

EFFECT OF PLANT DENSITY AND FERTILIZER LEVELS ON GROWTH AND SEED QUALITY OF PEA PLANT.

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ABSTRACT

Two experiments were carried out at Parramoon Experimental Farm (El-Dakahlia Govenorate) during winter seasons of 1998 – 1999 and 1999 – 2000. Seeds of dwarf pea *Pisum sativum* L. cv. "Master B." were sown either on one or both sides of the ridges; 60 cm width at 10 cm apart. Plants were fertilized with three level of ammonium sulphate (20.5% N), calcium super phosphate (16% P₂O₅) and potassium sulphate (48% K₂O) i.e. (150, 200 and 75 Kg/fed.), (200, 250 and 100 Kg/fed.) and (250, 300 and 150 Kg/fed.) of each fertilizer, respectively.

Therefore, this experiment included 6 treatments which are the two plant densities arranged in main plots with three N, P and K treatments as sub plots.

Low plant density were significantly increased plant height, dry weight, dry matter % and No. of pods per plant and hepocetyl length at the first season only. Fresh yield per plant, per plot and per feddan, NPK content of leaves were significant increasing both season.

Plant density did not significantly affect these parameters; No. of branches and leaves per plant, No. of seeds per pod, No. of pods per plant, seed yield per plant and feddan, misocotyl length and dry seeds protein content %.

Moreover, increasing NPK fertilizer levels clearly increased all vegetative characteristics of plant growth, fresh pod yield and seed weight per pod in both seasons. However, number and weight of pods per plant, per plot and per feddan were significantly affected by NPK fertilizer application levels only in the first season. Seed index and germination rate were also increased with increasing levels of NPK fertilizer only first season.

It could be concluded that low plant density combined with level of NPK fertilizer i.e. 250, 300 and 150 Kg of ammonium sulphate super phosphate and potassium sulphate, respectively improved dry seed yield and seed quality.

Keywords: *Pisum sativum* fertilization, NK fertilization leaves, plant density, dry seed yield, fresh pod yield and seed germination tests.

INTRODUCTION

Pea (*Pisum sativum* L.) is an important crops of fabaceae family. It is used as greens pods or dry seed. Maximizing the productivity of peas yield per unit area and improving its quality could be achieved by choosing the suitable cultural practices such as plant density.

Increasing plant population per feddan creates a competition among plants hence fertilizers requirements must be increased. Many studies were conducted in this field to determine the optimum rates of fertilizers under the different plant densities. In this respect, Abo Shetaia, 1990 and Amer, 1990 working on Master B pea plant, found that increasing plant density increased plant growth and dry matter content and total yield/feddan while low density caused a reduction in pods per plant and dry seed yield per plant. However, using higher density gave taller plants and higher dry seed yield/feddan.

As for the effect of nitrogen and phosphorus fertilizers on peas and its relation with the growth, Vijai and Singh (1990); Parased and Maurya (1992); Abo Baker *et al.* (1993a); Omar *et al.* (1996); Negm *et al.* (1998) and Amer (1998), indicated that increasing nitrogen and phosphorus application gave a significant increase in growth characters i.e., plant height, number of branches and leaves/plant and dry weight of leaves and branches/plant.

Regarding the effect of combination N, P and K fertilizers, Bakry *et al.* (1984 and 1985) and El-Neklawy *et al.* (1985) showed that the plant growth were increased by increasing N, P and K application. On the other hand, Zaghoul *et al.* (1988) and Hassan *et al.* (1993) pointed out that the vegetative growth in terms of plant height, number of leaves/plant and fresh and dry weight of plant was not significantly affected by N, P and K treatment.

Moreover, concerning the effect of N, P and K fertilizer on fresh podyield, seed yield and N, P and K content of leaves and proten content in dry seeds, several workers, Bakry *et al.* (1986) and Omar *et al.* (1990) on pea seed yield, mentioned that the highest yield of pea pods as well as the number and weight of seed per pod were obtained from the plants fertilized and with 60 Kg N, P and K/feddan. El-Neklawy *et al.* (1985); Tomes and Hungaria (1988); Pachauri *et al.* (1988); Zaghoul *et al.* (1988) and Abo-Baker *et al.* (1993b). Hewedy and Mohamed (1994). Moreover, Hammam (1995) on faba bean and El-Desoky and El-Far (1996) on soybean plants all reported that the seed yield was significantly increased with increasing N, P and K fertilizers application.

Recently Mohamed and El-Kabbany (1999) pointed that the number of pods/plant, seed index and green pod yield of pea per plant were significantly affected by increasing N, P and K fertilizer level. On the other hand Fritz and Rosen (1991) showed that N rate up to 92 Kg/ha had no effect on the seed yield of pea. Whereas, Vijai and Singh (1990) found that, N and K fertilizer rates had no significant effects on the dry seed yield of pea plants, while Shahien (1996) indicated that N and P fertilizers rates had no significant effect on the dry seed, yield of pea 1st year, however, in the 2nd year, dry seed yield increased with the rate of N and P fertilizers.

This work was undertaken to determine the optimum density of pea plants as well as the optimum N, P and K rate required with this density, in order to produce the maximum dry seed/yield withen the best quality.

MATERIALS AND METHODS

This study was conducted at El-Paramoon Experimental Farm during the two winter seasons of 1998 – 1999 and 1999 – 2000.

Seeds of pea *Pisum sativum* L. cv. Master B were sown on October 15th for both seasons (ridges 60 (cm.) width, 4 m. length in hills 10 (cm.) apart).

Chemical analysis of the experimental soil was determined by methods of Jackson (1958) and shown in Table (1).

Table (1): Mechanical and chemical analysis of the experiment soil.

Soil properties	98/1999	99/2000	Soil properties	98/1999	99/2000
Coarse sand %	1.50	1.63	Clay	2.80	2.75
Fine sand %	22.00	21.47	Organic matter	1.90	2.10
Silt %	25.73	25.88	Total nitrogen	0.13	0.14
Clay %	49.60	49.13	Available P	7.15	7.95
Organic matter %	Clay	Clay	Exchangeable K	215.00	229.00
			pH	7.90	8.02

The following treatments were used:

- 1- Two plant densities as seed sowing on one or two side of the ridges.
- 2- Three levels of NPK nutrient as follows:
 - The low fertilizer level is 150 Kg. ammonium sulphate (20.5% N) plus 200 Kg. calcium superphosphate 16% P₂O₅ plus 75 Kg. potassium sulphate (48% K₂O) per feddan.
 - The medium fertilizer level is 200 Kg. ammonium sulphate 20.5% plus 250 Kg. calcium superphosphate 15.5% plus 100 Kg. potassium sulphate 48% per feddan.
 - The high fertilizer level is 250 Kg. ammonium sulphate plus 300 Kg. calcium superphosphate plus 150 Kg. potassium sulphate per feddan.

These fertilizers amount were mixed and divided into two equal parts, applied 3 and 6 weeks after sowing.

A split-plot design with three replicates was used, plant density was considered as main plots however the three NPK fertilizer levels were arranged in the sub plot. Each treatment consisted of 4 ridges (9.6 m²). Representative sample (4 plants) were taken by at random from each plot 75 days after sowing to study plant growth measurements.

Data were recorded for the following items and were taken as follows:

- 1- Vegetative growth characteristics presented as stem length cm., number of branches, leaves and dry weight, dry matter % plant foliage.
- 2- Yield and quality of green pods per plot and calculated per fed..
- 3- Dry seed yield and it's components i.e. No. of pods plant No. of seeds/pod, seed weight pod (g.), seed weight plant (g.) and seed yield Kg. feddan.
- 4- Dry seed parameter i.e. seed index as weight of 1000 seeds, seed germination percentage, germination rate (days). Germination rate days was determined at 25°C according to the equation reported by Cleland, 1957 as follows:

$$GR = \frac{d_1n_1 + d_2n_2 + \dots + d_xn_x}{\text{germination percentage}}$$

Where: n₁, n₂, n₃ = number of seed germinated in the first, second, third and x countings.

d₁, d₂, d₃ and d_x = number of days after planting up to the first, second, third and x countings.

Germination rate index ERT according to the equation reported by Bartlett (1937) as follows:

$$ERT = \frac{n_1 + (n_2 + n_2) + (n_1 + n_2 + n_3) + \dots + n_x}{C (n_1 + n_2 + \dots + n_x)}$$

Where: $n_1, n_2, n_3, \dots, n_x$ = number of germinated seeds at first, second, third and x counting

C = number of counts.

Germination test experiment was applied on mature extracted seeds from pods 100 seeds was taken by random to test seed viability. The germination test of seed took place for 15 days in the incubator under optimum temperature of 25°C.

At 15 days after germination the following measures were taken.

- 1- The length of each of hypocotyl (cm.)
- 2- The length of each of mesocotyl (cm.).
- 3- Seedling length (cm.).

Chemical composition of leaves:

Leaf contents of N, P and K; were determined in the fourth and fifth/leaves from the top of the main stem from three plants of each treatment chosen at random according to the methods described by Piper (1947); Richard (1954) and Mettk – John (1970) respectively.

Chemical composition of seeds:

Total protein was determined in dry seeds as gm/100 gm dry weight by using Micro-Kjeldahle method according to Piper (1947).

Data were statistically analysed by methods of Snedecor and Cochran (1967).

RESULTS AND DISCUSSION

1- Vegetative Characters:

Data recorded at Table (2) showed a clear significant effect due to plant density on plant height stem length, dry weight and dry matter content per plant in the first season only but these characters were insignificant in the second season. On the other hand, plant densities had no significant effect on branches and leaves number per plant in both seasons. Similar results were reported by Abo-Shetaia (1990) who found that low density of faba bean gave the highest number of branches and pods per plant as well as dry seed yield per plant. Mean while, increasing N, P and K levels significantly increased stem length, branches and leaves number, dry weight and dry matter content per plant, compared with the first level in two seasons. The favorable effect of N, P and K on the growth rate of pea plants might be due to increasing photosynthetic capacity which depend on the number of leaves per plant (Table 2). Number of leaves could be a reliable index for the superiority in the dry matter content.

These results are in agreement with these reported by Omar *et al.* (1990); Vijai and Singh (1990); Parased and Maurya (1992); Abo Baker *et al.*

(1993); Negm *et al.* (1998) and Amer (1998). They indicated that increasing nitrogen and phosphorus application gave a significant increase in growth of pea plant characters, i.e. plant height, number of branches and leaves/plant and dry weight of leaves and number of branches/plant. As for combination of N, P and K fertilizers on peas, Bakry *et al.* (1984 and 1985) and El-Neklawy *et al.* (1985). Showed that the studied characters were increased by increasing N, P and K application.

The same data showed also that the interaction between low plant density (one side of ridges) and levels of N, P and K fertilizers could an increase in stem length dry weight and dry matter content per plant. This trend was observed in both seasons and was significant in the first season. On the other hand, the interaction between density and N, P and K levels did not have a clear trend low number of branches and leaves per plant in both two seasons.

2- Yield and its components:

Data showing number of pods, yield of green pods per plant, per plot and per feddan are presented in Table (3). It's evident from such data that green yield and its component were significantly affected by low density when seeds were sown on one side of ridges than two sides in both seasons. While number of pods was affected in both seasons with a significant effect in the first one. These increments may be due to increasing light intensity by plants grown at low density. These results are in harmony with those of Abo-Shetaia (1990) who found that low density of faba bean plants gave the highest values of number of branches and pods per plant as well as dry seed yield per plant.

Concerning effect of nitrogen, phosphorus and potassium fertilizers, yield of green pods and its components was substantially increased by increasing N, P and K levels. This trend was observed in both seasons with a significant effect.

These results may be due to the stimulative effect of these nutrients on plant metabolism. In accordance with this view on pea plants Bakry *et al.* (1984) mentioned that the highest yield of pea pods as well as the number and weight of seeds per pod were obtained from the plants fertilized with 60 Kg NPK/feddan. (El-Neklawy *et al.* (1985); Pochauri *et al.* (1988); Zaghoul *et al.* (1988) and Tomes and Hungaria (1988)).

Recently, Mohamed and El-Kabbany (1999) clearly showed that the number of pods/plant, seed index and green yield of pea plant were significantly affected by increasing N, P and K fertilizers level.

Moreover, the interaction of density and N, P and K fertilizer levels revealed that high level of nitrogen, phosphorus and potassium application increased significantly green yield of plant grown on one side of the ridges. This trend was observed in both seasons but number of pods per plant was significantly affected in the first one.

3- Seed yield components:

It is evident from data presented in Table (4) that number of seeds per pod, number of pods and number of seeds per plant were not affected when

sown on both sides of the ridges in both two seasons. But seed index (weight 1000 seed) was affected at growing on two sides of the ridges. This trend was observed in both seasons and number of seeds per plant in the second one. Finally, seed index is worthy to mention that seeds development of pea and its production may be considered as an expression of plant growth and its dry matter content. Also the data illustrated in the same table indicated significant effect on number of pods per plant in both seasons but significant effect on number of seeds per plant in the second one and seed index in the first one. These results may be due to N, P and K fertilizers levels. These results are supported by findings of Abo-Baker *et al.* (1993) on peas, Hewedy and Mohamed (1994). They found that increasing N, P and K fertilizers levels markedly increased seed yield/feddan. Moreover, Hamman (1995) on faba bean and El-Dosoky and El-Far (1996) on soybean plants. They reported that the seed yield was significantly increased with increasing N, P and K fertilizers application. Besides, Mohamed and El-Kabbany (1999) showed that the number of pods/plant, seed index and green yield of pea plant were significantly affected by increasing N, P and K fertilizers level. The interaction between density and N, P and K fertilizers level did not show clear trend in both seasons, but significantly affected on number of seeds per plant in the second season one and seed index in the first one.

4- Seed yield:

It is obvious from data presented in Table (5) that plant density had no significant effect on seed yield on quality in both seasons, while N, P and K fertilizer had less affect it could be noticed the superiority effect of N, P and K fertilizers levels in seed weight per pod in both season but seed weight per plant, plot and per feddan with a significant effect in the second one by increasing N, P and K level. Increasing seed yield with N, P and K application may be due to the simulative effect of these nutrients on plant metabolism synthesized. Also the difference in results may be due to using different treatments of N, P and K levels under different environmental conditions. Several reports were showed. Bakry *et al.* (1984) mentioned that highest yield of pea pods as well as the number and weight of seed per pod were obtained from the plants fertilized with 60 Kg N, P and K/feddan El-Neklawy *et al.* (1985); Pachauri *et al.* (1988); Zaghoul *et al.* (1988) and Tomes and Hungaria (1988).

However, interactions between each two of these studied factors were not significant.

5- Seed germinability:

In Table (6) data showed that germination percentage, germination rate and seedling length of the seeds produced due to seed sowing on the one sides of the ridges. These results are significant effect in this respect. But germination rate index and hepocotyle length in the first one. On the other hand mesocotyl length had no significant effect in both seasons. This may be due to the increase in seed index occurred by this treatment (Table 4).

It is clearly noticed from data shown in Table (6) that N, P and K fertilizer levels resulted in a significantly effect of germination percentage, germination rate index, hepocotyle, misocotyle and seedling length in both seasons-but germination rate in the first one. El-Shamma (1998) obtained

the opposite these results who found that bean seed germination percentage did not affected with NPK levels.

The interaction between density and N, P and K fertilizer levels had a significant effect on germination percentage and seedling length in both seasons and germination rate, germination rate index and hypocotyle length observed with a significant effect in first one. On the other hand hypocotyle length insignificant effect in both seasons.

6- Mineral composition of pea leaves and protein content in dry seed (%):

Data showing leaves content of nitrogen, phosphorus and potassium, also protein content in dry seed (%) are presented in Table (7). It's evident from such data that leaves content of N, P and K were significantly affected by low density when seeds were sown on one side of ridges than two side in both seasons. These results agree with Omar *et al.* (1990) on pea. But the interaction between N, P and K levels and plant densities treatments did not have a significant effect on the contents of N, P and K in leaves tissues of pea plant. Also data presented in the same table show that protein content in dry pea seed was not effected by either plant densities or N, P and K fertilizers level in both seasons of study. Also, the interaction between plant densities x N, P and K fertilizers had no significant effect on this character in both seasons of study.

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تأثير الكثافة النباتية ومعدلات مختلفة من السماد الكيماوى على النمو الخضرى والمحصول وجودة البذور فى البسلة .

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أجريت تجربتان فى مزرعة البرامون - محافظة الدقهلية خلال موسمى شتوى علمى ١٩٩٨ - ١٩٩٩ و ١٩٩٩ - ٢٠٠٠ لدراسة تأثير الكثافة النباتية مع استخدام معدلات مختلفة من التسميد الكيماوى ن، فو، بو على النمو والمحصول وجودة البذور لصنف البسلة ماستربى .
وكانت الكثافة النباتية هى الزراعة على ريشة واحدة وريشتين، بينما كانت معدلات التسميد الكيماوى هى ثلاث معدلات كالتالى:-

المعدل الأول	المعدل الثانى	المعدل الثالث	
٢٠٠ كجم/فدان	٢٥٠ كجم/فدان	٣٠٠ كجم/فدان	سوبر فوسفات الكالسيوم
١٥٠ كجم/فدان	٢٠٠ كجم/فدان	٢٥٠ كجم/فدان	سلفات الأمونىوم
٧٥ كجم/فدان	١٠٠ كجم/فدان	١٥٠ كجم/فدان	سلفات البوتاسيوم

ولقد أظهرت النتائج مايلى:-

- ١- قلة الكثافة النباتية (الكثافة المنخفضة) أدت إلى زيادة معنوية فى طول الساق والوزن الجاف للنبات والمادة الجافة للنبات وذلك للسنة الأولى فقط، بينما زاد دليل البذور (وزن الألف بذرة) فى كلا الموسمين .
 - ٢- بينما كان للزراعة على ريشة واحدة (قلة الكثافة النباتية) تأثيراً معنوياً بالنسبة لوزن القرون الخضراء ومكوناتها وقياسات الإنبات فى كلا الموسمين .
 - ٣- لم يكن هناك تأثيراً معنوياً للكثافة النباتية لعدد الأفرع وعدد الأوراق للنبات الواحد وكذلك عدد بذور القرن وعدد بذور النبات فى كلا الموسمين .
 - ٤- علاوة على ذلك فإن زيادة معدلات التسميد الكيماوى أدت إلى زيادة جميع صفات النمو والمحصول الطازج فى كلا الموسمين، وكانت الزيادة معنوية فى عدد بذور النبات ووزنها فى الموسم الثانى فقط .
بينما زاد وزن الألف بذرة وسرعة الإنبات فى الموسم الأول .
- والخلاصة:** زراعة بذور البسلة صنف ماستربى بكثافة قليلة مع استخدام التسميد الكيماوى بمعدل سلفات أمونيوم ٢٥٠ كجم/فدان مضافاً إليها سوبر فوسفات الكالسيوم ٣٠٠ كجم/فدان، وكذلك سلفات بوتاسيوم ١٥٠ كجم/فدان أدت إلى زيادة المحصول الأخضر والجاف إلى جانب جودة عالية .