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# Effects of Potassium Fertilizer on Bean growth and Yield parameters

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## ABSTRACT

*Bean is globally an important leguminous vegetable that has been used for several centuries as a food for humans. Originated from the American, the bean is now cultivated all over the world due to its nutritional and culinary values. However, it is very sensitive to applied fertilizers. In Mabayi commune of Cibitoke province, many farmers use to cultivate bean without potassium while it is one of the most important nutrients for plant growth and development. An experiment was carried out in completely randomized blocs design with three treatments (T1 (NPK: 00-00-00), T2 (NPK: 18-46-00) and T3 (NPK: 18-46-30)) and four replications for each to evaluate the treatments which could effectively improve crop bean growth and yield parameters. The recorded parameters were the plant height, leaf area, flowers number, stem diameter, root length, yield and production attributes (number of pods, grains, full pods and empty pods). The results highlighted treatment T3 as the most effective treatment. It has significantly improved plant height, leaf area, flowers number, stem diameter, and root length. Moreover, treatment T3 has enhanced the yield and number of pods, grains and full pods. The treatment T3 is suggested for improving the bean growth and yield parameters at Nyabungere hill in Mabayi commune.*

***Key words:*** *Bean plant, Potassium fertilizer, Growth, Yield parameters.*

## 1. INTRODUCTION

Bean is globally an important leguminous vegetable that has been used for several centuries (Brink & Belay, 2006) as food for humans [1]. Originated from the American, now is cultivated all over the world due to its nutritional and culinary values. It contains proteins, minerals, fibers calories and vitamins [2]. Bean is a good source of vitamins, particularly thiamine, riboflavin, niacin, vitamin B6, and folic acid [3]. Higher dry beans nutrients component like phenolics and antioxidant were reported in dry bean, as well as micronutrients, especially iron and zinc [4] [5]. Furthermore, bean contains high amounts of protein and vitamins [6]. Its production and marketing can be a potential pathway for improving rural livelihoods. In Burundi, it is the major culture which is daily consumed for the whole population. Moreover, consumption demand of this crop is expected to increase due to high population growth, lack of protein animal source and the higher prevalence of HIV/AIDS that necessitates an improved intake to maintain good health [5]. Despite all these reasons above mentioned, beans are frequently an integral part of the cropping systems on small farms in some communes like Mabayi, especially at Nyabungere hill. Moreover, as in many communes, farmers at this hill use to cultivate bean without potassium fertilizer while this fertilizer is one of the essential elements for plants [7]. Foregoing research reported that Potassium plays roles in regulating the opening and closing of stomata and water retention [8]. It promotes the growth of meristematic tissue, activates some enzymatic reactions, aids in nitrogen metabolism, and the synthesis of proteins [9]. It catalyzes activities of some mineral elements, and aids in carbohydrate metabolism and translocation. Wilfret (1980)



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highlighted that Potassium deficiency result in reduced bud count, weak stalks and delay in flowering [10]. He affirmed that with lack of potassium, roots become more easily infected with root-rotting. Potassium increases the resistance of plants to abiotic factors (frost, aridity, airless soil conditions, salinity and sodicity) and biotic factors such as disease Colpan et al. (2013) [11]. Plants with adequate potassium during growth can provide good yields even under stressed conditions [12]. Owing to Potassium advantages, there is a need to assess its effectiveness in bean cultivation for production improvement. This study aimed to assess the effects of potassium fertilizers on bean growth and yield parameters at Nyabungere hill of Mabayi commune.

## 2. MATERIALS AND METHODS

### 2.1. Experimental site localization

The experiment was carried out in 2016 at Nyabungere hill of Mabayi commune located in the North of Cibitoke Province. The experimental site temperature was varying between 28 and 29$^{o}$C with A monthly precipitation of 11.36 mm. The soil properties are summed up in the following table 1

**Table 1. Soil properties**

| $P^{H}H_2O$ | $P^{H}KCl$ | $N\text{-}NH^+_4$en mg/kg | $N\text{-}NO_3^-$en mg/kg | P (mg/kg) | K (mg/kg) |
|---|---|---|---|---|---|
| 4.5 | 3.96 | 31.31 | 24.51 | 72.5 | 0.28 |

### 2.2. Experiment design

The experiment was undertaken in lysimeters and has considered three treatments: T1 treatment (NPK: 00-00-00), T2 treatment (NPK: 18-46-00) and T3 treatment (NPK: 18-46-30). These agents were set in randomized complete blocks design with 4 replications for each. During the growth period, all treatments had the same agricultural management practices, while diseases and pests were controlled through insecticide and fungicide application.

### 2.3. Sampling and data collection

Plant were sampled and monitored during growth period to determine the plant height, leaf area, flowers number, root length, and stem girth. Furthermore, number of: pods, full pods per plant, empty pods, and grains were recorded at harvest, as well as the total yield.

### 2.4. Statistical analysis

The recorded data were analyzed statistically with applied Excel and Genstat discovery software edition 4. The comparison among treatments was conducted by using least significant difference (LSD) at a $P< 0.05$.

## 3. RESULTS AND DISCUSSIONS

### 3.1. Effects of potassium on plant height

Plant height results are shown in the following figure 1

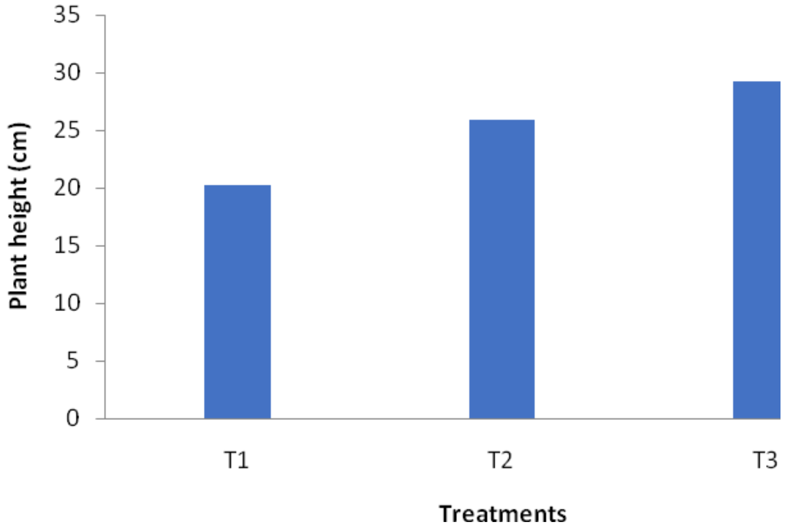


*Figure 1. Effects of potassium on plant height*



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From this above figure, results revealed the effectiveness of T3 in improving plant height than other treatments. Specifically, this treatment T3 got the highest plant of 29.17cm and significantly differed ($p<0.05$) to the control T1. It followed by T2 of 25.9 cm, while T1 got the shortest plant of 20.23 cm. The higher performance of T3 may be attributed to the potassium fertilizer level added in this treatment. These results support those of Huda et al. (2010), who reported improved plant height due to potassium higher level application [13]. Furthermore, they endorse those of Ascencio (1987) who affirmed an increased plant height for treatments with potassium application [14].

### 3.2. Potassium fertilizers effects on bean leaf area

Beside that bean leaf can be eaten as legume, it also reduces a little bit the soil evaporation resulting in improved soil moisture needed by the plant for growth and development. In this study, relate results are displayed in this figure 2. It can be seen that fertilized treatments have more influenced leaf area than the control.

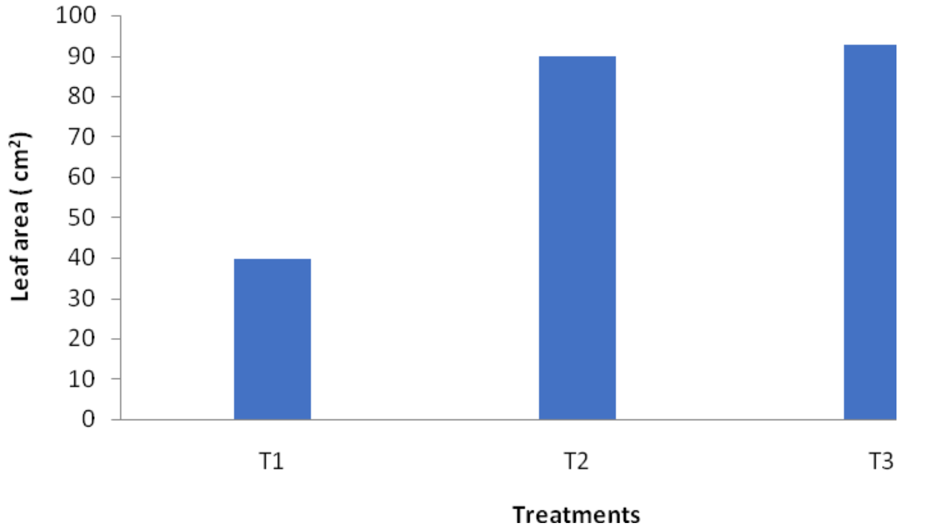


***Figure 2. Potassium fertilizers effects on bean leaf area***

The maximum leaf area was recorded for treatment T3 with 92.8 cm, followed by treatment T2 of 89.8 cm, while the minimum was obtained for the control T1 with a minimum value of 39.83 cm. Moreover, treatment T3 showed higher significance difference from the control with $p<0.001$, whence the efficiency of this treatment in improving leaf area than others. This supports the findings of Abdel et al. (2005) who reported improved growth parameters due to higher potassium application [15].

### 3.3. Potassium's effects on stem diameter

Stem diameter has been influenced by the fertilizers with maximum stem diameter for both treatments T3 and T2 with the same value of 5.2 cm (Figure 3).

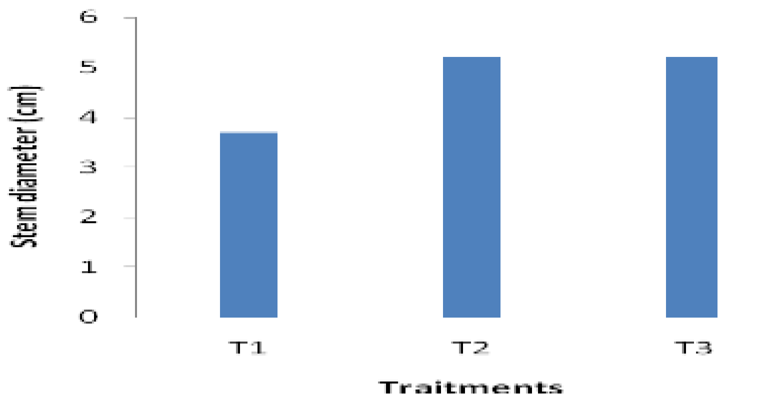


***Figure 3. Effects of Potassium on stem diameter (cm)***

From this figure 3, the outcomes revealed the effectiveness of T3 and T2 in enhancing stem diameter than the control. These treatments got the maximum same value of 5.2 cm, while the treatment T1 got the minimum with 3.7 cm. These results support those of Colpan et al. (2013) who highlighted increased stem diameter for higher potassium rate application [11].



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### 3.4. Potassium's effects on flowers number

Results on potassium's effects on flowers number is displayed in the following figure.

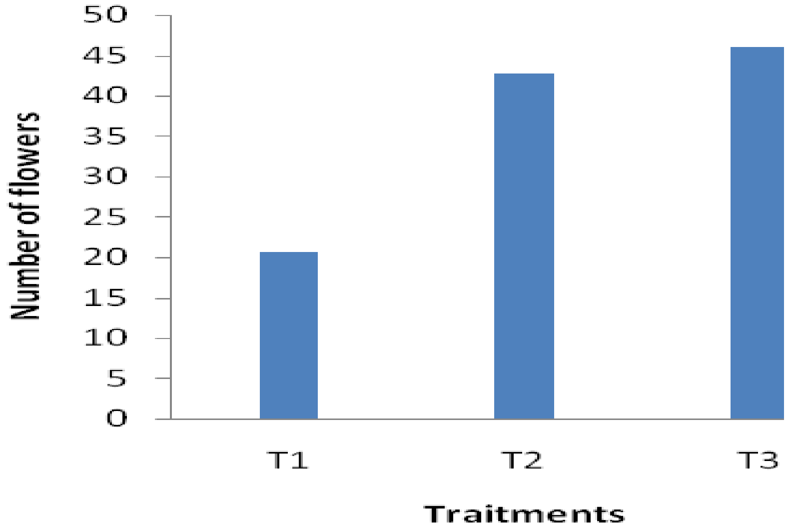


*Figure 4. Potassium's effects on flowers number*

With results of figure 4, the highest flowers number was attained under treatment T3 (47 flowers) with significant difference ($p<0.05$) from the control treatment T1. The treatment T2 (43 flowers) was the following and significantly exceed ($p<0.05$) the control treatment (T1) which was having a lowest number of flowers (20 flowers). Even though T2 and T3 improved the flowers number, treatment T3 was the most effective treatment in increasing the number of flowers. This effectiveness of T3 was due to the applied higher potassium level in this treatment. This endorses the results of Javid (2005) who reported highest flowers number with applied potassium higher level [16]. The results are also in line with Pal and Ghosh (2010) who highlighted highest flowers yield for treatments with increased potassium rate to some extent [17].

### 3.5. Effects of Potassium on root length

As Potassium is a key nutrient in the development of new root growth (McAfee, 2008) [18], this parameter has been accessed in this study, results are shown in the below figure 5.

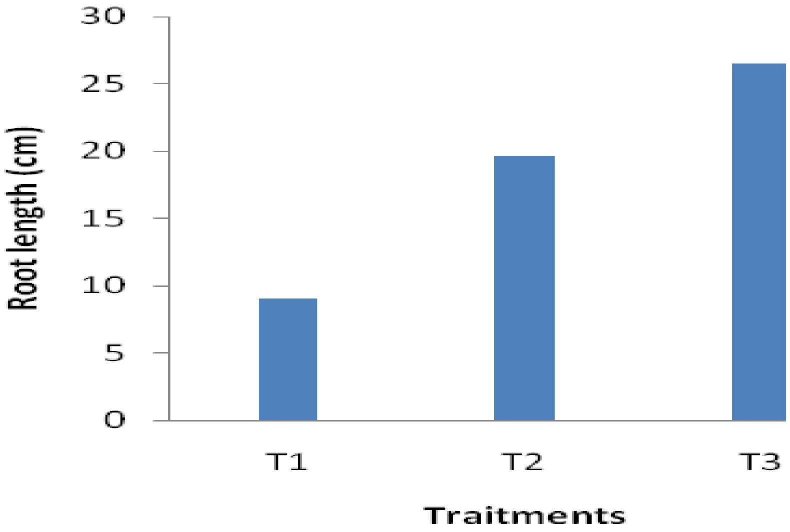


*Figure 5. Potassium's effects on root length*

From this figure, the outcomes showed maximum root length (26.5cm) for treatment T3, while the minimum (9.03 cm) was obtained for the control treatment T1. This reduced root length for T1 was due to the K deficient which decreases root elongation as reported by Alam and Naqvi, 2003 [19]. However the effectiveness of T3 in increasing root length results to the applied higher potassium level as it is reported as a major nutrient for root development [18]. These results support those of khan (2007) which reported maximum root length for treatments with increased potassium level [20].



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### 3.6. Potassium's effects on production parameters

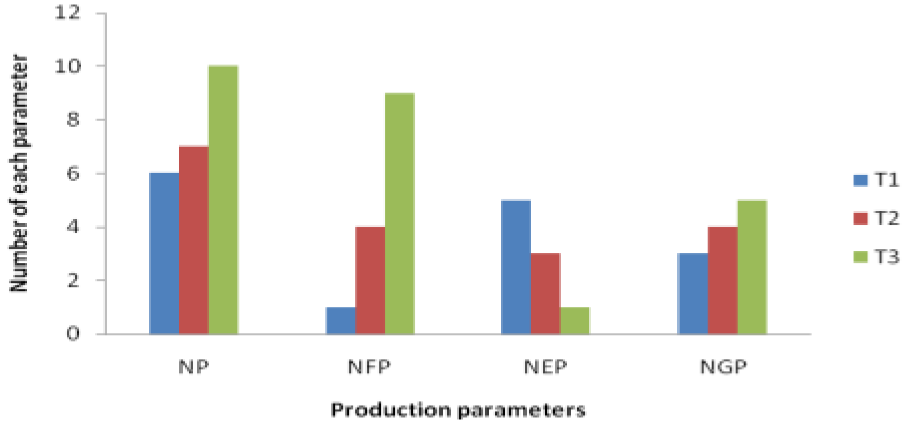


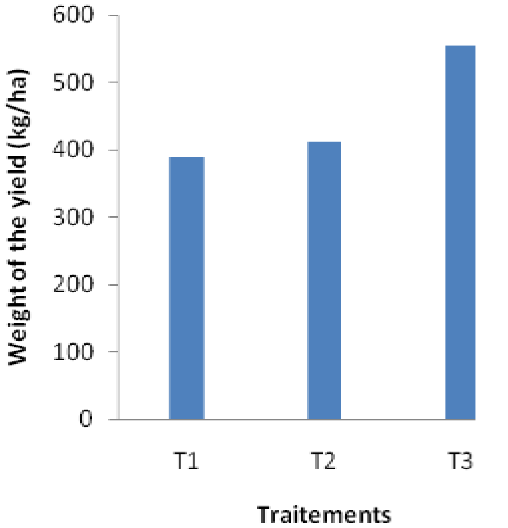

***Figure 6. Effects of Potassium on stem diameter (cm)***

*NP: Number of Pods; NFP: Number of Full Pods; NEP: Number of Empty Pods; NGP: Number of Grains per Pod*

From the outcomes of figure 6, there were significant differences between treatments. Specifically, treatment T3 was the most effective treatment. Considering NP, treatment T3 got the maximum pods per plant (10 pods), followed by T2 with 7pods, while the minimum was recorded for treatment T1 with 6 pods per plant. Similarly, the full pods number (NFP) was highest for T3 of 9 full pods per plant and lowest under treatment T1 with an average of 1 full pod per plant. The same trend was observed for NGP, where the maximum grains number was maximum for T3 (5 grains per pod), followed by T2 (4 grains per pod) and minimum for T1 (3 grains per pod). On the other hand, the number of empty pods (NEP) was highest for the control treatment T1 of 5 empty pods per plant and lowest for treatment T3 with 1 empty pod per plant. These results support those of Huda et al (2010) who affirmed improved pods number for applied highest potassium level [13].

### 3.7. Effects of Potassium on plant yield and thousand grains

Results on crop yield and thousand grains have also been affected by the applied treatments, the figure 7 and 8 show the details.



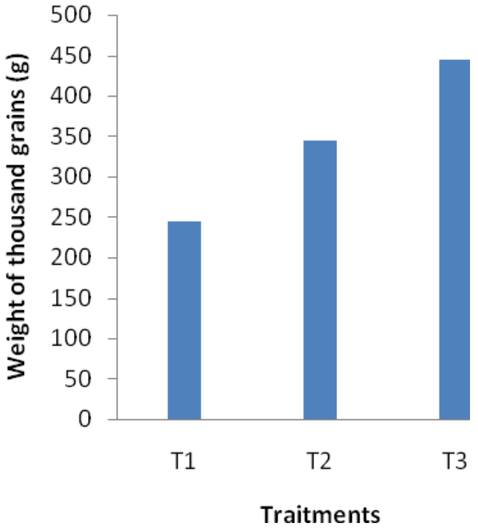




**Figure 7. Effects of potassium on crop yield** **Figure 8. Potassium's effects on thousand grains**

The outcomes showed maximum yield weight for treatment T3 with 555.2 kg/ha. It was followed by the treatment T2 of 412 kg/ha, while the minimum was recorded for the control treatment T1 with 389.5 kg. The same trend was observed for Figure 8 where highest thousand grains was observed for treatment T3 and lowest for the control T1. The effectiveness of T3 in increasing crop yield and thousand grains is linked with the potassium's role of promoting the enzyme activity and enhancing the translocation of assimilates and protein synthesis as affirmed by Devlin and Witham (1986) [21]. These outcomes endorse those of Abou Hadid (2010) who revealed improved crop yield due to potassium higher level application [22]. Likewise, these results are in agreement with the finding of Kanaujia et al (1999) who highlighted higher grain yields weight with increased potassium rates [23].



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## 4. CONCLUSION

The experimental outcomes showed that the bean crop growth parameters and yield parameters were increased significantly with the increase of potassium fertilizer. Treatment T3 with NPK (18-46-30) was the most effective and could improve significantly the plant height, stem diameter, leaf area and leaves number. Moreover, treatment T3 has also enhanced the root length, the number grains, pods and full pods as well as the yield weight and the thousand grains. This suggested that treatment T3 could improve bean growth parameters and yield attributes in Mabayi commune of Cibitoke province in Burundi.

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## REFERENCES

[1] Amira, A., El-Fallal and F.M. Fatma (2003). Metabolic changes in broad bean infected by Botrytis fabae in response to mushroom spent straw. Asian J. of Plant Sci., 2(14):1059-1068.

[2] Shehata, S.A., Ahmed, Y.M., Emad, A.S. and Omaima S.D. (2011) Influence of Compost Rates and Application Time on Growth, Yield and Chemical Composition of Snap Bean (Phaseolus vulgaris L) Australian Journal of Basic and Applied Sciences 5 (9), 530-536.

[3] Nirmal Sinha, T.H. Hui, E. OzgulEvrnuz, Muhammad Siddig, Jasim Ahmed, 2010. Hand book of vegetables and Vegetable processing. Wiley .com, Amazon France 2010

[4] Xu and wang, 2008 cited in Hand book of vegetables and Vegetable processing by Nirmal Sinha, T.H. Hui, E. OzgulEvrnuz, Muhammad Siddig, Jasim Ahmed, 2010

[5] Bernard Vanlauwe, Piet Van Asten, Guy Blomme, 2014. Challenges and opportunities for agriculturalnintensification of the humid highland Systems of Sub-Saharan Africa. Springer Cham Heidelberg New York Dordrecht London, 2014. DOI: 10.1007/978-3-319-07662-1

[6] Valdez-Perez, M.A., F. Fernandez-Luqueno, O. Franco-Hernandez (2011). Cultivation of beans (Phaseolus vulgaris) in limed or unlimed wastewater, sludge, vermicompost or inorganic amended soil. Scientia Hort., 128:380-387

[7] El-Bramawy, M.A.S.A. and Shaban, W. I. (2010) Effects potassium fertilization on agronomic characters and resistance to chocolate spot and rust diseases in faba bean. Tunisian Journal of Plant Protection., 5, 131-150.

[8] Salisbury, F. B. and C. W. Ross. 1992. Mineral nutrition: In Plant Physiology. 4th Ed. Pp. 116-135. Wadsworth Pub. Co. Belmont, California.

[9] Bhandal, I. S. and C. P. Malik. 1988. Potassium estimation, uptake, and its role in the physiology and metabolism of flowering plants. Intern. Review of Cytology110:205-254.

Bio.7(3):474–476

[10] Wilfret, G. J. 1980. Gladiolus. Introduction to floriculture. Larson R. A. Ed. pp. 165-181. Academic Press, Inc. New York

[11] Çolpan, E., Zengin, M. & Özbahçe, A. 2013. The effects of potassium on the yield and fruit quality components of stick tomato. Journal of Horticulture, Environment and Biotechnology, 54 (1): pp 20–28. https://doi.org/10.1007/s13580-013-0080-4

[12] Kemler, G. and A. Krauss. 1987. Potassium and stress tolerance. N-K interaction in plant production. Intl. Fertilizer Seminar, 6–7 October 1987, Ankara, Turkey. (in Turkish).

[13] Huda, A. Ibrahim, U.A. El-Behairy, M. EL-Desuki, M.O. Bakry and A.F. Abou–Hadid. 2010. Response of Green Bean to Fertilization with Potassium and Magnesium. Research Journal of Agriculture and Biological Sciences, 6(6): 834-839, 2010.

[14] Ascencio, J., 1987. Potassium and calcium distribution patterns along the leaf insertion gradient of bean plants grown in nutrient solutions. Journal of Plant Nutrition, 10(4): 455-484.

[15] Abdel-Mawgoud, A.M.R., M. El-Desuki, S.R. Salman and S.D. Abou-Hussein, 2005. Performance of some snap bean varieties as affected by different levels of mineral fertilizers. Journal of Agronomy, 4(3): 242-247.

[16] Javid QA, Abbasi NA, Hafiz IA and Mughal AL. 2005. Performance of Zinnia (Zinnia elegans) “Dahlia flowered”crimson shade by application of NPK fertilizer. Int J Agri &



DOI: 10.31695/IJASRE.2019.33001

[17] Pal P. and Ghosh P. 2010. Effect of different sources and levels of potassium on growth, flowering and yield of African marigold (Tagetes erecta Linn.) cv. “Siracole”. Indian J Nat Prod Rescs. 1(3): 371-375

[18] McAfee J. 2008. Potassium, A Key Nutrient for Plant Growth. Department of Soil and Crop Sciences:http://jimmcafee.tamu.edu/files/potassium%20a%20key%20nutrient%20for%20plant%20growth.pdf

[19] Alam SM and Naqvi MH. 2003. Potassium and its role in crop growth. Dawn Newspaper Dec. 10

[20] Khan GA, Sajid M and Amanullah. 2007. Response of Dhalia (Dhalia pinnata) to different levels of nitrogen alone and in combination with constant doses of phosphorus and potassium. American-Eurasian J of Sustainable Agri. 1(1): 25-31.

[21] Devlin, R.M. and F.H. Witham, 1986. Plant physiology. 4thEd . CBS publishers and distributors 485, Jan Bhawan, Shadhara, Delhi, 110032 ( India)

[22] Abou Hadid, Ayman, 2010. Response of green bean to fertilization with potassium and magnesium. Research Journal of Agriculture and Biological Sciences. Vol 6 (6) pge 834.

Alam SM and Naqvi MH. 2003. Potassium and its role in crop growth. Dawn Newspaper Dec. 10

[23] Kanaujia, S.P., Raj Narayan and Sumati Narayan, 1999. Effect of phosphorus and potassium on growth, yield and quality of French bean (Phaseolus vulgaris L.) cv. Contender. Vegetable Science, 26(1): 91-92.



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