Advances in Crop Science and Technology
ISSN: 2329-8863

Negash et al., Adv Crop Sci Tech 2018, 6:3
DOI: 10.4172/2329-8863.1000369

Research Article Open Access

Yield and Yield Components of Snap Bean (*Phaseolus vulgaris* L.) as affected by N and P Fertilizer Rates at Jimma, Southwestern Ethiopia

Abdela Negash[1], Solomon Tulu[1] and Essubalew Getachew[2*]

[1]Department of Agricultural Extension Directorate General, Ministry of Agriculture and Natural Resource, PO Box 62347, Addis Ababa, Ethiopia

[2]Department of Horticulture and Plant Sciences, College of Agriculture and Veterinary Medicine, Jimma University, PO Box 307, Jimma, Ethiopia

[*]**Corresponding author:** Essubalew Getachew, Assistant Professor, Department of Horticulture and Plant Sciences, College of Agriculture and Veterinary Medicine, Jimma University, PO Box 307, Jimma, Ethiopia, Tel: +251-917-836108; E-mail: g.essu2011@gmail.com

Rec date: April 25, 2018; **Acc date:** May 29, 2018; **Pub date:** June 06, 2018

Abstract

Snap bean is one of the newly introduced legume crops in Ethiopia and it is an important crop in the provision of food security and earing forging currency. It responds much better to the application inorganic fertilizer especially N and P fertilizers due to lack of nodule forming bacteria in the soil and low in building of fertile soil. However, information concerning the production package of snap bean at Jimma was scares and due to this there is limited evidence in the response of snap bean to inorganic fertilizers (N and P fertilizers) which can increase yield and quality. Cognizant to this fact, the experiment was conducted to realize the effect N and P fertilizers rates on yield and yield components of snap bean at Jimma, Southwestern Ethiopia. The experiment consisted of two factors, five levels of N (0, 41, 82, 123, and 164 kg/ha) and four levels of P (0, 46, 92 and 138 kg/ha) arranged 5 × 4 in randomized complete block design with three replications. N as urea was applied in split application (50% at sowing and 50% at flowering) whereas the full dose of P was applied at sowing as triple super phosphate. There was a significant difference (P ≤ 0.05) for main effects of N and P fertilizer rates for all yield and yield component variables. Out of the whole variables tap root length were significant by the interaction effects of N and P fertilizers rate. The result showed that the maximum marketable pod yield was obtained from 123 kg/ha N and 92 kg/ha P_2O_5 fertilizer application rates. While, the minimum marketable pod yield was recorded from the application of 0 N and P fertilizer rate. So, form this experiment application of 123 kg/ha N and 92 kg/ha P_2O_5 increased the marketable pod yield of snap bean at Jimma. Since, the experiment was conducted in a single location and season. So, repeating the experiment for more seasons and similar location would help us draw sound conclusive recommendations to the end users.

Keywords: Inorganic fertilizers; Marketable pod yield and variables; Snap bean

Introduction

In many developing countries, protein rich foods, such as meat, milk, fish are still quite expensive; hence, many people still suffer from malnutrition. For this reason, most of food scientists are doing an effort that focusing on legumes to be developed as source of non-conventional protein [1,2]. It is a warm season vegetable crop [3] grown in all continents except Antarctica [4]. It is an important vegetable crop in Africa which is grown as a cash crop by large scale and small holder farmers and more than 90 percent of the crop produced in Eastern Africa is exported to regional and international markets [5].

In Ethiopia snap bean production for export to the European markets was started by large-scale state-owned farms in the early 1970's [6] and large-scale state-owned farms contribute 80% of snap bean produced [7] but the share of small holder out growers in production is quite small [8]. Economically it is an important crop helps for farmers since its price is by far better than other vegetable crops even in local markets of the country [9]. It also helps for farmers and their families to improve the nutrition and diversify their production system by intercropping crops such as beans and vegetables [10].

According to Katungi et al. in Ethiopia soil fertility degradation, erratic rainfall, pest pressure, poor agronomic practices and poor accessibility to good quality seed attributed to the low yield and quality of snap bean [11]. Soil acidic problem is one of the major tricky limiting snap bean production and productivity in Ethiopia [12]. In addition, soil fertility management is limited and the application of fertilizer by small holder farmers mainly depends on the blanket recommendation for snap bean in which it was practiced regardless of production area, soil type and fertility status [13].

Soil studies in Jimma area indicated that about 88% of the soil had available P below the critical level (10-15 ppm) and additionally total N also one of the limiting plant nutrients. The reason for the decline of total N in cropped fields can be N leaching problem as the area receives high rainfall and farmers have a limited cultural practice to integrate leguminous plants on their farmlands [14,15]. Furthermore, yield and yield components of snap bean improved by the applications of both macro and micro nutrient [16,17].

Applications of both high and low N and P fertilizer result in low yield and quality of snap bean [18]. Information regarding the impact of N and P fertilizer application rates on yield and quality snap bean generally in Ethiopia and particularly in Jimma was scares. Hence, examining the effects of N and P fertilizer application at different rates is required on snap bean production in Jimma area. Therefore, the experiment was undertaken with an overall objective to determining the effects of N and P fertilizer rates on snap bean pod yield at Jimma, Southwestern Ethiopia.

Materials and Methods

Description of the study area

The experiment was conducted under field condition at Jimma University College of Agriculture and Veterinary Medicine (JUCAVM) research field in the year 2016/17 through irrigation. JUCAVM geographically located at 346 km southwest of Addis Ababa at about 70, 33'N latitude, 360, 57' E longitude and at an altitude of 1710 meter above sea level. The mean maximum and minimum temperatures are 26.8°C and 11.4°C, respectively and the mean maximum and minimum relative humidity are 91.4% and 39.92%, respectively. The mean annual rainfall of the area is 1500 mm.

Composite soil sample was collected from the experiment field to analyze the physicochemical properties of the soil before the experiment was conducted. The analyses were carried out at JUCAVM, soil laboratory. Physic-chemical properties of the soil (0-30 cm) used in the field experimental site both before sowing and after harvest (Table 1).

Soil depth (cm)	pH	Organic carbon (%)	Total nitrogen	Available phosphorus (mg/Kg)	CEC (Cmol (+)/Kg)	Clay	Silt	Sand	Texture group	Remark
0-30	5.71	0.06	0.005	3.95	20	59.34	23.33	17.33	clay	Before sowing

Table 1: The physicochemical properties of a soil of the experimental site.

Experimental treatments, design and procedures

The experiment consisted of five levels of N fertilizer (0, 41, 82, 123 and 164 N kg/ha) and four levels of P fertilizer (0, 46, 92 and 138 P_2O_5 kg/ha). One snap bean variety (BC 4.4) seeds were obtained from Melkassa Agricultural Research Center. The experiment was laid out in a 5 × 4 factorial arrangement in a randomized complete block design (RCBD) with three replications. The whole experimental field was divided into three blocks each containing 20 plots. The size of each plot was 2.4 m × 1.5 m (3.6 m^2) having six rows, each contains 15 plants. A foot path of 0.5 m and 1.5 m were left between plots and blocks, respectively. Triple Superphosphate (TSP) (46% P_2O_5) was used as a source of P. Urea (46% N) was used as source of N and it was applied in two split applications (at time of sowing and flowering). All agronomic practices were kept uniform for all treatments as recommended and adopted for the location [13].

Results and Discussion

Leaf number per plant

Data depicted in Table 2 showed that application of different rates of N and P fertilizer was significantly ($P \leq 0.05$) affect leaf number per plant. In the present study the maximum leaf number per plant was obtained from the application of 123 N kg/ha whereas the minimum was obtained from the control treatment (Table 3).

Parameters studied	Mean squares for sources of variation			
	N (4)	P (3)	N X P (12)	Error (40)
Leaf number per plant	87.58*	250.45**	40.16^{ns}	319.52
Number of primary branch per plant	1.40*	2.64**	0.67^{ns}	0.4
Tap root length (cm)	4.08^{ns}	17.03**	5.85*	2.71
Marketable pod yield (t/ha)	64.75***	33.78**	6.66^{ns}	4.67
Average marketable pod weight (g/pod)	8.39***	4.61**	1.23^{ns}	0.77

Table 2: Mean square values for yield and yield related variables of snap bean. *=Significant at P=0.05; ***=Significant at P=0.001; ns=Non-significant.

The possible reason for the increased leaf number per plant with an increase in N application might be due to the occurrence of less nutrients competition between plants. On the other hand, application of low rate of N was resulted in increase in competition within plants which as a consequence reduced leaf number. This result in coherent with the finding of Moniruzzaman et al. [19], Elkhatib [20] and El-Awadi et al. [21] that leaf number per plant has showed a significant increment with successive application of N fertilizer rate.

With respect to P the maximum leaf number per plant was obtained from the application of 92 P_2O_5 kg/ha and the minimum was obtained from the control (Table 3). This might be due to the great role of P in photosynthesis, respiration, energy reaction, cell division, development of new tissue and nutrient transport in plants. The finding is at par with the work of Veeresh [22], Shubhashree [23], Moniruzzaman et al. [19] and Turuko and Mohammed [24] reported that application of P up to optimum level was improved the leaf number per plants of snap bean.

N (Kg N/ha)	Leaf Number per plant
0	**56.72^{b}**
41	61.70^{a}
82	62.03^{a}
123	**63.55^{a}**
164	61.25^{ab}
LSD (0.05)	**4.54**
P (Kg P_2O_5/ha)*	

0	**55.19[b]**
46	63.38[a]
92	**63.98[a]**
138	62.44[a]
LSD (0.05)	**4.06**
CV (%)	**8.98**

Table 3: Effect of N and P fertilizer application rates on leaf number per plant of snap bean. * Means followed by the same letter(s) are not significantly different at P=0.05. a,b=Different plant values.

Primary branches number

Primary branches number was significantly (P ≤ 0.05) affected by different rates of N and P fertilizer application (Table 2). More number of primary branches was observed from the application of 123 N kg/ha which was statistically similar with 41 and 82 N kg/ha application whilst, the least number of primary branch was observed from the control treatment which was also statistically similar with 164 N kg/ha application (Figure 1). This might be due to the fact that increased numbers of primary branches with an increase in N application result in the occurrence of less nutrients competition between plants, when the application of N was lower it resulted in increase in competition which as a consequence reduced the number of primary. The present study in agreement with finding of Moniruzzaman et al. [19], Elkhatib [20] and El-Awadi et al. [21] also reported that number of branches per plant has shown a significant increment with successive application of N fertilizer.

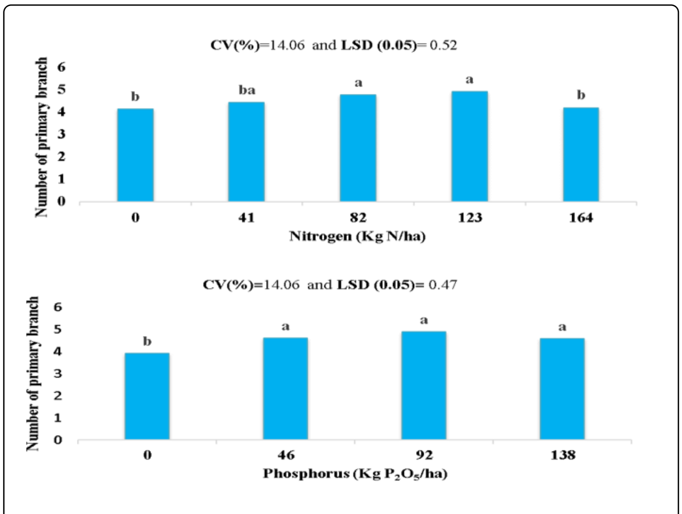

Figure 1: Effects of N and P fertilizer application rates on primary branches number of snap bean.

Application P fertilizers at different rate affect number of primary branches. Data observed in Figure 1 showed that the largest number of primary branches was obtained from the application of 92 P_2O_5 kg/ha which was statistically similar with 46 and 138 P_2O_5 kg/ha. Whereas, the smallest number of primary branches was obtained from the control treatment. This might be due to the stimulating effect of P in protein synthesis, energy reaction, cell division, development of new tissue and nutrient transport in plants. The obtained result was in agreement with the finding of Moniruzzaman et al. [19] and Turuko and Mohammed [24] that the application of P up to certain limit increased the number of primary branches.

Tap root length

Results presented in Table 2 indicated there was a significant interaction effect of N and P fertilization on tap root length of snap bean (P ≤ 0.05). The longest tap root length was obtained from N and P fertilizer application at the rate of 123 N kg/ha with 46 P_2O_5 kg/ha (Table 4) and this also statistically similar with the application of 0 N kg/ha with 46, 92 and 138 P_2O_5 kg/ha; 41 N kg/ha with 0 and 92 P_2O_5 kg/ha; 82 N kg/ha with 46, 92 and 138 P_2O_5 kg/ha; 123 N kg/ha with 0, 92 and 138 P_2O_5 kg/ha and 164 N kg/ha with 46, 92 and 138 P_2O_5 kg/ha. In contrast, the shortest tap root length was noted from control treatment. This mainly because of application of N and P fertilizers promote root growth and development in which both N and P are responsible proteins and nucleic acids production in the roots in which they are responsible for further cell division and multiplication. Costa et al. [25], Fageria and Moreira [26] and Wondemagegn [27] also observed enhanced bean plants root growth due to N fertilization and increasing P fertilizer application rate also promote root growth.

N (Kg N/ha)	P (Kg P_2O_5/ha)*				
	0	46	92	138	Mean
0	**13.09[d]**	17.05[abc]	18.33[ab]	18.77[ab]	**16.81**
41	18.36[ab]	16.44[bc]	17.89[ab]	16.35[bc]	**17.26**
82	16.49[bc]	17.60[ab]	18.71[ab]	18.70[ab]	**17.88**
123	17.25[ab]	**19.64[a]**	17.86[ab]	18.55[ab]	**18.33**
164	14.60[cd]	18.51[ab]	18.57[ab]	17.92[ab]	**17.4**
Mean	**15.96**	**17.85**	**18.27**	**18.06**	**17.53**
LSD (0.05)		**2.65**			
CV (%)		**9.38**			

Table 4: Interaction effect of N and P fertilizers application rates on tap root length of snap bean. * Means followed by the same letter(s) are not significantly different at P=0.05. a,b,c,d=Mean values of different root lengths.

Marketable pod yield (ton ha^{-1})

Application N and P fertilizers at a different rates highly significantly (P ≤ 0.001) affect marketable pod yield of snap bean (Table 2). The highest marketable pod yield was recorded from 123 N kg/ha application which was statistically at par with the application of 82 N kg/ha. While, the lowest marketable pod yield was recorded from the control treatment (Figure 2). This was probably because of the highest N application was related with the increase in N fertilizer rate that resulted in better vegetative growth which in turn to produce greater photo assimilate in the pods. Similar result also stated by Rahman et al. [28], El-Tohamy et al. [29], Mahmoud et al. [30], El-Awadi et al. [21] and Beshir et al. [31] reported that with increasing the N fertilizer application rates the marketable pod yield also increased. This is due to increased pod yield, heavier pod weight, pod length and pod diameter were obtained due to increased application of N rates.

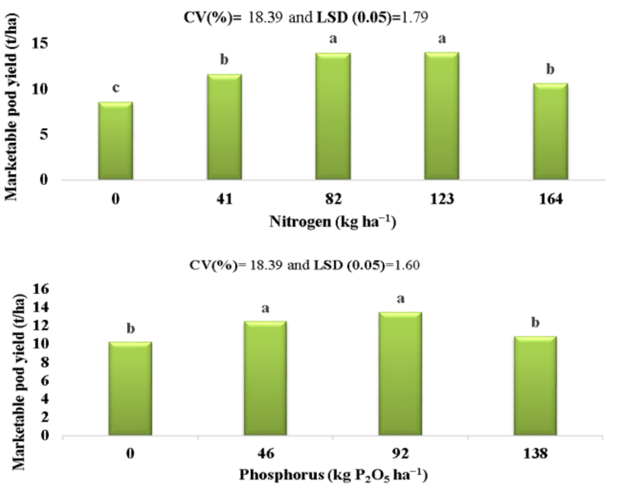

Figure 2: Effects of N and P fertilizer application rates on marketable pod yield of snap bean.

With regard to P the results depicted in Figure 2 showed that the application P at different rates has shown variation on marketable pod yield. The maximum marketable pod yield was recorded from the application 92 P_2O_5 kg/ha which was statistically at par with 46 P_2O_5 kg/ha. While the minimum marketable pod yield was recorded from the application of 0 P_2O_5 kg/ha and this result statistically similar with 138 kg P_2O_5 kg/ha. This probably P improves flower formation and fruits expansion and increases the pod yield. This work is in line with Dauda et al. [32] who found that application of P at a different rates produced high marketable pod yield than non-applied treatment in green bean.

Average marketable pod weight

Average marketable pod weight was highly significantly affected by the different rates of N and P fertilizer application ($P \leq 0.001$) (Table 2). The maximum average marketable pod weight was resulted from application of 123 N kg/ha which was statistically similar with the application 41 and 82 N kg/ha. In contrast, the minimum average marketable pod weight was recorded from the control treatment. Average marketable pod weight increased by 53.85% at 123 N kg/ha application as compared to the control (Table 4). This might be due to the fact that highest average pod weight obtained from the highest N application is an increased supply of N fertilizer which results for more foliage, leaf area and higher supply of photosynthesis which induced formation for bigger pods there by resulting in higher pod weight. This finding in line with the work of Mahmoud et al. [30] and El-Awadi et al. [21] reported that average pod weight of snap beans has showed a significant increment with successive application of N and minimum value was recorded from the lowest rate of N [33-35].

On the other hand average marketable pod weight in the different application of P rates ranged from 4.31 to 5.45. The highest marketable pod weight obtained at 92 P_2O_5 kg/ha was in statistically similar the application of 46 P_2O_5 kg/ha. In contrast, the lowest marketable pod weight was recorded from the 0 P_2O_5 kg/ha and statistically similar with 138 P_2O_5 kg/ha (Table 5). This might be due to the fact that application of P improves flower formation and fruits expansion consequently it increases the marketable pod weight. Dauda et al. also found that highest marketable pod weight was obtained from the increased application of P in green bean.

N (Kg N/ha)	Average marketable pod weight (g/plod)
0	**3.64^{c}**
41	4.89^{ab}
82	5.59^{a}
123	**5.60^{a}**
164	4.38^{b}
LSD (0.05)	**0.72**
P (Kg P_2O_5/ha)	
0	**4.31^{b}**
46	5.12^{a}
92	**5.45^{a}**
138	4.41^{b}
LSD (0.05)	**0.65**
CV (%)	**18.19**

Table 5: Effects of N and P fertilizers application rates on average marketable pod weight of snap bean. Means within a column followed by the same letter(s) are not significantly different at P=0.05; AMPW=Average marketable pod weight (g/plod). a,b,c=Significant values of snap bean.

Conclusion

Snap bean is one of the most cultivated leguminous vegetable in the world. Knowing the optimum rate of N and P fertilizer rate are very important factors to increase the productivity and marketability of snap bean. The study was conducted to realize the effect N and P fertilizers rates on yield and yield components of snap bean at Jimma, Southwestern Ethiopia. Yield and yield components of snap bean were significantly ($P \leq 0.05$) affected both by the main and interaction effect of N and P fertilizer application. The highest number of leaf, primary branch and average marketable pod weight were obtained from N application at 123 kg/ha whereas the lowest value was recorded from the control (0 kg/ha N). The maximum marketable pod yield was resulted from plants subjected to highest dose of applied N fertilizer 123 kg/ha, in which it was statistically at par with applied 82 kg/ha. On the other hand, application P fertilizer rates on the also indicated there were a significant effect of all variables. Number of leaf, primary branch, average marketable pod weight and marketable pod yield were obtained from 92 P_2O_5 kg/ha which was statistically at par with the application of 46 P_2O_5 kg/ha. The interaction effect of N and P was significant ($P \leq 0.05$) only to tap root length of growth variables. The highest tap root length value was obtained from the combined application of 123 N kg/ha and 46 P_2O_5 kg/ha. So, form this experiment it can conclude that application of 123 kg/ha N and 92 kg/ha P_2O_5 increased the marketable pod yield of snap bean at Jimma. However, repeating the experiment for more seasons and similar location would help us draw sound conclusion and recommendations.

Acknowledgements

We are giving our appreciation to the Ministry of Agriculture and Natural Resource for financial support that has made our studies possible. In addition, USAID-MASHAV-MoANR, SHP project for financial support to accomplish this final research works and soil analysis.

References

1. Adebowale YA, Adeyemi IA, Oshodi AA (2005) Functional and physicochemical properties of flours of six Mucuna species. African Journal of Biotechnology.
2. Adeniji AA, Ehiermere S (2003) Effects of replacing maize with sorghum offal in the diets of weaner rabbits. Journal of Agricultural Research and Development 2: 1-6.
3. Yirga M, Said A (2013) Enhancing communities' adaptive capacity to climate change in drought-prone hotspots of the Blue Nile Basin in Ethiopia. Training manual on Forage Husbandry and Dairying For extension workers and farmers at Kabe Watershed.
4. Gepts P (1998) Origin and evolution of common bean: past events and recent trends. HortScience 33: 1124-1130.
5. Kimani PM (2006) Snap beans for income generation by small farmers in east Africa.
6. Desalegne L, Zewdie Y, Herath E (1994) Agronomic Studies on Tomato and Capsicum. In 2. National Horticultural Workshop of Ethiopia, Addis Abeba, Ethiopia, 1-3 Dec 1992, IAR.
7. Wiersinga R, Jager A (2007) Identification of opportunities and setting agenda of activities in the Ethiopian fruits and vegetables sector. Mission Report, Ethiopian-Netherlands Horticulture Partnership.
8. Okello JJ, Narrod C, Roy D (2007) Food safety requirements in African green bean exports and their impact on small farmers. Intl Food Policy Res Inst.
9. Beshir MH (2015) Improving Snap Bean (Phaseolus vulgaris L.) Production under Reduced Input Systems. A PhD Thesis submitted to University of Saskatchewan, Canada, pp: 24-72.
10. Setegn G, Legesse D (2010) Improved bean technologies: production and post-harvest guideline. EIAR (Ethiopian Institute Agricultural Research), CRS (Catholic Relief Service). Addis Ababa, Ethiopia.
11. Katungi E, Farrow A, Mutuoki T, Gebeyehu S, Karanja D, et al. (2010) Improving common bean productivity: An Analysis of socioeconomic factors in Ethiopia and Eastern Kenya. Baseline Report Tropical Legumes II. Centro Internacional de Agricultura Tropical-CIAT. Cali, Colombia.
12. Abebe M (2007) Nature and management of acid soils in Ethiopia.
13. MoANR (Ministry of Agriculture and Natural Resource) (2016) Major vegetable crops production system. In: Efficient use of irrigation water and improved agronomic practices of irrigated crops. A working manual, Small Scale Irrigation Development Directorate, MoANR, pp: 209-225.
14. Tisdale SL, Nelson WL, Beaton JD, Havlin JL (1993) Soil fertility and fertilizers. Macmillan Publishing Co., NY, p: 634.
15. Nigussie A, Ambaw G, Kissi E (2013) Fertility status of eutric nitisol and fertilizer recommendation using numass in the selected areas of Jimma zone, Southwestern Ethiopia. Tropical and Subtropical Agroecosystems 16: 487-495.
16. Tantawy AS, Abdel-Mawgoud AMR, Habib HA, Hafez MM (2009) Growth, productivity and pod quality responses of green bean plants Phaseolus vulgaris to foliar application of nutrients and pollen extracts. Res J Agric Biol Sci 5: 1032-1038.
17. Abdel-Mawgoud AMR, El-Bassiouny AM, Ghoname A, Abou-Hussein SD (2011) Foliar application of amino acids and micronutrients enhance performance of green bean crop under newly reclaimed land conditions. Aust J Basic Appl Sci 5: 51-55.
18. Mano JI (2002) Early events in environmental stresses in plants. Induction mechanisms of oxidative stress. Oxidative Stress in Plants pp: 217-245.
19. Moniruzzaman M, Islam MR, Hasan H (2008) Effect of NPKS Zn and B on yield attributes and yield of French bean in South Eastern Hilly Region of Bangladesh. Journal of Agriculture & Rural Development 6: 75-82.
20. Elkhatib HA (2009) Growth and Yield of Common Bean (Phaseolus Vulgaris L.) in Response to Rhizobium Inoculation, N and Molybdenum Fertilization. Alex Sci Exch J 30: 319-332.
21. El-Awadi ME, El-Bassiony AM, Fawzy ZF, El-Nemr MA (2011) Response of snap bean (Phaseolus vulgaris L.) plants to nitrogen fertilizer and foliar application with methionine and tryptophan. Nature and Science 9: 87-94.
22. Veeresh NK (2003) Response of French bean (Phaseolus vulgaris L.) to fertilizer levels in Northern Transitional Zone of Karnataka. MSc (Agri.) Thesis, pp: 37-79.
23. Shubhashree KS (2007) Response of Rajmash (Phaseolus vulgaris L.) to the levels of nitrogen, phosphorus and potassium during rabi in the Northern transition zone (Doctoral Dissertation, UAS, Dharwad).
24. Turuko M, Mohammed A (2014) Effect of different phosphorus fertilizer rates on growth, dry matter yield and yield components of common bean (Phaseolus vulgaris L.). World Journal of Agricultural Research 2: 88-92.
25. Costa C, Dwyer LM, Zhou X, Dutilleul P, Hamel C, et al. (2002) Root morphology of contrasting maize genotypes. Agronomy Journal 94: 96-101.
26. Fageria NK, Moreira A (2011) The role of mineral nutrition on root growth of crop plants. In Advances in Agronomy, Academic Press 110: 251-331.
27. Wondemagegn NH (2012) Effect of N Rate on Growth, Yield and Quality of Green Bean (Phaseolus Vulgaris L.) Varieties at Bishoftu, Central Ethiopia. An MSc Thesis submitted to the School of Graduate Studies Jimma University, pp: 25-49.
28. Rahman MA, Hoque AKMS, Rahman MN, Talukadar MB, Islam MS (2007) Effects of N and phosphorous on growth and yield of French bean. J Soil N 1: 30-34.
29. El-Tohamy WA, Ghoname AA, Riad GS, Abou-Hussein SD (2009) The influence of slow release fertilizer on bean plants (Phaseolus vulgaris L.) grown in sandy soils. Aust J Basic Appl Sci 3: 966-969.
30. Mahmoud AR, El-Desuki M, Abdel-Mouty MM (2010) Response of snap bean plants to bio-fertilizer and nitrogen level application. International Journal of Academic Research.
31. Beshir HM, Tesfaye B, Bueckert R, Taran B (2015) Pod quality of snap bean as affected by Nitrogen fixation, cultivar and climate zone under dryland agriculture. African Journal of Agricultural Research 10: 3157-3169.
32. Dauda SN, Ndor E, Azagaku ED, Isa AS, Onuk EG (2016) Production and Economic Returns of Green Bean (Phaseolus vulgaris L) Varieties under Rates of N and P Application in Sudan Savanna of Nigeria, PAT 12: 211-219.
33. Abate G (2006) The market for fresh snap beans. Working Paper, The Strategic Marketing Institute, pp: 6-8.
34. BPEDORS (2000) Physical and Socio-Economical Profile of 180 District of Oromia Region. Ethiopia.
35. Anonymous (2012) Investment opportunity profile for production of fruits and vegetables in Ethiopia.