Effect of nitrogen application methods and harvesting dates on yield and yield components of some flax cultivars

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Two field experiments were conducted during 2015/16 and 2016/17 seasons at Kafr El-Hamam Agricultural Research Station, Sharkia Governorate to study the effect of two methods of nitrogen application on yield and quality of three flax cultivars. In the 1st method, all N was applied prior to the first irrigation and in the 2nd method half N was applied prior to the first irrigation + ½ N dose prior to the second one. Application of 2nd method and delaying harvest from 135 to 150 up to 165 days after sowing (DAS) were associated with the highest values of yield and quality. Giza 10 variety ranked first and significantly surpassed the two other cultivars (Belnika and Sakha 5) in terms of straw yield. However, Sakha 5 outyielded significantly the two tested flax cultivars regarding seed yield. For highest values of yield and quality, we recommend planting Giza 10 and Sakha 5 flax cultivars with a split application of nitrogen and delaying harvest to up to 150 DAS.

Key words: Flax, cultivars, splitting nitrogen, harvest date

INTRODUCTION

Flax (Linum usitatissimum) is the most important dual purpose crop for oil and fiber production in Egypt and in the world. Therefore, more attention has been given lately to grow high yielding cultivars under more adapted agronomic practices for increasing not only seed yield but also quality traits of flax.

The applying of appropriate fertilizers at the suitable time and in the required quantities needed for the plant is one of the most essential elements that make the plant give a high output. Nitrogen fertilization splitting plays an important role in increasing the productivity and quality of flax as reported by Leilah et al., (1991), El-Hindi et al., (1992), Zedan (1994), Amany El-Refaie (1996). Harvesting dates were studied by many investigators who recorded the optimum stage of harvesting date gave the highest yields of straw and seed of flax as stated by El-Kady et al., (2010), Hussein (2012) and Amal El-Borhamy et al. (2015). Wider variability among flax cultivars for yield and yield components was reported by several investigators such as Hussein (2012), Mousa and Amal El- Borhamy (2015), Amal El-Borhamy (2016), Rashwan et al. (2016), Nawar et al. (2017), Sadi et al. (2017) and Emam (2019).

Therefore, the present investigation aims to study effect of nitrogen application methods on yield and quality of some dual flax cultivars under different harvesting dates and yield analyses.

MATERIALS AND METHODS

Experiments sites and design

Two field experiments in split split plot design with four replications were conducted during 2015/16 and 2016/17 seasons at Kafr El-Hamam Agricultural Research station, Sharkia

Governorate to study the effect of two methods of nitrogen application (1st method as all N dose prior to the first irrigation and 2nd one as ½N dose prior to the first irrigation + ½ N dose prior to the second one) and three harvesting dates (135, 150 and 165 DAS) on yield and quality of three flax cultivars.

In each season, a split split plot design with four replications was used. Every experiment included 18 treatments which are the combination between two methods of nitrogen application (All N dose before the first irrigation, ½ N dose before the first irrigation + ½ N dose before the second one), three harvesting dates (135, 150 and 165 DAS) and three flax cultivars (Belnika, Giza 10 and Sakha 5). The two methods of nitrogen application were arranged in the main plots and the three harvesting dates were allocated in the sub plots however the three flax cultivars were assigned in the sub sub plots. The sub sub plot area (the experimental unit) was (2 m x 3 m) equal 6 m2. The pedigree of the three tested flax cultivars were as follows: Belnika, Fiber type imported from Holand, Giza 10: local variety, fiber type selected from cross between (1.420 x Bombay) and Sakha 5, local variety, oil type selected from a cross (1.370 x 1.2561).

Some physical and chemical properties of a representative soil sample used in the experimental soil site (Table 1) were determined before preparation according to Jackson (1973).

Nitrogen fertilizer was applied at rate of 45 kg N/fed in the form of ammonium nitrate (33.5%N) according to the studied treatments. All other normal agronomic recommended practices of flax growing were followed.

At each studied harvesting time sample of ten guarded plants in each experimental unit in four replications were hand pulled carefully at random and left one week for complete air drying to determine yield components. However seed, straw and fiber yields/fed estimated from the central area of m2 of each sub sub plots and then the yields of seed, straw and fiber yields/fed were calculated. The retting process was made in Fiber Crops Research Department, Field Crops Research Institute, ARC, Egypt.

Data recorded

Yield and yield components: as total plant length (cm), technical length (cm), upper branching zone length (cm), straw yield/plant (g), straw yield/fed. (ton), fiber yield/fed. (ton), number of apical branches/plant, number of capsules/plant, number of seeds/capsule, seed yield/plant and seed yield/fed (kg).

Quality characters: as long fiber percentage, fiber length (cm) and fiber fineness (N.m) as according to Radwan and Momtaz (1966).

Statistical analyses

Analyses of variance of split split plot design were performed in each season according to Snedecor and Cochran (1982). Differences among treatment means were judged with least significant difference (LSD) at 5% level of significance. Moreover, combined analyses of variance over the two seasons was undertaken after confirmed of error variance homogenous at both evaluated seasons for each character according to Le Clerg et al., (1966).

RESULTS AND DISCUSSION

Yield and yield components

Effect of nitrogen fertilization methods

Significant differences were detected for yield and its components at both seasons and their combined as affected by N application methods as seen in table 2.

Splitting nitrogen fertilizer into two equal portions (½ dose before 1st watering + ½ dose before 2nd one) followed by significantly increased of total length/plant, technical length/plant, upper branching zone length, straw yield/plant, straw yield/fed, fiber yield/fed, number of apical branches/plant, number of capsules/plant, number of seeds/capsule, seed yield/plant, seed yield/fed, in the same order compared with adding all amount of nitrogen in one dose before 1st watering, which recorded the lowest values for all yield and yield components traits at both seasons and their combined analyses. Similar results were recorded by Leilah et al., (1991), El-Hindi et al., (1992), Zedan (1994), Amany El-Refaie (1996).

Effect of harvesting dates

Significantly responded with delaying harvesting dates from 135 to 150 days after sowing (DAS) was detected for yield and its components at both seasons and their combined analyses as shown in table 2. On the other hand, delaying harvesting dates up to 165 (DAS) increased total length/plant, technical length/plant, upper branching zone length/plant, without significant difference between the medium and the late harvesting dates for total and technical length/plant treats in this respect. This might be attributed to an increase in metabolites synthesized by flax plants owing to prolonged growth period and this was more pronounced especially during the second pulling dates which in turn increased dry matter accumulation plant organs till it reached the full maturity stage (2nd harvesting date). After this period the decline in yield could be due to decline in moisture content of flax. In addition delayed harvesting exposed flax plants to over maturity stage which often accompanied by decrease in dry matter content owing to be stored in seeds. In addition delay harvest exposed flax plants to over maturity which is often as companied by a loss of some plants organs (basal and apical branches and capsules). Confirmed results were recorded by El-Kady et al., (2010), Hussein (2012) and Amal El-Borhamy et al., (2015).

Effect of flax cultivars

Significant differences among three tested flax cultivars were observed with regard to yield and yield component traits at both seasons and their combined analyses as shown in table 2. Results of pooled data revealed that, Giza 10 exceeded Sakha 5 for total length/plant, technical length/plant, straw yield/plant, straw yield/fed, and fiber yield/fed. While, Sakha 5 out yielded Giza 10 for upper branching zone length, numbers of apical branches and capsules/plant, number of seeds/capsule, seed yield/plant and seed yield/fed. Whereas, Blenika cv. recorded intermediate estimates for straw yield traits, however it recorded lowest seed yield traits. The differences between the three evaluated flax cultivars could mainly be attributed to the difference in their genetically constitution and their response to the environmental conditions. These results are in a good line with those reported by Hussein (2012), Mousa and Amal El-Borhamy (2015), Amal El-Borhamy (2016) Rashwan et al. (2016), Nawar et al. (2017), Sadi et al. (2017) and Emam (2019).

Effect of interaction

The interaction effect between N application methods and harvesting dates on straw yield/plant and number of apical branches / plant (Table 3) were significant effect higher value of straw yield / plant were obtained with N application methods with 150 DAS in the combined (3.30 g), and number of apical branches/plant gave higher value of (11.1 branch) were obtained with N application methods and 165 DAS. However, lowest value of them (2.09 g) and (7.53 branch) for straw yield/plant were and number of apical branches/plant, respectively.

The interaction effect between N application methods and flax cultivars on total length, technical and seed yield/plant (Table 4) were significant effect higher value of total length were obtained with N application methods with Giza 10 in the combined (107.2 cm) and technical length (101.1

cm), while seed yield /plant with Sakha 5 (0.91 g). However, lowest value of them (84.6 cm), (71.0 cm) and (0.64 g) for total length, technical length and seed yield/plant, respectively. The interaction effect between harvesting date and flax cultivars on total length, technical length and seed yield/plant (Table 5) were significant effect higher value of total length were obtained with harvesting dates 165 after sowing with Giza 10 in the combined (117.8 cm) and technical length (104.2 cm), while seed yield/plant with harvesting dates 150 after sowing with Sakha 5 (0.93 g). However, the lowest value of them (80.8 cm), (67.9 cm) and (0.58 g) for total length, technical length and seed yield/plant. Similar results were reported by El-Farouk et al. (1980), El-Hariri et al., (1996), Hussein (2012) and Amal El-Borhamy et al., (2015).

Quality characters

Effect of nitrogen application methods

Data presented in table 6 revealed that flax quality traits i.e. long fiber percentage, fiber length and fiber fineness were significantly affected by nitrogen application methods. Results of the two seasons and their combined as presented in table 6 indicated that splitting nitrogen fertilizer in two equal portions (1/2 dose before 1st watering + ½ N dose before 2nd watering produced the highest values of quality traits as compared with adding nitrogen fertilizer fully in one before 1st watering.

The increase percentage of splitting nitrogen fertilizer in two equal doses than adding nitrogen fertilizer fully in one dose were for long fiber percentage, fiber length and fiber fineness traits as average of both seasons. This may be due to the addition of nitrogen in two doses may favorably influence accumulation of metabolites during the critical period of growth and development. These results are in agreement with those reported by Zedan (1994) and Amany El-Refaie (1996).

Effect of harvesting dates

Results presented in Table 6 revealed that flax quality traits i.e. long fiber percentage, fiber length and fiber fineness were increased significantly with delaying harvesting date from 135 to 150 DAS. As average of the two seasons, the second harvesting date (150 DAS) exceeded the first one (135 DAS) for long fiber percentage, fiber length and fiber fineness traits, respectively. The obtained results may be attributed to an increase in metabolites synthesis by flax plants owing to prolonged growth period and in turn the significant increase in quality traits.

Moreover, delayed harvesting date up to 165 DAS exposed flax plants over maturity which is often accompanied by a decrease in the moisture content inside flax plants. The increment in long fiber percentage towards maturity up to the second harvesting date (150 DAS) might be attributed to continuous precipitation of cellulose in the secondary walls of fiber cells. Whereas, fiber percentage after the second harvesting date was declined, this might be due to more lignifications which occurred late and this in turn increased retting losses resulting in lower fiber percentage. As for fiber length trait, results presented in table 6 indicated that fiber length, showed significant increase with delaying harvesting date up to 150 DAS, without significant different effect between the second and the third harvesting date for this trait as the average of the two seasons. Finally, fiber fineness trait, responded favorably to delay harvesting date Table (6). The maximum values of fiber fineness was achieved at the second harvesting date (150 DAS), this showed that the medium harvesting date could be recommended for high fiber fineness. The decline in fiber fineness with delaying harvesting date up to (165 DAS) is might be due to lignification which occurs in flax plants were left too long before harvesting. The results of fiber quality traits are in harmony with those obtained by El-Kady et al., (2010) Hussein (2012) and Amal El-Borhamy et al., (2015).

Effect of flax cultivars

Combined analyses of the two seasons for result given in Table (6) revealed that the differences among the tested flax cultivars reached the level of significant in flax quality traits i.e. long fiber percentage, fiber length and fiber fineness. Giza 10 ranked first and surpassed significantly the other flax cultivars and produced the highest values of fiber quality traits. However, Sakha 5 cv. gave the lowest values of these traits. The increments were between Giza 10 and Sakha 5 for long fiber percentage, fiber length and fiber fineness traits as average of the two seasons, respectively. On the other hand, Blenika recorded intermediate estimates for these traits. It could be concluded that fiber quality parameters depended mainly on varieties and this is mainly due to the genetic constituents and it is interaction with environmental conditions. Similar results were reported by Hussein (2012), Mousa and Amal El-Borhamy (2015) and Amal El-Borhamy (2016).

Effect of interaction

The interaction effect between N application methods and flax cultivars on long fiber % and fiber length (Table 7) were significant effect higher value of long fiber % and fiber length were obtained with N application methods with Giza 10 in the combined (18.1 %) and (94.1 cm), while lowest value of them (14.4 %) and (67.3 cm) with N application methods with Sakha 5, respectively.

Combined data in (Table 7) showed that significantly affected by the effect between N application methods and harvesting dates on fiber length, where highest value (89.2 cm) were obtained with N application methods and 150 DAS, however , lowest value (74.0 cm) with N application methods and 135 DAS.

The interaction effect between harvesting dates and flax cultivars on fiber fineness (Table 8) were significant effect higher value were obtained with harvesting date 150 DAS with Giza 10 in the combined (273.2 Nm), However lowest value (220.5 Nm) were obtained by harvesting date 135 DAS and Sakha 5.

Recommendations

Under the condition of the present study, it could be recommended to growing the new released flax cultivars Giza 10 and Sakha 5 by splitting nitrogen fertilizer in two equal doses (1/2 N dose before the first irrigation + ½ N dose before the second one) and harvesting their plants at 150 days after sowing for maximizing their straw and seed productivity with best quality.

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