EFFECT OF MINERAL FERTILIZATION AND PLANT DENSITY ON SOME FLAX VARIETIES UNDER SANDY SOIL CONDITIONS

By

RIHAM HAMED HASSAN AHMED
B.Sc.Agric.Sci. (Agronomy), Fac. Agric., Cairo Univ., 2004

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APPROVAL SHEET

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ABSTRACT

This study was carried out at Ismailia Agric. Res. Station, Ismailia Governorate, Egypt, during two seasons (2005/06 and 2006/07) to study the effect of three NPK combinations {(45, 25, 24 kg/fed.), (60, 50, 36 kg/fed.) and (75, 100, 48 kg/fed.)} and three plant densities i.e. 1500, 1750 and 2000 seeds / m^2 on yield and yield attributes for three flax **(*linum usitatissimum* L.)** varieties (Sakha 2, Sakha 3 and Sakha 4) under sandy soil conditions. The experimental design was split-split plot design with three replications. The obtained results could be summarized as follows:

Sakha 4 variety ranked first in plant height (first season), technical length, fiber yield, fiber length and total fiber percentage (in both seasons). Whereas Sakha 2 variety ranked first in plant height (second season), stem diameter, straw yield / plant as well as per feddan, biological yield / plant as well as per feddan, upper branching zone length, number of capsules / plant, number of seeds / capsule, seed index, seed yield / plant, as well as per feddan, oil yield / fed. and oil percentage in both seasons.

The use of 1500 seeds /m^2 resulted in a significant increase in stem diameter, straw yield / plant, biological yield / plant, upper branching zone length, number of capsules / plant and seed yield / plant. While increasing plant density to 2000 seeds / m^2 increased significantly plant height, technical length, straw yield / fed., fiber yield / fed., biological yield / fed., seed yield / fed., oil yield / fed., fiber length, total fiber percentage and oil percentage in both seasons.

The use of 75, 100 and 48 kg / fed. NPK combination caused significant increase in all characters under study such as plant height, technical length, straw yield / plant as well as per fed., fiber yield / fed., seed yield / plant as well as per fed. and oil yield / fed. in both seasons.

All the interactions between the three factors under study were significant in the most cases. Where the highest fiber yield / fed. was produced by Sakha 4 variety when sown with 2000 seeds / m^2 and received the highest NPK combination. Whereas the highest seed yield / fed. was produced by Sakha 2 when sown with the same plant density and NPK combination.

Key words: Flax, Varieties, Plant density, NPK fertilization, oil, fiber.

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CONTENTS

INTRODUCTION

In Egypt Flax (***linum usitatissimum*** **L**.) ranked second after cotton as a fiber crop regarding the cultivated area and industry importance. The fibers, which extracted from flax stem by retting process is a good row material for textile in addition to the oil obtained from seeds. Therefore, many industries had been established on fiber and seeds of flax. Flax yield potential could be sustained through the use of high yielding varieties with application of the best agronomic practices such as plant densities and NPK fertilization.

Fresh linseed oil is used as human food and after boiling and treated chemically used as painting and varnish industries. Moreover, linseed cake is a valuable protein source to poultry and ruminants. Recently, the cultivated area by flax in Egypt tended to decrease in the valley lands due to great competition with other major winter crops. Therefore, the flax limited area was insufficient to provide with the progressive demands for Egyptian population. For this reason, the extension of flax cultivated area must be occur in newly reclaimed lands especially in sandy soils under modern sprinkler irrigation system.

Varietal differences among flax varieties have been reported by many investigators they found that significant differences among the test genotypes in seed yield, straw yield and oil yield as well as their components.

The effect of plant density on fiber and seed yields as well as their quality was studied by many investigators found significant increased in plant height, straw as well as seed yield per feddan, but

significant decreased in number of capsules, straw and seed yield per plant with increasing plant density.

Concerning mineral fertilization with nitrogen, phosphorus and potassium (NPK), many workers illustrated the great role of these elements for flax plants growth, especially nitrogen and phosphorus in ancient valley land. Increase NPK fertilizer level gave significant increase in plant height, technical length, number of capsule and seed numbers / plant, seed and oil yields (kg/fed.), straw yield (ton/fed.).

The sandy soil contains small amount of nitrogen and organic matter in addition to few potassium element. Therefore, it could be compensate this case by adding nitrogen fertilizer levels, phosphorus and potassium. In this respect, many studies should be carried out in this case to maximize the flax productivity on such new lands.

The main goals of this investigation were to study the response of three flax genotypes to three plant densities and three NPK fertilization levels under sandy soil conditions.

REVIEW OF LITERATURE

Hassan and El-Farouk (1987) studied the effect of three plant densities (35, 50, 65 kg seeds/fed.) on yield for two flax varieties Giza 6 and Belinka. They found that Giza 6 sowing at 50 kg/fed. gave the highest seed yield of 796.5 kg and fiber yield of 650.9 kg, whereas in Belinka, sowing at 35 kg/feddan gave max. seed yield of 448 kg and max. fiber yield of 877 kg. Sowing rate had no effect on seed oil content in Giza 6 but this declined in Belinka at the highest sowing rate. Sowing rate had no effect on fiber length in either cultivar, but increased fiber strength and fineness in Giza 6.

Mukherjee *et al*. (1987) found that increasing rates of N from 0 to 120 kg /ha. increased the number of capsules/plant and seed yields, but had no effect on oil content. Application of 50, 100 kg P_2O_5/ha. increased number of capsules/plant but had no effect on yield.

Rafey *et al*. (1988) found that application of 40 kg N/ ha. gave seed yields of 1.42 t/ha. and seed oil contents of 39.7% compared with 1.21 t and 40.3% respectively**.** Without N further increase in N rates decreased yields and oil contents. Application of 20, 40 kg P_2O_5/ha. had no effect on yields or oil contents.

Tiwari *et al*. (1988) showed that application of 30, 60 and 90 kg N/ ha. increased seed yields by 56.2, 90.1 and 104.7% respectively**.**

Awashti *et al*. (1989) found that seed yield increased from 0.87 to 1.25 ton/ha. with increasing N rates from 0, 15, 30 to 45 kg N /ha. and from 0.98 to 1.22 ton with increasing P rates from 0, 10 and 20 P_2O_5/ha. (45 kg N + 20 kg P_2O_5 / ha.). Increasing N rates increased the

number of capsules/plant and seed index but increasing P rates had no effect on seed index.

Jain *et al.* (1989) reported that increasing N rates from 0 to 20, 40 and 60 kg/ha. increased seed yields from 0.80 to 1.01, 1.41 and 1.95 t/ha., respectively. Appling 0, 15 or 30 kg P_2O_5/ha. gave yields of 1.16, 1.29 and 1.43 ton respectively. N and P application also increased number of branches and capsules/ plant, number of seed/ capsules and seed index.

Thakur and Srivastava (1989) found that increasing N rates (0, 20, 40 and 60 kg/ha.) increased seed yields from 425 to 787 kg/ha. but decreased seed oil contents from 38.6 to 36.9%.

El-Gazzar (1990) indicated that Belinka variety had higher values in fiber percentage, fiber length, fiber yield per plants as well as per fed than the commercial variety Giza 5. He found also the S.2419/1 surpassed Belinka variety in oil content and oil yield per fed.

Gaafer *et al.* (1990) found that S.81/4 was superior in total plant height, technical length, straw yield per plant as well as per fed and fiber yield per fed. They also found that Giza 6 variety was superior in seed yield and its associated characters followed by I.191. Meanwhile, S.3248/1 was the lowest in this trait.

Ghanem (1990) studied the effect of N fertilizer levels (0, 25, 50 and 75 kg N/fed.) on oil and fiber yield of Giza 6 cultivar. Found that increase N fertilizer level up to 75 kg N / fed gave significant increases in plant height, technical length, capsule and seed numbers / plant, 1000- seed weight, seed and oil yields / fed., straw yield / fed, fiber

length and percentage and fiber yield / fed., compared to other N levels and un-fertilized control.

Khalil (1990) found that straw yield of flax increased significantly by 7.9% and 13.1% while fiber yield increased by 16.0% and 35.3% when seeding rate was 70 and 90 kg / fed, respectively. On the other hand, oil percentage significantly decreased by 0.17% and 0.50% when plant density increased from 50 to 70 or 90 kg / fed, respectively.

Mostafa (1990) concluded that seed yield per fed and oil percentage in flax seeds were not significantly affected by variation in seeding rate from 30 to 60 kg / fed. He found that fiber length significantly increased when seeding rate increased from 30 to 60 kg / fed.

Yadav *et al*. (1990) showed that applying 0, 30, 60 and 90 kg N/ ha. gave seed yields of 0.81, 1.07, 1.25 and 1.27 t / ha. respectively and 0, 15 and 30 kg P_2O_5/ha. gave 0.94, 1.16 and 1.20 t / ha. respectively. Increasing rates of N and P increased seed index, seed oil contents increased with increasing P rates but were not affected by N rates.

Zedan (1990) found that Giza 6 flax variety had the highest values of main stem diameter, number of capsules per plant, seed yield per plant, straw yield per plant, straw yield per fed, seed yield per fed, seed index and oil percentage. While Belinka variety surpassed Giza 6 in total plant height, technical length, fiber yield per fed and fiber length.

Kineber (1991) compared eleven strains of flax with the commercial variety Giza 5. He found that S.193/1 significantly out

yielded Giza 5 by 27% with regard to straw yield per fed and by 32% concerning fiber yield per fed. He also found that technical stem length, straw yield per plant, fiber length and fiber fineness of S.193/1 were higher than in Giza 5. Moreover, S.2561/1 surpassed the other strains in seed yield and its components, i.e. number of capsules per plant, seed yield per plant as well as per fed, seed index, oil percentage and oil yield per fed.

Abo-Kaied (1992) evaluated twenty flax genotypes including 4 commercial varieties (Giza 5, 6, 7 and 8). He found significant differences among genotypes for straw yield / plant, seed yield / plant, plant height, stem diameter, seed yield / plant, seed yield / fed., number of capsules / plant, number of seeds / plant, seed index. Also, Giza 7 flax variety gave the higher values for straw yield / plant, plant height and stem diameter than Giza 8.

Augustinussen (1992) used seeding rates of 80, 120, 160 and 200 kg seeds / ha. He found that straw yield increased from 2.24 t/ha at 80 kg seeds / ha to 5.72 t / ha at 200 kg seeds / ha, whereas plant height and seed yield decreased. A seed rate of 120 and 140 kg / ha were optimum for achieving the best total result based on utilization of both fiber and seed.

Bassi and Badiyala (1992) found that seeding rates of 60, 80 and 100 kg/ha gave mean fiber yields of 434, 572 and 606 kg/ha and seed yields of 573, 780 and 930 kg/ha, respectively.

Bramm and Dambroth (1992) used seeding rates of 150, 250, 500 and 1000 plants / m^2. Showed that the highest straw yield 5.68 t/ha was recorded from 1000 plants / m^2, seed number / plant ranged 44

from the highest crop density and 215 at the lowest density and number of tillers and capsules per plant decreased with increasing plant density.

Increasing N fertilizer from 0, 30, 60 or 90 kg/ha. increased plant height, number of capsules / plant, seed number / plant, seed yield / plant, seed index, oil yield and oil composition. But the highest oil yield / ha and straw yield / ha resulted from 60 kg N / ha.

Chaubey *et al*. (1992) found that N application at 40 and 80 kg / ha. increased seed yield by 37.4 and 39%, respectively in both seasons compared with the control, but decreased the oil content by 33.3 and 2.69%, respectively. Phosphorus application at 25 and 50 kg / ha increased seed yield and oil content over the control and significant responses were found with up to 80 kg N and 50 kg P_2O_5 / ha.

Dolgikh (1992) showed that the long fiber percentage was decreased with the increase of seeding rates from 25 up to 35 million seeds/ha.

Easson and Long (1992) in Northern Ireland using 60-180 kg seeds/ha and 20-25 kg N/ha. they found that the plant height, main stem diameter and fiber length decreased with higher seeding rates. While straw and fiber yield were increased with increasing N rate. Moreover, they added that the optimum plant density was 1800 plants / m^2, and that an N rate of 25 kg/ha was adequate for Northern Ireland.

Eghbal and Kahnt (1992) indicated that there were no differences in seed yield when flax was grown at plant densities ranged from 600-800 plants/m^2.

Freer (1992) found that the number of capsules per plant and seed yield per plant decreased with increasing plant density from 233 to 723 plants / m^2.

Mohamed (1992) studied oil seed flax *cv* Giza 6 at 30, 45, 60 and 75 kg seed / fed. He found that the greatest seed yield was obtained from 60 kg seed / fed in the first season and 45 kg seed / fed in the second season.

Shafshak *et al*. (1992) tested the effect of sowing rates of 30, 40, 50 and 60 kg/fed on the yield of flax cultivar Giza 6. They found that the sowing rate of 60 kg / fed gave the highest total plant height, technical stem length and straw yield / fed.

Sorour *et al.* (1992) reported that insignificant effect was obtained for seeding rates on total plant height, technical plant length, top branching zone length, seed index, seed yield per fed and oil percentage**,** but increasing seed rate increased straw yield per fed, fiber yield / fed and number of capsules per plant, while increasing seed rate decreased stem diameter, straw yield per plant, fiber length and seed yield per plant.

El-Shimy *et al.* (1993) evaluated four flax genotypes and found significant differences among them in all characters under study, whereas S.162/12 ranked the first followed by Giza 5, S.2465/1 and S.2419/1 in relation to plant height, technical length, main stem diameter as well as straw and fiber yields per fed., meanwhile, Giza 5 variety was superior in number of capsules per plant and seed yield per fed, followed by S.162/12, S.2419/1 and S.2465/1.

Obtained highly significant differences in technical length, straw and seed yields per fed, fiber length and fiber per fed due to increasing seed rate up to 70 kg / fed. On the contrary, there was remarkable reduction in main stem diameter, straw yield per plant, number of capsules per plant, seed yield per plant, seed index and oil percentage with increasing seeding rates.

El-Sweify (1993) reported that Giza 7 flax variety recorded higher values of technical length, straw yield per plant as well as per fed, fiber length, long fiber percentage and fiber fineness. On the other hand, S.2419/1 was superior in main stem diameter, number of capsules per plant, seed yield per plant as well as per fed, seed index, oil percentage and oil yield per fed.

Increasing plant density from 750 to 1000, 1250 and 2000 seeds / m^2 increased plant height, technical length, straw yield per fed and fiber length. On the other hand, there was a reduction in the main stem diameter, straw yield per plant, number of capsules per plant, seed yield per plant, seed index and oil percentage with increasing plant density from 750 up to 2000 seeds / m^2.

Lafond (1993) using sowing rates of 22-78 kg seed/ha with low (0-32 kg N/ha) or high (24-72 kg N/ha) rates of N fertilizer. He found that seeding rate caused significant effect on the yields of the straw and seed whereas increasing seeding rate from 22-78 kg seeds / ha increased significantly straw yield and seed yield / ha. and higher N rates increased seed yield in both seasons.

Mahmoud (1993) found that the highest seed rate increased the total length, technical length, straw yield, fiber yield, seed yield, oil