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Planting Density and Dose of Nitrogen and Potassium as Influencing Pod Characters of Snap Bean (*Phaseolus vulgaris* L.)

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ABSTRACT

The objective of this study is to investigate the planting density, nitrogen and potassium influencing on the pod characteristics of bean. The experiment is made in a Split Randomized Complete Block Design, replicated three times. Two plant densities and seven doses of nitrogen and potassium fertilizers were examined. The results reflected that density had no effect on pod attributes, except pod length in the second season, whereas significantly increased by the lower density. The plant received lower nitrogen lacking potassium increased length in the both seasons however, the higher individual potassium dose and control increased length in first and second seasons, respectively. The widest and narrowest pod diameters shown by the lower dose of nitrogen and higher dose of both fertilizers, subsequently. The separately maximum and minimum dose of potassium in the first and second season subsequently, in addition to the individual lower dose of nitrogen in the second season have a heaviest dry weight. The interaction significantly affected overall parameters, except pod diameter and dry matter in the first season. Pod dry matter is commonly constant, except with the higher density received the greatest dose of both fertilizers, whereas record significant decline. Pod length and diameter are good indicator of quality, it can be given by the lower density and lower dose of nitrogen without potassium. The combination between lower density with higher potassium dose or neutral dose of both fertilizers is a preferable for length while, the higher density with both doses of potassium or with lower nitrogen, is an appropriate for diameter. The best treatment for both, dry weight and dry matter are wobbly.

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Introduction

Bean plant (*Phaseolus vulgaris* L.) is a member of the family, Fabaceae, considered as one of the most important vegetable crops cultivated in many African countries for local markets and as a source of foreign currency (Hussien 2015). More than 90% of snap bean produced in Africa is exported to within Africa or to Europe (CIAT 2006). Bush type, is the common type grown for commercial production and have a somewhat uniform pod set (Ugen et al., 2005). Acceptable snap bean quality includes well-formed and straight pods, bright in color with a fresh appearance, free of defects, tender (not tough or stringy) and firm (Cantwell and Suslow 1998). Pod appearance, texture and curvature are the major physical qualities that directly influence pod quality for the fresh market. The diameter of the pod, rather than length, is a good indicator of quality. Buyers prefer pods with no or only slight bulges that indicate tender (Myers et al., 1999). There is no denying that supplying sufficient food for the rapidly growing population of the world presents one of the greatest challenges facing mankind at the present time. Supplying the world's food is the business of both farmers and researchers scientists in developed and developing countries alike. They are so little reserve lands suitable for cultivation, it is only possible to increase food quantity and quality by increasing crop production per unit area. To insure that, a proper cultural practices should be taking place, one of these, is a suitable plant density with a proper combination dose of fertilizer. Therefore, the objective of this study is to investigate the effect of plant density and nitrogen and potassium fertilizers on some the pod characteristics of snap bean plant Cv. Djadida.

Materials and Methods

This study was made out at the winter seasons of the years 2015 and 2015/2016 (means of the minimum and maximum temperature were 16.9; 26.1º C and 14.1; 24.4º C in both seasons, respectively), in the glasshouse of the laboratory of vegetables biotechnology production, Faculty of Nature and Life Sciences, University of Blida-1, Algeria. The layout of the experiment is a split randomized complete block design, replicated three times. Four plastic containers used as an experimental piece (33 cm length and 30 cm width), holding of 8.5 Kg soil.The treatments are two plant densities (D_1; D_2) D_1 equal to one plant and D_2 equal to two plants per container, it used as the main plot, 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; and N_0 K_2) used as sub plot. N_0, N_1 and N_2 equal to 0, 0.46 and 0.92 gram urea per pot respectively, while K_0, K_1 and K_2 equal to 0, 0.42 and 0.84 gram potassium sulfate per pot respectively. Twenty pods were randomly selected as a pattern during the harvesting time (five pods in barter harvest) and measured to obtain the mean of pod length (cm), pod diameter (mm), pod dry weight (g) and pod dry matter (%). The data were statistically analyzed using computer software programme (MSTAT-C), and Duncan Multiple Range Test used to separate means at a probability of ≤ 0.05.

Results

Planting Density and Dose of Nitrogen and Potassium Influencing Pod Length.

The results of variance analysis of pod length in Table 1. provide that plant density had a negligible and significant increase in the first and second season, respectively, whereas the longest pod obtained by the lower plant density (D_1). In both seasons, the longest pod observed in the plant treated with a half dose of nitrogen without potassium (N_1 K_0). The pod was also longest with a higher dose of potassium without nitrogen (N_0 K_2) and with no fertilizer application (N_0 K_0) in the first and second season, respectively. In the first and second seasons, the plant received no fertilizer (N_0 K_0) and the plant treated with a higher dose of nitrogen without potassium (N_2 K_0) gave the shortest pods, respectively. The combined effect of lower density (D_1) treated by a high dose of potassium (N_0 K_2) as in the first season, and the half dose of both nutrients (N_1 K_1) as in the second season, had a remarkable increase in pod length. Contrary to this, the higher density (D_2) which appeared shortest pod over most fertilizer treatment especially in the second season.

Planting Density and Dose of Nitrogen and Potassium Influencing Pod Diameter.

The results obtained from the pod diameter are set out in Table 2. closer inspect of both seasons shows that plant density had no significant effect on pod diameter. Different dose of both fertilizers were statistically similar in term of pod diameter during the first season, while it had a significant effect in the second season, whereas the half dose of nitrogen without potassium (N_1 K_0) increased pod diameter, while the high dose of both nutrients (N_2 K_2) decreased width. The interaction between plant density and fertilizer lacking significant effect on the first season, while in the second season, the maximum and minimum pod diameter recorded by the higher and lower plant density (D_2; D_1) treated with the low dose of nitrogen without potassium (N_1 K_0) and high dose of both fertilizers (N_2 K_2) respectively.

Table 1. Planting Density and Dose of Nitrogen and Potassium Influencing Pod Length.

Fertilizer	Season 1		Mean	Season 2		Mean
	D_1	D_2		D_1	D_2	
N_0 K_0	11.94	11.37	11.66	11.77	11.63	11.70
N_1 K_0	12.31	12.26	12.28	11.75	11.68	11.71
N_1 K_1	12.16	11.73	11.94	11.92	11.39	11.66
N_2 K_0	11.87	11.82	11.84	11.50	11.28	11.39
N_2 K_2	12.34	11.70	12.02	11.79	11.25	11.52
N_0 K_1	12.18	12.01	12.09	11.82	11.41	11.61
N_0 K_2	12.53	11.90	12.22	11.76	11.34	11.55
Mean	12.19	11.83		11.76	11.43	
LSD at 0.05	D 0.43	F 0.46	DF 0.55	D 0.13	F 0.27	DF 0.32
C V%		2.73			1.65	

The letter D, F and DF in Row of LSD mean Density, Fertilizer and Interaction between them, respectively.

Table 2. Planting Density and Dose of Nitrogen and Potassium Influencing Pod Diameter.

Fertilizer	Season 1		Mean	Season 2		Mean
	D_1	D_2		D_1	D_2	
N_0 K_0	7.87	7.85	7.80	7.46	7.49	7.56
N_1 K_0	7.87	7.11	8.02	7.46	7.76	7.70
N_1 K_1	7.87	7.92	7.89	7.61	7.37	7.49
N_2 K_0	7.87	7.81	7.82	7.45	7.39	7.42
N_2 K_2	7.87	7.88	7.91	7.31	7.38	7.34
N_0 K_1	7.87	8.07	7.89	7.54	7.54	7.54
N_0 K_2	7.87	8.06	8.04	7.38	7.40	7.39
Mean	7.87	7.69		7.51	7.48	
LSD at 0.05	D 0.04	F 0.14	DF 0.38	D 0.35	F 0.19	DF 0.24
C V%		2.84			1.88	

The letter D, F and DF in Row of LSD mean Density, Fertilizer and Interaction between them, respectively.

Table 3. Planting Density and Dose of Nitrogen and Potassium Influencing Pod Dry Weight.

Fertilizer		Season 1		Mean	Season 2		Mean
		D_1	D_2		D_1	D_2	
N_0	K_0	0.276	0.235	0.256	0.266	0.228	0.227
N_1	K_0	0.275	0.299	0.288	0.233	0.227	0.230
N_1	K_1	0.271	0.261	0.266	0.233	0.219	0.226
N_2	K_0	0.267	0.302	0.285	0.218	0.212	0.215
N_2	K_2	0.278	0.272	0.275	0.228	0.194	0.211
N_0	K_1	0.278	0.308	0.294	0.233	0.229	0.231
N_0	K_2	0.317	0.293	0.306	0.231	0.209	0.220
Mean		0.281	0.282		0.229	0.217	
LSD at 0.05		D 0.03	F 0.04	DF 0.05	D 0.02	F 0.02	DF 0.02
C V%			10.65			6.23	

The letter D, F and DF in Row of LSD mean Density, Fertilizer and Interaction between them, respectively.

Table 4. Planting Density and Dose of Nitrogen and Potassium Influencing Pod Dry Matter.

Fertilizer		Season 1		Mean	Season 2		Mean
		D_1	D_2		D_1	D_2	
N_0	K_0	5.27	4.80	5.04	4.44	4.31	4.37
N_1	K_0	4.89	5.67	5.28	4.18	4.23	4.21
N_1	K_1	5.02	5.11	5.06	4.29	4.22	4.26
N_2	K_0	4.91	5.72	5.31	4.30	4.17	4.23
N_2	K_2	5.07	5.07	5.07	4.45	3.57	4.01
N_0	K_1	5.27	5.87	5.57	4.27	4.57	4.42
N_0	K_2	5.71	5.28	5.49	4.57	4.16	4.37
Mean		5.14	5.47		4.36	4.18	
LSD at 0.05		D 0.75	F 0.89	DF 1.06	D 0.34	F 0.47	DF 0.56
C V%			11.92			7.77	

The letter D, F and DF in Row of LSD mean Density, Fertilizer and Interaction between them, respectively.

Planting Density and Dose of Nitrogen and Potassium Influencing Pod Dry Weight.

Table 3. clarified that the pod dry weight did not affect by the plant density. The application of full dose of potassium without nitrogen (N_0 K_2) in the first season and the separated half dose of both fertilizers (N_1 K_0; N_0 K_1) in the next season, had a weightiness dry pod. In the first season, the slight weight of dry pods presenting by a plant received no fertilizer (N_0 K_0) however, in the second season a mild weight reflected by a plant received a full dose of both fertilizers (N_2 K_2). A significant different appear due to the interaction, generally, the heaviness pod dry weight distributed overall densities (D_1; D_2) with different doses of fertilizer. The less weight of dry pod presented by the dense planting (D_2) received no fertilizer (N_0 K_0) and high dose of both fertilizers (N_2 K_2) in the first and second season, respectively.

Planting Density and Dose of Nitrogen and Potassium Influencing Pod Dry Matter.

As in Table 4. pods dry matter did not affect neither by plant density nor fertilizer and by their interaction except, in the second season. During the second season, dense planting (D_2) treated by the higher dose of nitrogen and potassium (N_2 K_2) significantly decreased the percentage of the pod dry matter against all other treatments.

Discussion

Bean is the most importance vegetable grown in Africa for consuming locally or for export, accordingly pod characters such as pod length, diameter, dry weight and dry matter is most be considered. The pod length was influenced by the treatments, the present result is confirmed by the findings of (Ellal et al., 1982; Stoffella et al., 1981) they regarded that the fruit size have been lower at high plant populations and Peter and Bonita, (1985) pod length recorded the highest values at lower plant density and Elhag, and Hussein, (2014) they get a positive effect on pod length with increasing plant spacing, this result exactly is a similar result of the first season. The increase in pod length due to increase plant spacing justified by many authors such as Aliyu (2007) who reported that the increase in pod length in the wider spacing may be a result of the availability of better growth resources to the individual plants. Narrow spacing might cause mutual shading which may cause floral abscission and pod dropping in the lower canopy strata. In the first season, the neutral dose of nitrogen improved this attribute. The result of researchers Kamanu et al., (2012) showed that used nitrogen improved pod length, while in the second season, the higher dose of nitrogen decreased pod length, this is a disagreement with the result of (Dahatonde and Nalamwar 1996; Dhanjal et al., 2001) who found that the highest level of nitrogen leading to the maximum pod length. The role of potassium effect on pod length being not sustainable, the findings of Beg and Sohrab (2012) presented that pod length increased with potassium concentration was increased and Nadeem et al., (2003) regarded that the different levels of potassium significantly affected the length of the pods and Kanaujia et al., (1999) who noticed that the pod length was significantly increased by the increasing level of potassium, however the authors (Kanaujia et al., 1997; Kanaujia et al., 1998) reflected that the increase in potassium level had no significant effect on pod length in pea, and Jamadagni and Birari (1994) in snap bean. The result of pod diameter, confirmed by the researcher Aguiar et al., (1998) who reported that plant density has no significant difference in pod size and (Ellalet al., 1982; Stoffella et al., 1981) which find that fruit size have generally been lower at high plant populations, in addition to Peter and Bonita (1985) which reported that pod width recorded the highest values at lower plant density. The individual lower dose of nitrogen at second season increased pod diameter is, this in a close with the findings of (Dahatonde and Nalamwar 1996; Dhanjal et al., 2001) which regarded that the level of 120 kg nitrogen, leading to the maximum width, and contrary to the notice of Kanaujia et al., (1999) reported that when potassium was applied to French bean, pod girth was significantly increased by the increasing level of potassium up to middle dose. The interaction between the combined treatments appear no significantly different during the first season and significant increase during the second season and this within the line of the researcher Elhag and Hussein (2014) which found a significant effect on the pod diameter due to the interactions between treatments. In spite of the pod dry weight is statically alike, the result of other indicate to a significant increase such as Essubalew et al., (2014) who get that the highest dry weight pod in a wider plant spacing, they justified that to the probably of that wider plant spacing allow plants get enough amount of moisture, with less competition between plants that resulted in better development of pods. The researcher Abubaker (2008) evaluates six planting densities found that pod dry weight tended to be higher under the lower planting densities. The contrary of this result may be due to different cultivar, soil, or environmental factors. In first and second seasons, higher and lower dose potassium application increased pod dry weight, subsequently, this in agreement of the result of Fanaei et al., (2011) they mentioned that the amount of potassium sulfate had a significant effect on yield weight, and with Hussien (2015) they reported that nitrogen application significantly affected pod dry weight, while the least value was produced by control. In both season, dry weight presented variable values due to the interaction combination, Likewise Moniruzzaman (2009) who indicated that there was a significant difference in the pod weight due to plant density and nitrogen rate interaction and Anonymous (2000) they found the maximum pod weight recorded with the lower plant density at the highest nitrogen level. The current of pod dry matter result was confirmed by Herath and Wahab (1972) which clarified that dry matter accumulation was the same throughout, except for 43 days after planting where the intermediate spacing happened to contain a higher amount of dry matter than the high density planting. However, this difference was no significant, Likewise (Amissah et al., 1999) who noted that dry matter was increased with increase in seed rates. The reference Ayub et al., (2010) noticed that the quality parameters like dry matter increased significantly by nitrogen application over control, while the authors Herath and Wahab (1972) inference that pod dry matter did not respond to interaction effect of nitrogen and spacing.

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