Revue Agrobiologia
www.agrobiologia.net
ISSN (Print): 2170-1652
e-ISSN (Online): 2507-7627

EFFECT OF PLANT POPULATION AND DOSE OF NITROGEN AND POTASSIUM ON GROWTH AND YIELD OF SNAP BEAN *PHASEOLUS VULGARIS* L.

ABDALLA Hussein[1,2*] and BENMOUSSA Mebrouk [1]

1.University of Blida-1- Faculty of Nature and Life Sciences - Department of Biotechnology - Laboratory of Vegetables Biotechnologies Production., B.P. 270, road of Soumaa, Algeria
2.University of Kassala – Faculty of Agiculture and Natural Resources -Department of Horticulture Sudan

Reçu le 24/05/2017, Révisé le 19/06/2017, Accepté et mis en ligne le 30/06/2017

Abstract

Description of the experiment: This experiment was carried out in a split randomized complete block design with three replications.
Objectifs: This study goaled to evaluate the performance of plant population and dose of nitrogen and potassium on bean Cv. Djadida.
Méthodes: the effect of two plant population [P], one plant [P_1] and two plants per sac [P_2], and seven fertilizers doses [F], [N_0 K_0] [N_1 K_0] [N_1 K_1] [N_2 K_0] [N_2 K_2] [N_0 K_1] [N_0 K_2] were investigated.
Results The results presented that the plant population had no effect on number of leaves and branches per plant and plant dry matter, while the plant height significantly increased with increasing plant population [P_2] and on the other hand significantly decreased number of pods per plant. Fertilizers showed no significant difference on number of leaves and plant dry matter but significantly affected number of branches, plant height and number of pods per plant. The presenting of lower or higher dose of potassium without nitrogen [N_0 K_1], [N_0 K_2] gave the greatest number of branches, and the longest plant showed by lower dose of nitrogen without potassium [N_1 K_0] while the biggest number of pods presented by a plant received higher dose of both fertilizers [N_2 K_2]. Higher plant population [P_2] gave the higher number of leaves and the tallest plant when it was received no fertilizer [N_0 K_0] and the greatest number of branches in case of treated by lower dose of potassium without nitrogen [N_0 K_1], while single sowing [P_1] significantly increased plant dry matter and pods number when it was treated by lower dose of nitrogen without potassium [N_1 K_0] and higher dose of both fertilizers [N_2 K_2] respectively. In all case of treatments pod fresh weight was not affected.
Conclusion:: Despite the increase the number of pods in lower planting [P_1] the total number of pods was deficient, therefore, bean plants should be cultivated at two plants per sac [P_2] with application of higher dose of nitrogen and potassium [N_2 K_2].
Key words: Plant population, Fertilizers doses, bean, Growth, yield.

EFFET DE LA DENSITÉ ET DE LA DOSE DE L'AZOTE ET DE POTASSIUM SUR LA CROISSANCE ET LE RENDEMENT DE L'HARICOT *PHASEOLUS VULGARIS* L

Résumé

Description du sujet: Le dispositif expérimental adopté pour cette expérimentation est un split plot avec trois répétitions.
Objectifs: Cette étude a pour objectif d'étudier la performance du haricot Cv. Djadida sous l'effet de la densité de plantation et la fertilisation en azote et potassium.
Méthodes: afin d'étudier les effets de deux densités de semis [P], un plant par pot [P_1], deux plants par pot [P_1] respectivement et sept doses d'engrais selon les traitements suivants [F], [N_0 K_0] [N_1 K_0] [N_1 K_1] [N_2 K_0] [N_2 K_2] [N_0 K_1] [N_0 K_2].
Résultats: Les résultats ont montré que la densité de semis n'a pas d'effet sur le nombre de feuilles et de branches et la teneur en matière sèche, alors que la hauteur des plants augmente d'une manière significative avec la densité de semis [P_2]. La fertilisation affecte le nombre de branches, la hauteur des plants et le nombre de gousses par plant. L'utilisation d'une dose de potassium élevée ou basse sans apport d'azote a donné le plus grand nombre de branches et le plant le plus long a été obtenu avec une dose d'azote la plus faible sans apport de potassium alors que les doses les plus élevées ont donné le nombre de gousses le plus élevé par plant. Dans tous les cas des traitements, le poids frais des gousses n'a pas été affecté.
Conclusion: Malgré l'augmentation du nombre de gousses par plant avec une dose de semis basse [P_1], le nombre de gousses a été déficient par unité de surface. De ce fait, les plants de fève doivent être cultivés d'une manière convenable avec une densité élevée de deux plants par sac [P_2] en combinaison avec des doses élevées d'azote et de potassium [N_2 K_2].
Mots -clés Densité de semis engrais, fève, croissance, rendement.

* Auteur correspondant: Abdalla Mohamed Hussein, E-mail: *abdallamohussein@gmail.com*

INTRODUCTION

There are many competitive factors that play an extremely important role in beans production and profitability to the producer. Therefore, fertilizers, row spacing and seeding rate are vital factors that producers must consider when planting bean crops. It is important to plant, the number of seeds that will achieve the desired number of plants per acre in a uniform stand of beans [3]. Plant population and soil fertility are both important crop production factors [10; 9]. Application of nitrogen and potassium with variable quantities, enhanced almost all the vegetative and yield characteristics [1]. These two elements essential for plant growth: nitrogen (promotes leaf growth) and potassium (stem and root growth and protein analysis) [2]. Nasri and Khalatbari [7], reported that plants which were treated by nitrogen and potassium had more new leaves on the top of stem than those treated with other fertilizing treatments.–And caused an increase in light efficiency. Radiation absorption decreased when there were coating agents of nitrogen and potassium. Low crop productivity is a general problem facing most. Furthermore, low yields are often associated with declining soil fertility and are accentuated in vegetable farming systems. We investigate for that purpose, the performance of plant population and dose of nitrogen and potassium on bean (*Phaseolus vulgaris* L.) Cv. « Djadida ».

MATERIALS AND METHODS

1. Experiment description

This study was conducted during winter season in 2015/2016 in a greenhouse conditions (means of minimum and maximum temperatures were 14.40 and 24.42°C) situated in the department of biotechnologies at Blida region.

The experiment was laid out in split randomized complete block design with three replications. Four plastic bags, containing 8.5 kg of Blida soil were used as experimental units. Soil is heavy clay with pH 7.75, and electric conductivity 0.49 ds/m, contained 0.20 Meg/100g potassium sulfate, 0.80 g/Kg azotes and 1.80% organic matter.

2. Treatments

Two factors; two plant densities [P], one plant per pot [P_1] and two plants per sac [P_2] used as main plot, and seven fertilizers doses [F], [N_0 K_0] [N_1 K0] [N_1 K_1] [N_2 K_0] [N_2 K_2] [N_0 K_1] [N_0 K_2] used as sub plot. N_0, N_1 and N_2 equal to 0.46, and 0.92 g CO $(NH_2)_2$ [46% nitrogen] per pot respectively, while K_0, K_1 and K_2 equal to 0.42 and 0.84 g K SO_4 [50% potassium] per pot respectively. The fertilizer treatments were applied as one dose, at the first month from planting. The seeds were flooded in water for one day and pre-sown in moist piece for four days, and then were transplanted into pots, after that the plants were irrigated by equal quantities of water according to the needs of plants.

3. Data collection

The data was recorded [40 days from sowing] to evaluate the effect of treatments on number of leaves and branches per plant, plant height (cm) and shoot dry matter (%), number of pods per plant from four plants, in addition to pod fresh weight (g) from twenty ripened pods.

4. Statistical analyses

The data was statistically analyzed using computer software programme [MSTAT-C] and Duncan multiple range test D. M. R. T, at probability ≤ 0.05.

RESULTS

1. Number of leaves and branches per plant

As mentioned in table 1, increasing plant population up to two plants per pot [P_2] had no significant effect on leaves and branches number per plant. Different fertilizer doses of nitrogen and potassium showed no significant effect on number of leaves per plant while they affected significantly the number of branches. Few numbers of leaves and high numbers of branches recorded in both low and high fertilizers dose of potassium without nitrogen [N_0 K_1; N_0 K_2]. Lower value of branches observed in equal low dose of both fertilizers [N_1 K_1]. The interaction effect of plant population and fertilizer treatments was significantly different in both parameters.

High plant population [P_2] which was not fertilized [N_0 K_0] and that one which was treated by lower dose of potassium without nitrogen [N_0 K_1] gave the higher leaves and branches number, respectively. Single planting [P_1] which have only received lower dose of nitrogen [N_1 K_0] had a decreased leaves number per plant while, the sowing of two plants per pot [P_2] gave the lower number of branches per plant when they were treated by the same lower doses of both fertilizers [N_1 K_1].

Table 1: Effect of plant population, nitrogen and potassium fertilizer and their interactions on number of leaves and branches per plant

No. branches/plant			No. of leaves/plant				
Mean	P_2	P_1	Mean	P_2	P_1	Fertilizer	
4.11^{ab}	4.33^{ab}	3.89^{ab}	6.38^{a}	6.83^{a}	5.92^{ab}	N_0	K_0
4.33^{ab}	4.17^{ab}	4.50^{ab}	5.83^{a}	6.17^{ab}	5.50^{b}	N_1	K_0
3.74^{b}	3.16^{b}	3.86^{ab}	6.25^{a}	6.50^{ab}	6.00^{ab}	N_1	K_1
4.07^{ab}	3.97^{ab}	4.17^{ab}	5.90^{a}	6.25^{ab}	5.56^{ab}	N_2	K_0
4.09^{ab}	4.08^{ab}	4.11^{ab}	6.35^{a}	6.44^{ab}	6.25^{ab}	N_2	K_2
4.51^{a}	4.75^{a}	4.28^{ab}	6.21^{a}	6.50^{ab}	5.92^{ab}	N_0	K_1
4.49^{a}	4.42^{ab}	4.56^{ab}	6.00^{a}	6.17^{ab}	5.83^{ab}	N_0	K_2
	4.19^{a}	4.19^{a}		6.41^{a}	5.85^{a}	Mean	
PF 0,88	F 0.62	P 1.51	PF 1.09	F 0.91	P 0.69	LSD at 0.05	
		12.44			10.52	C V%	

The values holding different letters were significantly different according to duncan's multiple range test at probability ≤0.05

2. Plant height and shoot dry matter

The effect of plant population had on one hand a significant effect on plant height and on the other hand no significant effect on shoot dry matter. High plant population [P_2] increased plant height significantly against the lower plant density [P_1]. Plants which received small dose of nitrogen without potassium [N_1 K_0] and small dose of potassium without nitrogen [N_0 K_1] gave the longest and the shortest plant, respectively. Lower plant population [P_1] treated with higher nitrogen dose without potassium [N_2 K_0] and higher planting density [P_2] which received high quantity of potassium only [N_0 K_2] decreased plant height and the percentage of shoot dry matter, respectively (Table 2).

Table 2: Effect of plant population, fertilizer dose of nitrogen and potassium and their interactions on plant height (g) and shoot dry matter (%).

Shoot dry matter (%)			Plant height (cm)				
Mean	P_2	P_1	Mean	P_2	P_1	Fertilizer	
21.89^{a}	21.55^{ab}	22.23^{ab}	15.27^{ab}	17.54^{a}	13.00^{e}	N_0	K_0
21.77^{a}	19.59^{b}	23.69^{a}	16.04^{a}	16.13^{ab}	15.96^{abc}	N_1	K_0
19.42^{a}	19.49^{b}	19.35^{b}	15.58^{ab}	16.63^{ab}	14.52^{cde}	N_1	K_1
20.47^{a}	20.3^{0b}	20.63^{ab}	13.09^{c}	14.97^{bcd}	11.21^{f}	N_2	K_0
21.31^{a}	21.67^{ab}	20.95^{ab}	14.87^{ab}	15.84^{abc}	13.90^{de}	N_2	K_2
20.58^{a}	21.21^{ab}	19.94^{b}	13.02^{c}	13.13^{e}	12.92^{e}	N_0	K_1
20.10^{a}	18.78^{b}	21.60^{ab}	14.40^{c}	15.25^{bcd}	13.56^{de}	N_0	K_2
	20.37^{a}	21.24^{a}		15.64^{a}	13.58^{b}	Mean	
PF 3.11	F 2.61	P 1.19	PF 1.64	F 1.38	P 1.66	LSD at 0.05	
		8.87			6.68	C V%	

The values holding different letters were significantly different according to duncan's multiple range test at probability ≤0.05

3. Number of pods per plant and pod fresh weight

Number of pods per plant significantly response to the plant population, fertilizer dose and their interactions while, pod fresh weight had stable means against the treatments (Table 3). Plant population of one plant per pot_[P_1] increased number of pods per plant compared with higher population [P_2]. The greatest number of pods per plant generally given by the plants that received a higher dose of nitrogen and potassium [N_2 K_2] followed by plants treated by higher or lower doses of nitrogen with or without potassium [N_1 K_0; N_1 K_1; N_2 K_2]. Plants which received no fertilizer [N_0 K_0] had a fewer number of pods per plant which was statistically similar to the plants which received potassium without nitrogen in lower or higher dose [N_0 K_1; N_0 K_2]. The interaction between single plant per pot [P_1] in all fertilizer treatments gave the greatest number of pods per plant especially in case of nitrogen presence ~~of~~ [N_1 K_0; N_1 K_1; N_2 K_0; N_2 K_2] while the higher plant population [P_2] decreased the number of pods especially in case of nitrogen absence [N_0 K_0; N_0 K_1; N_0 K_2].

Table 3: Effect of plant population, fertilizer dose of nitrogen and potassium and their interactions on number of pods per plant and pod fresh weight (g).

Pod fresh weight (g)			No. of pods/plant				
Mean	P_2	P_1	Mean	P_2	P_1	Fertilizer	
5.17^{a}	5.17^{a}	5.17a	25.45^{c}	20.70^{d}	30.20^{b}	N_0	K_0
5.39^{a}	5.33^{a}	5.45^{a}	28.46^{ab}	23.38^{cd}	33.55^{a}	N_1	K_0
5.29^{a}	5.17^{a}	5.43^{a}	28.79^{ab}	23.49^{cd}	34.09^{a}	N_1	K_1
5.10^{a}	5.17^{a}	5.04^{a}	27.56^{abc}	21.04^{d}	34.07^{a}	N_2	K_0
5.26^{a}	5.20^{a}	5.33^{a}	29.37^{a}	23.88^{c}	34.87^{a}	N_2	K_2
5.34^{a}	5.30^{a}	5.38^{a}	26.59^{bc}	20.77^{d}	2240^{ab}	N_0	K_1
5.31^{a}	5.13^{a}	5.49^{a}	25.77^{c}	21.21^{cd}	30.33^{b}	N_0	K_2
	5.21^{a}	5.33^{a}		22.07^{b}	32^{a}	Mean	
PF 0.44	F 0.35	P 0.51	PF 2.55	F 2.14	P 3. 72	LSD at 0.05	
		4.93			5.52	C V%	

The values holding different letters were significantly different according to duncan's multiple range test at probability ≤0.05

DISCUSSION

The studies on the impact of various plant populations indicated that changing plants population per useable unit area may affect both the yield and yields components. As the plant population is increased per unit area, the absorbed light as well as the efficiency of using total radiation will be increased. Plant height increased with the increasing plant population because of light competition. Plant dry matter (except with interaction) and pod fresh weight were not affected by different treatments. Similar results were found by Dhanjal et al., [4], who noticed that the plant height increased with the increasing plant population. These results were also confirmed by Mureithi et al., [6], who evaluated bean plant Intra-row spacing of 10, 15, 20 and 30 cm (in rainy condition and the average annual temperature of 28°C). Spacing of 10 and 15 cm recorded the highest plant height while spacing of 20 cm produced the highest number of branches which was statistically similar to that of 15 cm spacing. Moniruzzaman et al., [5] noticed that a suitable combination of plant spacing and nitrogen level is very important in producing higher yield of French bean. Osman et al., [8] mentioned that fertilizers effect on bean plant showed no significant difference except on the number of pods per plant, which was the most important yield component affected by plant population. Increasing plant population up to two plants per pot [P_2] has induced decreased pods number per plant but not total pods number per unit area. Pod moisture content was slightly reduced by increasing plant population. Nasri and Khalatbari [7] found that the minimum pod yield was observed in lower nitrogen dose without potassium.

CONCLUSION

The total number of pods per bean plant is the most important yield component, which responded better to the plant population, nitrogen and potassium fertilizer application as well as their interaction. Therefore, it could be concluded from these results that bean plants should be cultivated at the suitable combination of plant population of two plants per pot [P_2] with application of higher dose of nitrogen and potassium [N_2 K_2].

REFERENCES

[1]. Beg, M.Z. & Sohrab, A. (2012). Effect of potassium on Moong Bean. *Indian J. L. Sci.* 1(2): 109-114.

[2]. Billore, S.D., Singh, K., Singh, A.P. & Bargale, M. (1994). Energy productivity of sorghum-wheat sequence through long term use of chemical fertilizers,[22] *Indian J of Agron* 39(2): 198-208.

[3]. Clint, H.B. & Timothy, B. (2005). The Effect of Different Seeding Rates on Soybean Yield. Institution: The University of Tennessee at Martin. Candidate for the Degree of Master of Science. https://www.utm.edu/departments/msanr/_pdfs/Clint%20Bain.pdf

[4]. Dhanjal, R., Prakash, O. & Ahlawat, I.P.S. (2001). Response of French bean (*Phaseolus vulgaris* L.) variety to plant density and nitrogen application. *Indian J. Agron*. 46: 277-281.

[5]. Moniruzzaman, M., Halim, G.M.A. & Firoz, Z.A. (2009). Performances of French bean as influenced by plant density and nitrogen application. *Bangladesh J. Agril. Res.* 34(1): 105-111.

[6]. Mureithi, D.M., Onyango, M.O., Jeruto, P. & Gichiu, B.M. (2012). Response of French bean (*Phaseolus vulgaris* L.) to intra-row spacing in Maseno Division Kenya. *J of Applied Sci,* 12: 96- 100.

[7]. Nasri, M. & Khalatbari, M. (2015). The effect of different Values of Nitrogen, Potassium and Zinc Fertilizers on Physiological characteristics of Green Bean (*Phaseolous vulgaris* gen. Sunray) in Iran. Biological Forum – *An International J* 7(2): 467-472.

[8]. Osman, A. A. M., Yagoub, S. O. & Tut, O.A. (2010). Performance of faba beans (*Vicia faba* L.) cultivars grown in new agro-ecological regions of Sudan (South Sudan). Aus. J. Basic and Applied Sci. 4: 5516-5521.

[9]. Rana, N.S., Singh, R. & Ahlawat, I.P.S. (1998). Dry matter production and nutrient uptake in French bean *(Phaseolus vulgaris* L.) as affected by nitrogen and phosphorous application. Indian J. Agron. 43 (1): 114-117.

[10]. Srinivas, K. & Naik, L.B. (1990). Growth yield and nitrogen uptake in vegetable French bean *(Phaseolus vulgaris* L.) as influenced by nitrogen and phosphorous fertilization. *Haryana J. Hort. Sci.* 19 (1-2): 160-167.