.054	3.026	3.242	3.291	0.021	3.071	3.009	2.97	3.13	3.18	0.023
Fiber yield/fed (Ton)	L_1	0.429	0.42	0.418	0.436	0.448	0.003	0.438	0.431	0.428	0.444	0.458	0.002
	L_2	0.449	0.44	0.438	0.456	0.468	0.004	0.466	0.449	0.447	0.463	0.477	0.001
Fiber fineness (N.m)	L_1	189.76	187.69	186.24	191.98	193.27	.74	176.72	175.09	179.24	178.37	179.24	0.61
	L_2	195.92	193.85	192.40	198.14	199.43	0.38	183.84	182.20	181.32	185.48	186.35	0.57
Number of Capsuls / plant	L_1	8.10	8.50	8.70	7.90	7.70	0.12	6.80	7.20	7.40	6.60	6.20	0.13
	L_2	7.90	8.30	8.50	7.80	7.50	0.08	5.90	6.20	6.40	5.70	5.20	0.11
Seed yield/plant (g)	L_1	0.39	0.41	0.45	0.39	0.37	0.009	0.51	0.52	0.53	0.49	0.46	0.01
	L_2	0.37	0.39	0.42	0.36	0.35	0.010	0.45	0.46	0.47	0.44	0.43	0.01
Seed yield/fed (kg)	L_1	708.56	715.55	722.67	694.20	684.97	1.22	657.44	664.73	674.23	657.71	653.50	0.12
	L_2	695.13	702.12	709.24	681.29	671.54	1.18	649.46	656.75	666.27	649.73	645.53	0.11

L : leveling method, P : planting method

6- The interaction effects:

Table (7) indicated that the interaction between leveling methods and planting methods had a significant effect on stem diameter, straw yield/fed, fiber fineness, number of capsules / plant, seed yield / plant and seed yield / fed in both seasons.

The interaction between leveling methods and seeding rates in table (8) indicated the significant effect on plant height, technical length, stem diameter, straw yield / fed, fiber yield / plant, fiber yield / fed and fiber fineness.

Table 7: Effect of interaction between leveling methods and seeding rates on yield components.

	L	2000 / 2001			LSD	2000 / 2001			LSD
		S_1	S_2	S_3		S_1	S_2	S_3	
Plant height (cm)	L_1	89.20	90.6	92.5	0.07	84.3	86.6	88.7	0.14
	L_2	94.40	95.8	97.8	0.03	88.9	91.2	93.3	0.18
Technical length (cm)	L_1	79.20	81.1	81.7	0.05	76.0	78.2	80.4	0.21
	L_2	81.60	83.5	85.1	0.19	78.2	80.4	82.6	0.24
Stem diameter (mm)	L_1	1.47	1.44	1.36	0.01	1.55	1.52	1.45	0.01
	L_2	1.23	1.17	1.09	0.02	1.39	1.36	1.23	0.01
Straw yield/fed (Ton)	L_1	2.88	3.00	3.20	0.07	2.89	2.95	3.18	0.04
	L_2	2.99	3.11	3.31	0.06	2.96	3.02	3.25	0.03
Fiber yield/plant (g)	L_1	0.22	0.23	0.24	0.01	0.20	0.21	0.22	0.01
	L_2	0.24	0.25	0.26	0.01	0.22	0.23	0.24	0.01
Fiber yield/fed (Ton)	L_1	0.401	0.429	0.461	0.015	0.417	0.439	0.463	0.013
	L_2	0.421	0.449	0.481	0.019	0.435	0.458	0.482	0.012
Fiber fineness (N.m)	L_1	186.24	190.07	191.75	0.12	171.94	177.26	180.99	1.31
	L_2	192.16	196.24	199.40	1.07	179.05	184.36	188.05	1.18

L : leveling method, S : Seeding rates

Table 8: Effect of interaction between sowing methods and seeding rates on yield components.

	S	2000 / 2001					LSD	2000 / 2001					LSD
		P_1	P_2	P_3	P_4	P_5		P_1	P_2	P_3	P_4	P_5	
Plant height (cm)	S_1	92.10	90.90	90.30	92.40	93.20	0.06	86.60	86.20	86.10	86.80	87.20	0.01
	S_2	93.60	92.40	91.70	93.80	94.60	0.04	88.90	88.50	88.30	89.10	89.40	0.05
	S_3	95.00	94.30	93.60	95.70	96.50	0.07	91.00	90.60	90.50	91.20	91.50	0.03
Technical length (cm)	S_1	80.9	79.5	78.4	81.50	81.90	0.11	77.1	76.7	76.50	77.30	77.70	0.02
	S_2	82.7	81.3	80.3	83.30	83.70	0.09	79.3	78.9	78.60	79.50	79.90	0.04
	S_3	84.3	82.9	81.9	84.90	85.30	0.08	81.6	81.2	80.40	81.80	82.20	0.02
Straw yield/fed (Ton)	S_1	2.924	2.8618	2.828	3.040	3.088	0.017	2.898	2.837	2.799	2.954	3.010	0.031
	S_2	3.041	2.966	2.941	3.157	3.206	0.020	2.960	2.819	2.861	3.041	3.071	0.019
	S_3	3.240	3.165	3.140	3.356	3.405	0.019	3.190	3.128	3.091	3.251	3.300	0.023
Fiber yield/fed (Ton)	S_1	0.409	0.401	0.398	0.416	0.428	0.001	0.424	0.417	0.414	0.430	0.445	0.001
	S_2	0.437	0.429	0.426	0.444	0.456	0.001	0.446	0.439	0.437	0.453	0.467	0.001
	S_3	0.469	0.461	0.458	0.476	0.488	0.001	0.470	0.463	0.461	0.477	0.491	0.001
Fiber fineness (N.m)	S_1	189.33	187.25	185.56	191.30	192.59	0.16	175.50	173.86	172.98	177.14	178.01	0.31
	S_2	193.15	191.08	189.64	195.37	196.67	0.54	180.31	179.17	178.30	182.45	183.33	0.40
	S_3	196.35	194.28	192.84	198.51	199.84	0.39	184.55	182.91	182.04	186.19	187.07	0.24

L : leveling method, S : Seeding rates, P : planting method

The interaction between seeding rates and planting methods had a significant effect on plant height, technical length, straw yield / fed, fiber yield / fed and fiber fineness.

Flax yield and its components:

Average flax yield and its components straw and seed as affected by sowing and leveling methods is illustrated in Figs. (3 and 4). Results revealed that, highest values of straw yield (3.183 and 3.291 ton/fed) yield were obtained at using zigzag stripe sowing at traditional and laser leveling method.

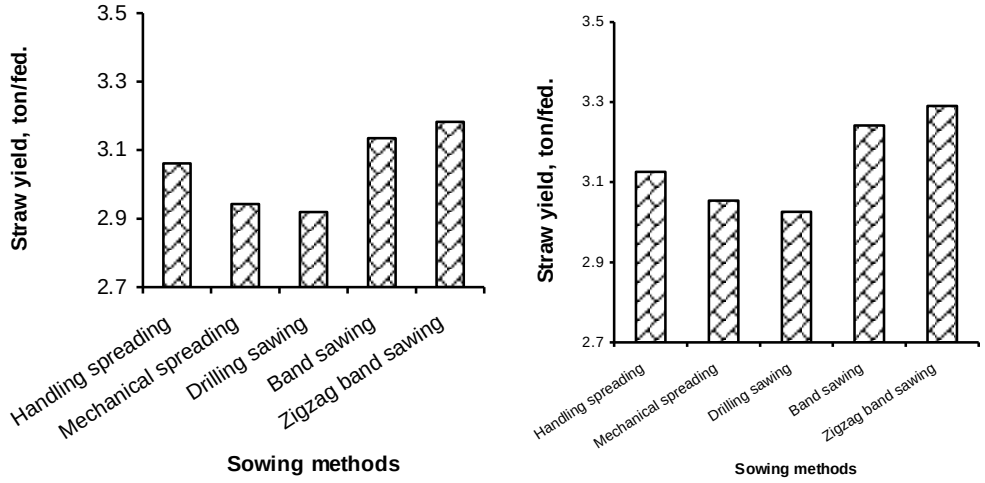


Fig. 3: Effect of leveling methods and sowing methods on straw yield.

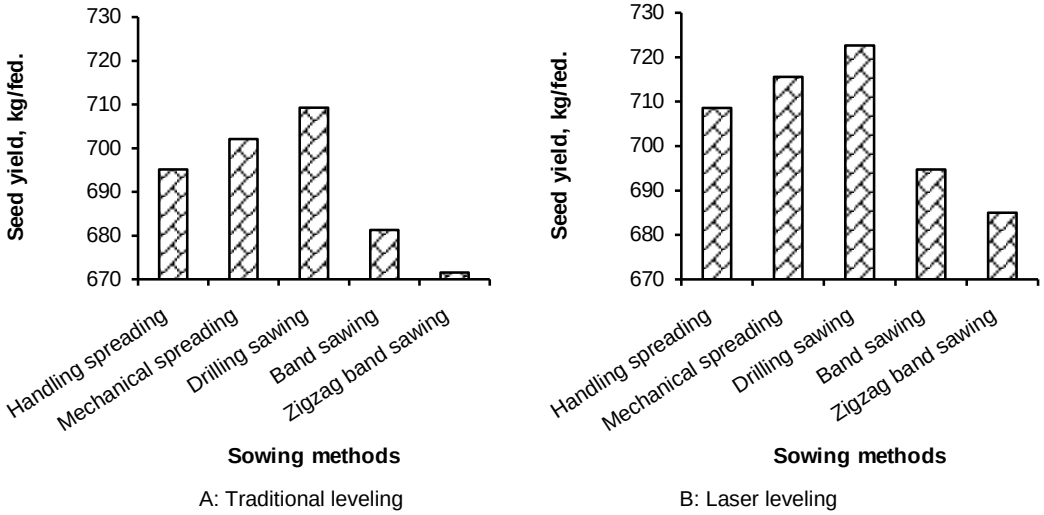


Fig. 4: Effect of leveling methods and sowing methods on seed yield.

The sequence of the different sowing methods according to the straw yield was found to be in the descending order:

Zigzag band sowing, band sowing, handling spreading, mechanical spreading, drilling sowing.

The drilling sowing method was less in the seed yield per feddan than the other methods. This results may be due to the increase in number of plants per unit area for drilling sowing method. Therefore, the plants suffer considerable competition for light, minerals and water.

On the other hand, the highest values of seed yield (709.24 and 722.67 kg/fed) were obtained at using normal drilling sowing at traditional and laser leveling methods respectively. It must be noticed that laser leveling increased productivity over traditional leveling. These results are in harmony with those obtained by Hinz (1978) and Abd EL-Maksoud *et al*. (1993), who found that laser leveling increased grain yield over traditional leveling.

Fiber Yield:

Average fiber yield as affected by leveling and planting methods is illustrated in table (4) the results revealed that, highest values of fiber yield (395 kg.) per fed. was obtained from zigzag band sowing with laser leveling method, the least value (271.45) per fed. Was obtained from seed drill with traditional leveling method. This may be due to increase in number of plants per unit area.

Fiber percentage:

The calculated data revealed that the lowest fiber percentage 11.42 % was obtained with sowing by seed dill and traditional leveling method, the highest value of fiber percentage 13.52% was achieved with

sowing by zigzag band sowing with laser leveling method. This trend may be explained by that with sowing by seed drill the plants gain thickness and consequently woody part of stem increased and bast part decreased and had signified fiber tissue. While with zigzag band sowing stems become thinner and total fiber percentage might increase and tended to ledge because of lack of woody part of stem.

CONCLUSION

In conclusion the results of the present investigation indicated that the use of Laser leveling and Zigzag-band sowing at sowing rate 80 kg seeding / fed proved to the most suitable treatments for best straw and fiber production. While using traditional leveling and drilling sowing by using seed drill and sowing with the rate of 60 kg seeds / fed proved to the most suitable treatments for best seed production.

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إستجابة الكتان لطرق تسوية التربة وطرق الزراعة ومعدلات التقاوى

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محصول الكتان يعتبر ثانى محاصيل الألياف فى العالم بعد القطن من حيث المساحة المنزرعة وثالثها بعد القطن والجوت من حيث الإنتاج العالمى، وترتيبه الرابع بين محاصيل الزيوت البذرية بعد القطن وفول الصويا والفول السودانى.

أجريت تجربه حقلية خلال موسمى 2000-2001، 2001-2002 بمحطة بحوث الجميزة بمحافظة الغربية لدراسة تأثير إستخدام طرقتين تسويه (عاديه - دقيقة بأشعة الليزر) وخمس طرق زراعة (نثر يدوى - نثر آلى - تسطير آلى - زراعة شريطية عادية - زراعة شريطية زجزاج) وثلاثة معدلات تقاوى (60، 70، 80 كجم/فدان) على إنتاجية محصول الكتان.

وكانت أهم النتائج المتحصل عليها:

- بإستخدام التسوية بأشعة الليزر زاد متوسط الإنتاج العام لمحصول الكتان (بذور - قش) مقارنة بالتسوية العادية.
- أعطت طريقة الزراعة الشريطية الزجزاج زيادة ملحوظة فى نسبة الإنبات نتيجة للتوزيع الجيد للبذور وكذلك إنتاجية كلاً من محصول القش والبذور للفدان مقارنة بالطرق الأخرى.
- كان لإستخدام طريقة التسوية بالليزر تأثير معنوى على إرتفاع النبات والطول الفعال ومحصول القش/فدان ومحصول الألياف للنبات الواحد ومحصول الألياف للفدان وأيضاً أدى إستخدام التسوية بالليزر إلى زيادة إنتاج البذور بمقدار 15 % عند التسوية التقليدية.
- أدت زيادة معدلات التقاوى من 60 إلى 80 كجم بذور/فدان إلى زيادة إرتفاع النبات والطول الفعال ومحصول القش للفدان ومحصول الألياف للنبات الواحد ومحصول الألياف للفدان وطول الألياف ونعومتها.
- كان للتفاعل بين عوامل الدراسة الثلاث تأثيراً معنوياً على معظم الصفات المدروسة ويمكن التوصية بإستخدام التسوية بالليزر وطريقة الزراعة الشريطية زجزاج والزراعة بمعدل 80 كجم/فدان وذلك للحصول على أعلى محصول من القش والبذور.
- طريقة الزراعة الشريطية الزجزاج أدت إلى توزيع جيد للبذور مما أدى إلى زيادة نسبة الإنبات.

Table 3: Fiber yield and its components.

Variables	Seasons	Leveling methods		Sig	LSD	Planting methods					Sig	LSD	Seeding rates (kg/fed)			Sig	LSD	Interactions			
		L_1	L_2			P_1	P_2	P_3	P_4	P_5			S_1 60	S_2 70	S_3 80			L × P	L × S	P × S	L×P×S
Plant height	2000/2001	88.20	98.8	**	1.50	94.1	91.70	90.40	94.60	96.20	**	0.10	90.20	93.10	96.90	**	0.66	NS	**	**	NS
(cm)	2001/2002	84.30	93.4	**	1.71	88.9	88.10	87.80	89.30	89.90	**	NS	84.40	88.90	93.20	**	0.79	NS	**	**	NS
Technical length	2000/2001	79.70	84.6	**	1.08	83.1	80.30	78.20	84.30	85.10	**	0.60	78.70	82.40	85.60	**	0.72	NS	**	**	NS
(cm)	2001/2002	77.10	81.5	**	1.13	79.4	78.60	78.10	79.80	80.60	**	NS	74.90	79.20	83.80	**	0.61	NS	**	**	NS
Stem diameter	2000/2001	1.63	1.35	**	0.09	1.48	1.60	1.63	1.41	1.33	**	0.03	1.58	1.52	1.36	**	0.02	**	**	NS	NS
(mm)	2001/2002	1.58	1.27	**	0.07	1.42	1.51	1.35	1.39	1.30	**	0.01	1.51	1.46	1.32	**	0.02	**	**	NS	NS
Straw yield/plant	2000/2001	1.20	1.04	**	0.05	1.06	1.27	1.36	0.99	0.91	**	0.02	1.25	1.14	0.98	**	0.04	NS	NS	NS	NS
(gm)	2001/2002	1.36	1.18	**	0.03	1.14	1.45	1.57	1.11	1.06	**	0.02	1.42	1.28	1.11	**	0.05	NS	NS	NS	NS
Straw yield/fed	2000/2001	2.976	3.192	**	0.071	3.061	2.910	2.861	3.293	3.390	**	0.033	2.787	3.022	3.420	**	0.046	**	**	**	NS
(ton)	2001/2002	2.992	3.131	**	0.087	3.010	2.887	2.812	3.132	3.231	**	0.041	2.787	2.911	3.370	**	0.053	**	**	**	NS
Fiber yield/plant	2000/2001	0.22	0.26	**	0.01	0.23	0.22	0.20	0.26	0.29	*	0.031	0.23	0.24	0.26	*	0.01	NS	*	NS	NS
(gm)	2001/2002	0.21	0.24	**	0.01	0.21	0.20	0.18	0.25	0.26	*	0.042	0.20	0.22	0.24	*	0.01	NS	*	NS	NS
Fiber yield/fed	2000/2001	0.422	0.461	**	0.007	0.437	0.422	0.415	0.451	0.475	**	0.006	0.381	0.437	0.501	**	0.017	**	**	**	NS
(ton)	2001/2002	0.431	0.468	**	0.009	0.445	0.431	0.426	0.458	0.486	**	0.002	0.403	0.448	0.496	**	0.013	**	**	**	NS

L : leveling method, S : Seeding rates, P : planting method

Table 4: Seed yield and its components.

Variables	Seasons	Leveling methods		Sig	LSD	Planting methods					Sig	LSD	Seeding rates (kg/fed)			Sig	LSD	Interactions			
		L_1	L_2			P_1	P_2	P_3	P_4	P_5			S_1 60	S_2 70	S_3 80			L × P	L × S	P × S	L×P×S
Number of	2000/2001	8.30	7.90	*	0.22	7.80	8.80	9.20	7.60	7.20	**	0.25	9.90	7.40	6.80	**	0.10	*	NS	NS	NS
capsules/plant	2001/2002	7.30	5.40	**	0.37	6.40	7.10	7.50	5.90	5.10	**	0.48	8.00	6.20	5.10	**	0.31	*	NS	NS	NS
1000-seed weight	2000/2001	9.87	9.65	*	0.11	9.76	9.87	9.98	9.65	9.53	NS	0.08	9.80	9.75	9.73	NS	NS	NS	NS	NS	NS
(gm)	2001/2002	10.31	10.09	*	0.10	10.19	10.28	10.32	10.12	10.09	NS	0.01	9.91	10.04	10.11	NS	NS	NS	NS	NS	NS
Seed yield/plant	2000/2001	0.41	0.37	**	0.01	0.37	0.42	0.48	0.37	0.33	*	0.009	0.48	0.37	0.32	*	NS	*	NS	NS	NS
(gm)	2001/2002	0.53	0.43	**	0.03	0.48	0.50	0.52	0.46	0.44	*	0.01	0.52	0.48	0.43	*	NS	*	NS	NS	NS
Seed yield/fed	2000/2001	712.7	685.9	**	2.50	704.4	718.4	732.6	676.7	657.2	NS	0.9	706.2	699.8	693.4	NS	NS	*	NS	NS	NS
(kg)	2001/2002	667.7	651.8	**	2.30	647.2	661.7	680.8	647.7	639.3	NS	0.4	589.4	654.8	634.9	NS	NS	*	NS	NS	NS

L : leveling method, S : Seeding rates, P : planting method

Table 5: Technological characteristics.

	Seasons	Leveling methods		Sig	LSD	Planting methods					Sig	LSD	Seeding rates (kg/fed)			Sig	LSD	Interactions			
		L_1	L_2			P_1	P_2	P_3	P_4	P_5			S_1 60	S_2 70	S_3 80			L × P	L × S	P × S	L×P×S
Fiber length	2000/2001	65.34	71.20	**	1.20	68.27	67.20	66.77	68.84	69.97	**	0.09	64.67	68.72	71.41	**	0.13	NS	NS	NS	NS
(cm)	2001/2002	67.88	73.92	**	1.96	70.90	69.15	68.89	71.74	73.81	**	0.07	67.01	71.46	74.22	**	0.14	NS	NS	NS	NS
Fiber percentage	2000/2001	14.85	14.44	**	0.22	14.28	14.85	14.83	13.70	13.42	NS	0.01	13.67	14.46	14.65	NS	NS	NS	NS	NS	NS
	2001/2002	14.41	14.95	**	0.28	14.78	15.28	15.50	14.62	14.43	NS	0.03	14.46	15.39	14.72	NS	NS	NS	NS	NS	NS
Fiber fineness	2000/2001	186.7	199.0	**	7.10	192.8	188.7	185.8	197.3	199.9	**	0.30	185.3	193.5	199.8	**	1.22	*	**	**	NS
(Nm)	2001/2002	173.2	187.4	**	7.40	180.3	177.0	175.3	183.6	185.3	**	0.20	170.7	181.3	188.8	**	1.31	*	**	**	NS
Seed oil percentage	2000/2001	39.69	39.53	NS	NS	39.25	39.66	39.38	39.84	39.92	NS	NS	39.61	39.64	39.59	NS	NS	NS	NS	NS	NS
	2001/2002	39.35	39.21	NS	NS	39.37	39.32	39.26	39.42	39.37	NS	NS	39.58	39.51	39.47	NS	NS	NS	NS	NS	NS

L : leveling method, S : Seeding rates, P : planting method

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