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### Effect of Harvesting Dates and Seeding Rates on Yield and Yield Components of some Flax Varieties



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#### ABSTRACT

A split-split plot field experiment with three replications was carried out at Sakha Agricultural Research Station, Kafre El-Shiekh Governorate, Egypt, during two seasons of 2017/18 and 2018/19 to study the effect of different harvesting dates (after 145, 155 days and 165 days from sowing), sowing rates (60, 70 and 80 kg seeds/fed) on yield and its components of some flax varieties (Giza 11, Giza 12 and Marlin). Harvesting flax plants at either 165 or 155 days from sowing consider as optimum dates to achieve highest estimates for technical length, fruiting zone length, straw yield/plant, number of capsules/plant, seed oil%, seed yield/fed., straw yield/fed and fiber yield/fed. The flax variety Giza 12 ranked first and recorded highest mean values of technical length, fruiting zone length, straw yield/plant, number of capsules/plant, seed oil%, seed yield/fed. and straw yield/fed, in both seasons. Meanwhile, the two newly flax varieties i.e., Giza 12 and Giza 11 did not differ significantly in most studies characters in both seasons. The introduce variety Marline recorded maximum estimates for fiber % and fiber yield /fed. Increase seeding rates up to 70 or 80 kg seeds/fed caused an increment in most studied traits without significance between them concerning most characters. The dual interaction of harvesting dates with flax varieties had significant effect on fruiting zone length, seed index, stem diameter, seed oil%, fiber% and fiber yield/fed.. In addition to, the triple interaction of harvesting dates with flax varieties and seed rates had significant effect on technical length and fiber yield/fed.

**Keywords:** Flax, varieties, seeding rates, harvesting dates, oil, fiber.



#### INTRODUCTION

Flax (*Linum usitatissimum* L) plant of the family Linaceae, cultivated for its fiber to make linen yarn and cloth. In addition to its nutritious seeds which called flaxseed or linseed from which linseed oil is obtain, flaxseed has grown in popularity as a health food for human and animals, flax oil is useful for many industries.

Great efforts had been done to increase flax yield and its quality by the way of release new flax varieties and different agricultural treatments. Many investigators recorded that delay harvest date caused increment in straw and seed yield such as Amna *et al.*, (2003), El-Deeb and Abd EL-Fatah (2006) and Kandil *et al.* (2010).

Regarding the flax varieties, varietal differences had been found by Abou- Zaied (1997), Amna *et al.* (2003), Badiyala and Chopra (2015), Kadam *et al.* (2015) and Raundal *et al.* (2015).

For seeding rates effect, Abdel-Dayem (2002), El-Azzouni *et al.* (2003), El-Deeb and Abd EL-Fatah (2006) and Yasemin *et al.* (2018), who reported that increase seeding rate caused an increment in flax yield and fiber quality.

Therefore, the main target of this study is to determine the optimum harvesting date and seeding rate for three flax varieties to obtained highest quantity and quality yield.

#### MATERIALS AND METHODS

This investigation was carried out at Sakha Agric. Res. Station, Kafre El-Shiekh Governorate Egypt, during 2017/18 and 2018/19 seasons. Each experiment included 27

treatments which were the combination of three harvesting dates (after 145, 155 and 165 days from sowing), three varieties (Giza 11, Giza 12 and Marlin) and three sowing rates (60, 70 and 80 kg seeds/fed). The experimental design was split-split plot in three replications. The three harvesting dates were distributed in the main plots, while the varieties were in sub- plots and seeding rates were allocated in the sub-sub plots. The sub-sub-plot area was 6 m<sup>2</sup> (2 x 3 m) in both seasons. Planting dates were 10<sup>th</sup> and 15<sup>th</sup> November in the first and second season, respectively, by used broadcast method.

#### Flax varieties

- Giza 11: Commercial flax variety selected by pedigree method from the cross between (Giza 8 x S.2419/1).
- Giza 12: Commercial flax variety selected by pedigree method from the cross between (S.2419/1 x S.148/6/1).
- Marlin: fiber type introduces variety from Holland.

The following Table (1) shows the three tested harvesting dates, seeding rates per feddan (Kg) for the three flax varieties.

**Table 1. distribution of studied treatments in split-split plot design**

Harvesting dates	Varieties.		
	Giza 11	Giza 12	Marlin
After 145	60 kg/fed	60 kg/fed	60 kg/fed
After 155	70 kg/fed	70 kg/fed	70 kg/fed
After 165	80 kg/fed	80 kg/fed	80 kg/fed

The soil texture of the experimental field was clay loam.

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Characters on individual plants and bulk sample were studied on plants pulled in the same harvesting date and retted plants, after removing seeds. The single plant studies were done on samples of ten randomly selected plants labeled during the growth period in the field from each sub sub-plots, while the bulk samples included the whole plot yield for the estimation of straw and seed and fiber yields per feddan. The individual plants were studied for the following characters: technical length. (cm), fruiting length. (cm), stem diameter. (mm), straw yield / plant, number of capsules/ plant, seed index. (g), seed oil%, fiber%, seed yield/fed. (kg), straw yield /fed. (ton) and fiber yield /fed. (kg). Oil percentage (%), as given by the A.O.A.C. (2000) using a Soxhlet apparatus and petroleum ether with a boiling range of 60-80°C as solvent for six hours. = Weight of oil × weight of sample /100.

All data were statistically analyzed according to procedures outlined by Snedecor and Cochran (1982), the least significant difference (LSD) test at 5% level of significance are used to compare treatment means.

### RESULTS AND DISCUSSION

Mean values of some flax characters as affected by harvesting dates, varieties and seeding rates in 2017/2018 season are presented in Table 2.

Statistical analysis appeared significant differences between each of harvesting dates; flax varieties and seeding rates in all six traits except with straw yield / plant affected by harvesting dates which did not reach the level of significance.

**Table 2. Six characters as affected by harvesting dates, varieties, seeding rates and their interactions during 2017/18 season.**

Treatments		2017/18					
		Technical length	Fruiting length	Stem diameter	Straw yield /plant	No. of capsules/ plant	Seed index
Harvesting dates (A)	145 days	68.46	19.68	2.62	2.10	5.31	8.43
	155 days	70.86	21.10	2.44	2.14	6.55	8.83
	165 days	71.09	22.00	2.36	2.19	6.61	9.04
	LSD 5%	0.753	0.103	0.132	N.S	0.342	0.205
Varieties (B)	Giza11	70.14	23.98	2.90	2.31	5.84	11.11
	Giza12	72.77	24.14	2.88	2.47	7.76	11.07
	Marlin	67.50	14.66	1.64	1.64	4.87	4.011
	LSD 5%	1.033	0.554	1.091	0.103	0.325	0.252
Sowing rates (C)	60 Kg	67.74	19.40	2.85	1.99	6.84	8.26
	70 Kg	70.54	21.13	2.29	2.19	5.94	9.10
	80 Kg	72.12	22.26	2.28	2.25	5.69	8.94
	LSD 5%	1.179	0.326	0.109	0.074	0.417	0.169
Interaction							
LSD 5% A x B		N.S	0.960	N.S	N.S	N.S	N.S
LSD 5% A x C		N.S	N.S	N.S	N.S	N.S	0.292
LSD 5% B x C		N.S	N.S	N.S	N.S	N.S	0.292
LSD 5% A x B x C		N.S	N.S	N.S	N.S	N.S	0.506

Seeding rates effect, results revealed sowing flax with 80 kg seeds/fed. recorded highest mean values of technical length (72.12 cm), fruiting length (22.26 cm) and straw yield /plant (2.25 g). There was no significant different between sowing flax with 70 kg and 80 kg seed /fed in stem diameter trait. Similar trend was recorded by Abdel-Dayem (2002), Abu El-Dahab (2002), Abou-Zaied and El-Azzouni (2003), El-Azzouni *et al.* (2003), Abd El-Fatah and El-Deeb (2006), and Yasemin *et al.* (2018).

Data showed that all interactions had no significant effect on all studied characters except with the interaction of harvesting date with flax varieties for fruiting length, the interaction of harvesting date with seeding rate, flax varieties

Concerning harvest dates, data illustrated that the more suitable harvest date was after 165 days from sowing for technical length (71.09 cm), fruiting length (22.00 cm), straw yield / plant (2.19 g), number of capsules / plant (6.61) and seed index (9.04 g). Meanwhile, the lowest estimates in five characters i.e., technical length (68.46 cm), fruiting length (19.68 cm), straw yield /plant (2.10), number of capsules /plant (5.31) and seed index (8.43 g) were obtained by harvest flax plants after 145 days old, for exception stem diameter which recorded maximum measurement (2.62 mm). It must be observed that the difference between harvest flax plants after 155 days and 165 days had insignificant effect in relation to technical length and number of capsules / plant. Similar finding were obtained by Ghanem (1990), Mostafa (1990), Shafshak *et al.* (1992), Mohamed *et al.* (1998), Mosalem *et al.* (1999), Amna *et al.* (2003), El-Deeb and Abd- El Fatah (2006), and Kandil *et al.* (2010).

Regarding the three flax varieties, the flax variety Giza 12 ranked first in technical length (72.77 cm), fruiting length (24.14 cm), straw yield/ plant (2.47 g) and number of capsules /plant (7.76 capsule). There was no significant difference between the two flax variety Giza 12 and Giza 11 concerning seed index character. The variety Marlin ranked the third position in all traits under study. Similar results were obtained by Abou-Zaied (1997), Amna *et al.* (2003), Zedan (2004), Kandil *et al.* (2010), Badiyala, and Chopra (2015), and Raundal *et al.* (2015).

with seeding rate and triple interaction of harvesting date with flax varieties and seeding rates had significant effect on seed index trait (Yasemin *et al.*, 2018).

Estimates of some flax characters as affected by harvesting dates, varieties and seeding rates in 2018/2019 season are presented in Table 3.

Analysis of variance revealed significant differences between each of harvesting dates, flax varieties and seeding rates, except for straw yield /plant as affected by harvesting dates which not significant. The optimum harvest date was 165 days old which achieved highest mean values of technical length (75.29 cm), fruiting length (22.25 cm), straw yield / plant (2.38 g) and number of capsules/ plant (7.25)

without significant differences with the date at 155 days old for stem diameter, and seed index traits. The lowest mean values were obtained when harvest date was 145 days from sowing in five characters, but it was the highest in only stem diameter. Harvest date at 155 days old recorded intermediate estimates between the lowest date and the maximum one. These results are agreed with Mohamed *et al.* (1992), Mosalem *et al.* (1999),

The flax variety Giza 12 surpass either Giza 11 or the lowest Variety Marlin in technical length, fruiting length, straw yield /plant, number of capsules/ plant and seed index. The respective mean values for these characters were 73.57 cm, 24.98 cm, 2.80 g, 7.66 and 11.54 g, respectively. Insignificant difference had been found between Giza 12 and Giza11 in fruiting zone length. Concerning seeding rates effect, data indicated that technical length ranged from 69.11 to 73.25 cm, fruiting length from 20.17 to 22.55 cm. and

straw yield / plant from 2.19 to 2.40 g for flax when sowing with 60 kg and 80 kg seed / fed, respectively. The differences between 70 kg, and 80 kg seed / fed did not reach the level of significance in technical length and straw yield/ plant characters. These results are in accordance with those obtained by Kandil (2010), Jana *et al.* (2013), Rahimi *et al.* (2014), and Kamble *et al.* (2015)

The interaction of harvesting date with flax varieties had significant effect on fruiting length, stem diameter and seed index, harvesting date × seeding date and flax varieties × seeding rate interactions had significant effect on stem diameter and number of capsules / plant, while harvesting date × flax varieties × seeding date interaction had significant effect on only technical length. These results are in accordance with those obtained by El-Shimy *et al.* (1993), Fontana (1996), and El-Shimy *et al.* (1997).

**Table 3. Six characters as affected by harvesting dates, varieties, seeding rates and their interactions during 2018/19 season.**

		2018/19					
Treatments		Technical length	Fruiting length	Stem diameter	Straw yield /plant	No. of capsules/ plant	Seed index
Harvesting dates (A)	145 days	68.61	20.11	2.62	2.29	5.75	8.86
	155 days	70.79	21.70	2.37	2.32	6.96	9.24
	165 days	75.29	22.25	2.40	2.38	7.25	9.17
	LSD 5%	2.481	0.465	0.116	N.S	0.191	N.S
Varieties (B)	Giza11	71.48	224.70	2.96	2.53	7.21	11.29
	Giza12	73.57	24.98	2.81	2.80	7.66	11.54
	Marlin	69.83	14.73	1.61	1.65	5.09	4.44
	LSD 5%	1.591	0.435	0.117	0.130	0.443	0.191
Sowing rates (C)	60 Kg	69.11	20.17	2.81	2.19	7.05	8.66
	70 Kg	72.51	21.33	2.31	2.40	6.95	9.45
	80 Kg	73.25	22.55	2.26	2.40	5.96	9.16
	LSD 5%	1.304	0.398	0.129	0.143	0.274	0.255
Interaction							
LSD 5% A x B		N.S	0.754	0.203	N.S	N.S	0.331
LSD 5% A x C		N.S	N.S	0.223	N.S	0.474	N.S
LSD 5% B x C		N.S	N.S	0.223	N.S	0.474	N.S
LSD 5% A x B x C		3.912	N.S	N.S	N.S	N.S	N.S

Mean values of five flax characters as affected by harvesting dates, varieties and seeding rates in 2017/18 season are presented in Table 4.

Data showed significant differences between each of harvesting dates, flax varieties and seeding rates in all traits except with fiber yield / fed. as affected by seeding rates which appeared to be insignificant.

**Table 4. Five characters as affected by harvesting dates, varieties, seeding rates and their interactions during 2017/18 season.**

		2017/18				
Treatments		Seed oil%	Fiber%	Seed yield / Fed	Straw yield / fed	Fiber yield / fed
Harvesting dates (A)	145 days	36.58	18.74	557.67	3.00	369.96
	155 days	37.97	18.85	601.19	3.25	446.85
	165 days	37.95	18.19	571.15	3.17	427.11
	LSD 5%	0.363	0.277	10.876	0.154	19.084
Varieties (B)	Giza11	39.73	16.46	662.48	3.36	338.41
	Giza12	39.89	17.92	732.22	3.44	438.37
	Marlin	32.87	21.40	335.30	2.62	467.15
	LSD 5%	0.312	0.381	22.487	0.125	16.227
seeding rates (C)	60 Kg	37.06	18.28	561.63	3.02	422.85
	70 Kg	37.80	18.78	584.41	3.20	411.52
	80 Kg	37.63	18.71	583.96	3.20	409.56
	LSD 5%	0.273	0.196	8.823	0.124	N.S
Interaction						
LSD 5% A x B		.0540	0.660	N.S	N.S	28.106
LSD 5% A x C		N.S	N.S	N.S	N.S	N.S
LSD 5% B x C		N.S	N.S	N.S	N.S	N.S
LSD 5% A x B x C		N.S	N.S	N.S	N.S	N.S

Harvest flax plants after 155 days from sowing caused highest mean values of seed oil % (37.97%), fiber %

(18.85%), seed yield/fed. (601.19 kg), straw yield/fed (3.25 ton) and fiber yield/ fed (446.85 kg).

On the other hand, harvest flax plants at 145 days old gave minimum estimates for seed oil % (36.58%) seed yield/fed (557.67 kg), straw yield/fed (3.00 ton) and fiber yield /fed (369.96 kg). There were insignificant differences between harvest flax at 155 and 165 days old in seed oil%. The introduce flax variety Marlin ranked first and achieved greatest estimates of fiber % (21.40 %) and fiber yield/fed (467.15 kg). At the same time, Giza 12 recorded highest seed oil % (39.89 %), seed yield/ fed (732.22 kg) and straw yield/ fed (3.44 ton). Planting flax with 70 kg seed/fed achieved maximum seed oil% (37.80%), fiber% (18.78%), seed yield/fed (584.41 kg) and straw yield /fed (3.20 ton).

Statistical analysis appeared that all the interactions had insignificant effect on all studied characters except for the interaction of harvesting date with flax varieties which had significant effect on seed oil%, fiber % and fiber yield/fed. These results are in accordance with those obtained by Singh *et al.* (1993), Sorour *et al.* (1992), Saghayesh *et al.* (2014), Raundal *et al.* (2015), and Rokade *et al.* (2015),

The results in Table 5 indicated that, there was a significant difference between each of harvesting dates, flax varieties and seeding rates in all traits except for fiber % and fiber yield /fed.

Harvest flax plants after 155 days from sowing caused highest mean values of seed oil % (37.86 %), fiber % (19.64 %), seed yield /fed (609, 93 kg), straw yield /fed (2,83 ton), fiber yield /fed (383.15 kg). On the other hand,, harvest flax plants at 145 days gave minimum estimates for seed oil % (36, 51 %), fiber % (18.87 %), seed yield /fed (554,74 kg), and fiber yield/ fed (317,96 kg).The newly local variety Giza 12 ranked first and achieved greatest estimates of seed oil %, seed yield / fed and straw yield /fed. At another hand, Marlin ranked first in fiber % and fiber yield/ fed. Planting flax with 70kg seed/fed. achieved maximum seed oil%, straw yield /fed and fiber yield /fed. At the same time, sowing flax at seeding rates 80 kg/ fed caused highest fiber %, and seed yield /fed.

**Table 5. Five characters as affected by harvesting dates, varieties, seeding rates and their interactions during 2018/2019 season.**

Treatments		2018/19				
		Seed oil%	Fiber%	Seed yield / Fed	Straw yield / fed	Fiber yield / fed
Harvesting dates (A)	145 days	36.51	18.87	554.74	2.79	317.96
	155 days	37.86	19.64	609.93	2.83	383.15
	165 days	37.71	18.97	587.70	2.75	376.85
	LSD 5%	0.643	N.S	16.806	0.047	31.979
Varieties (B)	Giza11	39.77	17.65	693.93	2.97	316.19
	Giza12	39.82	18.33	713.11	3.12	369.15
	Marlin	32.50	21.51	345.33	2.27	392.63
	LSD 5%	0.262	0.616	20.604	0.163	17.54
Seeding rates ( C)	60 Kg	37.07	19.17	559.07	2.59	355.63
	70 Kg	37.59	19.04	596.63	2.95	367.74
	80 Kg	37.43	19.27	596.67	2.82	354.59
	LSD 5%	0.230	N.S	15.619	0.163	N.S
Interaction						
LSD 5% Ax B		0.454	N.S	N.S	N.S	N.S
LSD 5% A x C		0.399	N.S	N.S	N.S	N.S
LSD 5% B x C		0.399	N.S	N.S	N.S	N.S
LSD 5% Ax B x C		0.691	N.S	N.S	N.S	46.160

Statistical analysis appeared that all the interactions had insignificant effect on all studied characters except for the interactions of harvesting dates with flax varieties, harvesting dates with seeding rates, flax varieties with seeding rates and triple interaction of harvesting dates with flax varieties and seeding rates had significant effect on seed oil % and also significant on fiber yield / fed. These results are in accordance with those obtained by Mostafa (1994), El-Shimy *et al.* (1998), Mostafa *et al.* (1998), El-Shimy and Moawed (2000), Abou-Zaied (2001), El-Borhamy (2003), El-Shimy and Ashry (2003), Zedan (2004), Abdel-Dayem (2007), and Abou-Zaied and Mousa (2007) showed that there were significant differences between the varieties and are in harmony with the present results.

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## دراسة تأثير مواعيد الحصاد و معدلات التقاوى على المحصول ومكوناته لبعض أصناف الكتان طه أحمد عمر ، امل عوض البرهامى ومايسه سعيد عبد الصادق

قسم بحوث محاصيل الألياف – معهد بحوث المحاصيل الحقلية مركز البحوث الزراعية - مصر

تم إجراء تجربتين حقليةً بمحطة سحا للبحوث الزراعية - محافظة كفر الشيخ خلال موسمي ٢٠١٧/٢٠١٨ و ٢٠١٨/٢٠١٩ لدراسة تأثير ثلاث تولىفات من مواعيد الحصاد ومعدلات التقاوى هي: (الحصاد بعد ١٥٥ - ١٦٠ - ١٦٥ يوم من الزراعة)، (٦٠ - ٧٠ - ٨٠ كجم تقاوى / فدان) على صفات النمو والمحصول ومكوناته لثلاثة أصناف من الكتان هي: (جيزة ١١ - جيزة ١٢ - مارلين) تحت ظروف الأراضي الطينية. وذلك في تصميم القطع المنشقة مرتين في ٣ مكررات. تقوئت مواعيد الحصاد (بعد ١٦٥ يوم - بعد ١٥٥ يوم من الزراعة) مع معدلات التقاوى في الطول الفعال، طول المنطقة الثمرية، محصول القش / نبات ومحصول الألياف / فدان، بينما كانت لا توجد اختلافات معنوية بين معادى الحصاد بعد ١٦٥، ١٥٥ يوم من الزراعة. بينما تقوئت الصنف جيزة ١٢ في كل من متوسط الطول الفعال، الطول الثمرى، محصول القش للنبات، عدد الكبسولات / نبات، النسبة المئوية للزيت ومحصول البذور / فدان ومحصول القش / فدان في كلا الموسمين. وتقوئت الصنف مارلين في صفات النسبة المئوية للألياف، محصول الألياف / فدان. أدى زيادة معدل التقاوى إلى ٧٠ كجم أو ٨٠ كجم / فدان إلى التفوق في كل الصفات تحت الدراسة ولكن ليس هناك فروق معنوية بين معدلى التقاوى المذكورين تقوئت التفاعل الثاني بين مواعيد الحصاد والأصناف إلى معنوية طول المنطقة الثمرية، ودليل البذرة، ويسمك الساق، والنسبة المئوية لمحصول الزيت، والنسبة المئوية للألياف، ومحصول الألياف للفدان. كان التفاعل بين عناصر الدراسة الثلاثة معنوياً في صفتي الطول الفعال ومحصول الألياف / فدان.