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Effect of Mineral and Bio-Nitrogen Fertilization on Yield and its Components of Some Flax Varieties

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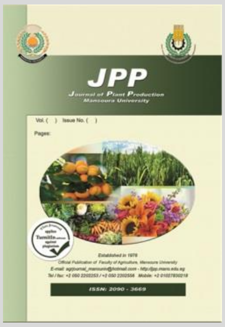

ABSTRACT

A field experiment was conducted at the Experimental Farm of Sakha Research Station, Kafr El-Sheikh Governorate, Agricultural Research Center, Egypt during 2017/2018 and 2018/2019 seasons to study the effect of mineral, bio-nitrogen fertilization and their combinations *i.e.* 45 kg N/fed, Nitroben and Nitrobein plus 30 kg N/fed on the straw and seed yields as well as their components of three flax varieties *i.e.* Sakha 5, Sakha 6 and Giza 11. A split plot design with four replicates was used. Results showed that varieties, fertilization treatments and their interaction, significantly affected straw and seed yields as well as their components in both seasons. Giza 11 variety was superior in straw and seed yields as well as their components over other varieties. Dual application of mineral N with N bio-fertilizer (Nitrobein plus 30 kg N/fed) produced the highest values of straw and seed yields as well as their components. The highest values of all traits were obtained from planting Giza 11 variety fertilized with dual application of mineral N and N bio-fertilizer (Nitrobein plus 30 kg N/fed). Hence, dual application of 30 kg N/fed with N bio-fertilizers could be recommended for improving flax varieties production especially Giza 11 variety under Kafr El-Sheikh Governorate conditions, Egypt.

Keywords:Flax, Varieties, mineral nitrogen, Nitrobein, straw and seed yields

INTRODUCTION

Flax is grown in Egypt as a dual purpose field crop for its seed and fiber, thus it plays an effective role in the national economy. The cultivated area in Egypt is very limited. Therefore, increasing flax yield per unit area is a very important challenge for crop scientists. This could be achieved through improving the agronomic practices such as mineral and bio-nitrogen fertilization. Many investigators found differences among flax genotypes concerning yield and its related characters such as Omar *et al.* (2020) and Omar (2020). Results of Mostafa *et al.* (2003) and El-Shimy *et al.* (2006) indicated that Nofatrin application times significantly differed and there are gradual increments in the mean values of all characters. Hussein (2007) reported that application of 45 kg N/fed resulted in the highest values for straw and seed yields as well as their components. Moawed *et al.* (2008) indicated that straw and seed yields increased with increasing N level up to 60 kg N/fed, also the bio-fertilizer as a nitrogen source caused gradual increment in all straw and seed yield characters. Abd El Daiem and El-Borhamy (2015) showed that fertilizing flax plants with 45 kg N/ fed significantly increased all studied characters and produced the highest values of all studied characters. Mousa and El Borhamy (2015) showed that application of 45 kg N/fed produced maximum mean values of straw and seed yields characters and their components. Amal El-Borhamy (2016) indicated that adding 45 kg N/ fed resulted in the highest values of straw and seed yields as well as their components.

Therefore, the main objective of the present investigation was to study the effect of mineral, bio-nitrogen fertilization and their combinations on straw and seed yields as well as their components of some flax varieties.

MATERIALS AND METHODS

A field experiment was conducted at the Experimental Farm of Sakha Research Station, Kafr El-Sheikh Governorate, Agricultural Research Center, Egypt during the two successive winter seasons 2017/2018 and 2018/2019. The experiment was arranged in a split plot design in four replications. The three flax varieties *i.e.* Sakha 5, Sakha 6 and Giza 11were randomly allocated in the main plots. While mineral and bio fertilization treatments and their combinations *i.e.* 45 kg N/fed, Nitroben and Nitrobein plus 30 kg N/fed were randomly distributed in the sub-plots. Nitrogen was given as urea (46.6% N). Nitrobein biofertilizer was added at the rate of 500 g/fed Fertilization whether single or dual applications were added in two equal portions prior to the first and the second irrigations in accordance with the treatment variables. The sub–plot area was 6 m^2 (2 x 3 m) in both seasons. Planting dates were 10^{th} and 15^{th} November in the first and second season, respectively, by used broadcast method. Soil samples (0-30 cm) collected from the experimental site were analyzed for physical and chemical characteristics as suggested by Jackson (1973) and results are summarized in Table 1.

The previous crop in both seasons was maize. The experimental area was well prepared through two perpendicular tillage and good harrowing, thereafter divided into units by constructing irrigation channels and alleys. All the other agricultural practices were carried out as recommended for flax growing under the conditions of Kafr El-Sheikh Governorate, Egypt.

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Table 1.Some chemical and physical properties of the experimental soils prior to sowing in both growing seasons

Season	Available (ppm) N	P	K	pH	EC ds m^{-1}	Organic matter %	Clay %	Silt %	Fine sand %	Texture
2017/2018	19	12	376	7.8	2.1	1.2	59.42	21.63	18.95	Clay
2018/2019	16.7	11.7	342	7.6	1.9	1.3	55.72	20.16	24.12	Clay

Data recorded

The single plant studied were done on samples of ten randomly selected plants labeled in the field from each sub-plots, while the bulk samples included the whole plot yield for the estimation of straw and seed yields per feddan. The individual plants were studied for the following characters; technical length (cm), fruiting zone length (cm), stem diameter (cm), straw yield/plant (g), number of capsule /plant (N^0), number of seeds/plant (N^0), seed index (g), seed yield/plant (g), seed yield/fed (kg) and straw yield/fed (ton).

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

RESULTS AND DISCUSSION

Flax variety performance:

Flax varieties significantly differed in their performance for all studied traits (Table 2) at both evaluated seasons. Giza 11 and Sakha 6 varieties exceeded Sakha 5 in technical length by (41.32 % and 40.44%) and (39.05 % and 38.02 %), fruiting length by (18.52% and 19.95%) and (15.27% and 16.88%), stem diameter by (50.00% and 57.83%) and (10.55 % and 22.09%), straw yield/plant by (54.57% and 59.68%) and (19.67% and 26.77%) and hence straw yield/fed by (33.93% and 27.41%) and (17.44% and 15.73%) at both 2017/2018 and 2018/2019 seasons, respectively. Similarly, the same two varieties *i.e.* Giza 11 and Sakha 6 outperformed over Sakha 5 in seed yield/plant and its components such as number of capsules/plant by (35.86% and 43.37%) and (14.14% and 21.94%), number of seeds/plant by (23.79% and 35.69%) and (5.75% and 17.97%), seed index (59.85% and 56.91%) and (44.76 % and 42.15%), seed yield/plant by (36.78% and 26.96%) and (15.35 %and 9.39%) and hence seed yield/fed by (38.52% and 34.06%) and (31.30 %and 25.92%) in both 2017/2018 and 2018/2019 seasons, in the same order. This could be attributed to genetic potential of tested flax varieties. These findings stand in conformity with those recorded by many investigators, among them (Omar *et al.*, 2020 and Omar, 2020).

Table 2. Agronomic performance of tested flax varieties in both 2017/2018 (1st) and 2018/2019 (2nd) seasons

Traits	Technical length (cm)		Fruiting length (cm)		Stem diameter (cm)		Straw yield/plant (g)		Number of capsule /plant (N^0)	
Variety	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Sakha 5	57.58	59.66	18.60	19.91	2.13	2.08	0.71	0.73	16.50	16.33
Sakha 6	80.06	82.34	21.44	23.28	2.36	2.53	0.85	0.93	18.83	19.92
Giza 11	81.37	83.78	22.05	23.89	3.20	3.28	1.10	1.17	22.42	23.42
LSD 5%	1.84	1.56	1.38	1.26	0.12	0.23	0.18	0.22	1.21	2.03

Traits	Number of seeds/plant (N^0)		Seed index (g)		Seed yield/plant (g)		Seed yield/fed (kg)		Straw yield/fed (ton)	
Variety	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Sakha 5	126.08	127.50	6.98	7.14	0.68	0.75	489.83	506.42	2.29	2.41
Sakha 6	133.33	150.42	10.10	10.15	0.79	0.83	643.17	637.67	2.69	2.79
Giza 11	156.08	173.00	11.16	11.20	0.94	0.96	678.50	678.92	3.07	3.07
LSD 5%	8.23	11.03	0.16	0.20	0.05	0.05	10.94	47.07	0.16	0.18

Fertilization effects:

Significance differences were observed among fertilizer treatments at both seasons (Table 3). The combined application of mineral and bio-nitrogen treatment (Nitriben plus 30 kg N/fed) increased straw yield and its components in both seasons. The dual application of mineral and bio-nitrogen treatment surpassed single application of 45 kg mineral nitrogen/fed and single application of bio-nitrogen in technical length by (3.89 % and 3.78%) and (23.11 % and 22.44 %), fruiting length by (18.82% and 17.08%) and (43.03% and 43.51%), stem diameter by (15.21% and 15.36%) and (37.98% and 42.08%), straw yield/plant by (49.63% and 40.13%) and (75.99% and 68.19%) and hence straw yield/fed by (9.34% and 5.44%) and (98.46% and 89.46%) at both 2017/2018 and 2018/2019 season, respectively.

Table 3. Effect of fertilization on straw, seed yields and their components in both 2017/2018 and 2018/2019 seasons

Traits	Technical length (cm)		Fruiting length (cm)		Stem diameter (cm)		Straw yield/plant (g)		Number of capsule /plant (N0)	
Item	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Nitrogen	75.97	78.25	20.57	22.46	2.58	2.66	0.80	0.87	20.33	20.92
Nitroben	64.11	66.33	17.09	18.32	2.15	2.16	0.68	0.73	11.75	12.92
Nitrogen +Nitroben	78.93	81.21	24.44	26.30	2.97	3.07	1.19	1.23	25.67	25.83
LSD 5%	1.61	1.65	0.83	0.92	0.14	0.11	0.17	0.15	1.32	1.15

Traits	Number of seeds/plant(N^0)		Seed index (g)		Seed yield/plant (g)		Seed yield/fed (kg)		Straw yield/fed (ton)	
Item	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Nitrogen	139.42	149.75	9.46	9.50	0.85	0.88	650.08	641.50	3.04	3.17
Nitroben	73.50	83.83	9.18	9.35	0.57	0.65	446.17	466.75	1.68	1.76
Nitrogen +Nitroben	202.58	217.33	9.59	9.64	0.99	1.01	715.25	714.75	3.33	3.34
LSD 5%	9.35	7.97	0.11	0.12	0.05	0.06	11.98	28.44	0.13	0.12

Likewise, the positive effect of dual application of mineral and bio-nitrogen treatment (Nitriben plus 30 kg N/fed) was observed in seed yield/plant and its components. In this respect, the dual application of mineral and bio-nitrogen exceeded single application of 45 kg mineral nitrogen/fed and single application of bio-nitrogen in number of capsules/plant by (26.23% and 23.51%) and (118.44% and 100.00%), number of seeds/plant by (45.31% and 45.13%) and (175.62% and 159.24%), seed index (1.32% and 1.42%) and (4.44% and 3.10%), seed yield/plant by (16.80% and 15.49%) and (73.83% and 56.37%) and hence seed yield/fed by (10.02% and 11.42%) and (60.31% and 53.13%) in both seasons 2017/2018 and 2018/2019, respectively. This could be attributed to a vital role of N supplied in the metabolism and the meristemic activity leading to the increase of vegetative traits, which are responsible for cell division and elongation in addition to formation of the plant organs. This leads to more vigorous growth and consequently accumulation of more photosynthesis assimilates, which resulted in greater straw and seed yields as well as their components. The positive effect of combined application of N fertilizer with bio-nitrogen on straw and seed yields and their components in flax were recorded by Mostafa *et al.* (2003), El-Shimy *et al.* (2006) , Hussein (2007), Moawed *et al.* (2008), Abd El Daiem and El- Borhamy (2015), Mousa and El Borhamy (2015) and El-Borhamy (2016).

Interaction effects:

As shown in Table 4 the interaction effect between flax varieties and nitrogen fertilization had a significant effect on straw, seed yields and their components in both seasons. It is obvious that, Giza 11 surpassed Sakha 5 and Sakha 6 varieties under all fertilization treatments in both seasons. Planting Giza 11 with dual application of mineral and bio-nitrogen treatment (Nitriben plus 30 kg N/fed) produced the highest values of straw and seed yields as well as their components. Similar positive interaction effect has been reported by Abd El Daiem and El- Borhamy (2015), Mousa and El Borhamy (2015) and El-Borhamy (2016).

Table 4 . Effect of interaction between varieties and fertilization treatments on straw and seed yields as well as their components in 2017/2018 and 2018/2019 seasons

Traits		**Technical length (cm)**		**Fruiting length (cm)**		**Stem diameter (cm)**		**Straw yield/plant (g)**		**Number of capsule/plant (N^0)**	
Item		**1st**	**2nd**	**1st**	**2nd**	**1st**	**2nd**	**1st**	**2nd**	**1st**	**2nd**
Sakha 5	Nitrogen	62.60	64.83	19.28	21.20	2.25	2.20	0.72	0.75	17.75	17.00
	Nitroben	45.28	47.30	14.93	14.92	1.78	1.63	0.66	0.67	10.25	10.75
	Nitrogen + Nitroben	64.85	66.85	21.60	23.63	2.38	2.40	0.76	0.78	21.50	21.25
Sakha 5	Nitrogen	81.55	83.78	21.13	22.85	2.33	2.48	0.76	0.86	19.25	21.00
	Nitroben	73.68	75.95	18.63	20.20	2.05	2.18	0.61	0.71	11.75	13.50
	Nitrogen + Nitroben	84.95	87.30	24.58	26.78	2.70	2.95	1.19	1.22	25.50	25.25
Giza 11	Nitrogen	83.75	86.15	21.30	23.33	3.15	3.30	0.91	1.01	24.00	24.75
	Nitroben	73.38	75.73	17.70	19.85	2.63	2.68	0.76	0.81	13.25	14.50
	Nitrogen + Nitroben	86.98	89.48	27.14	28.49	3.83	3.85	1.63	1.68	30.00	31.00
LSD 5%		2.78	2.86	1.43	1.60	0.24	0.20	0.30	0.26	2.29	2.00
Traits		Number of seeds/plant (N^0)		Seed index (g)		Seed yield/plant (g)		Seed yield/fed (kg)		Straw yield/fed (ton)	
Item		1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Sakha 5	Nitrogen	124.25	129.00	7.11	7.11	0.71	0.74	543.75	502.50	2.65	2.75
	Nitroben	70.50	72.50	6.62	7.11	0.47	0.62	309.00	391.25	1.39	1.52
	Nitrogen + Nitroben	183.50	181.00	7.21	7.20	0.88	0.90	616.75	625.50	2.84	2.96
Sakha 5	Nitrogen	134.75	147.00	10.20	10.30	0.86	0.89	683.50	692.00	3.00	3.15
	Nitroben	70.50	82.00	9.85	9.80	0.58	0.66	510.25	493.50	1.76	1.89
	Nitrogen + Nitroben	194.75	222.25	10.26	10.35	0.92	0.93	735.75	727.50	3.31	3.34
Giza 11	Nitrogen	159.25	173.25	11.08	11.11	0.98	1.00	723.00	730.00	3.48	3.61
	Nitroben	79.50	97.00	11.08	11.13	0.66	0.67	519.25	515.50	1.89	1.88
	Nitrogen + Nitroben	229.50	248.75	11.31	11.37	1.17	1.21	793.25	791.25	3.83	3.73
LSD 5%		16.20	13.81	0.19	0.20	0.09	0.10	20.75	49.26	0.22	0.20

CONCLUSION

From the above-mentioned results, it could be concluded that bio-nitrogen fertilization played a major role in improving traits of the evaluated varieties under Kafr El-Sheikh conditions. The yielding capacity of Giza 11 with dual application of mineral and bio-nitrogen treatment (Nitriben plus 30 kg N/fed) was superior with compared to other varieties. Therefore, the preference was in favor of sowing Giza 11variety under Kafr El-Sheikh conditions, with dual application of mineral and bio-nitrogen treatment (Nitriben plus 30 kg N/fed) for straw and seed yields as well as their components.

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تأثير التسميد النيتروجيني المعدني و الحيوي علي المحصول و مكوناته لبعض أصناف الكتان

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أقيمت تجربة حقلية في المزرعة التجريبية في محطة البحوث الزراعية بسخا، محافظة كفر الشيخ، مركز البحوث الزراعية، مصر خلال الموسمين الشتويين 2018/2017 و 2019/2018 لدراسة تأثير التسميد النيتروجيني المعدني، الحيوي و توليفاتهم (45كجم نيتروجين/فدان، 500جم نيتروبين و 500 جم /فدان نيتروبين مع 30 كجم نيتروجين/فدان)علي محصولي القش، البذور و مكوناتهم لثلاثة أصناف (سخا 5، سخا 6 و جيزة 11) من الكتان. استخدم تصميم القطع المنشقة مرة واحدة في أربع مكررات. أظهرت النتائج التأثير المعنوي للأصناف، معاملات التسميد و تفاعلهم علي محصولي القش ، البذور و مكوناتهم خلال موسمي الزراعة. تفوق الصنف جيزة 11 علي باقي الاصناف في محصولي القش، البذور و مكوناتهم خلال موسمي الزراعة. الاضافة المزدوجة للنيتروجين المعدني و الحيوي (نيتروبين بالإضافة الي 30 كجم نيتروجين/فدان) أعطت قيم مرتفعة من محصولي القش، البذور و مكوناتهم. القيم المرتفعة لكل الصفات تم التحصل عليها بزراعة الصنف جيزة 11 المسمد بالمعاملة المزدوجة من التسميد النيتروجيني المعدني و الحيوي (نيتروبين بالإضافة الي 30 كجم نيتروجين/فدان). لذلك توصي الدراسة بأفضلية معاملة التسميد المزدوجة من التسميد النيتروجيني المعدني و الحيوي (نيتروبين بالإضافة الي 30 كجم نيتروجين/فدان لتحسين إنتاجية أصناف الكتان تحت الدراسة و خاصة الصنف جيزة 11 تحت ظروف محافظة كفر الشيخ، مصر.