ISSN: 0974 - 0376

The Ecoscan : Special issue, Vol. IX: 487-490: 2016
AN INTERNATIONAL QUARTERLY JOURNAL OF ENVIRONMENTAL SCIENCES
www.theecoscan.com

EFFECTS OF POTASSIUM AND BORON ON QUALITY PARAMETERS OF CARROT (*DAUCUS CAROTA* L.)

Satish Kumar Subba *et al.*,

KEYWORDS

Carrot
Potassium
Boron
Quality
Carotene

Proceedings of National Conference on
Harmony with Nature in Context of
Resource Conservation and Climate Change
(HARMONY - 2016)
October 22 - 24, 2016, Hazaribag,
organized by
Department of Zoology, Botany, Biotechnology & Geology
Vinoba Bhave University,
Hazaribag (Jharkhand) 825301
in association with
National Environmentalists Association, India
www.neaindia.org

The Ecoscan
AN INTERNATIONAL QUARTERLY JOURNAL OF ENVIRONMENTAL SCIENCES

SATISH KUMAR SUBBA, PRADEEP YAMBEM*, R. K. ASHA, ASIM DAS, S. B. CHATTOPADHYAY AND PARTHA CHOUDHURI
Department of Vegetable Crops, Faculty of Horticulture,
Bidhan Chandra Krishi Viswavidyalaya, P. O. KrishiViswavidyalaya, Mohanpur, Nadia - 741 252 (West Bengal), INDIA
e-mail: pradeepyambem@gmail.com

ABSTRACT

Imbalance use of two essential nutrients such as potassium and boron along with other production factors limit quality production of carrot in India. To address this problem a field trial was carried out at Horticultural Research Station, Faculty of Horticulture, Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal during the year 2014-2015 to study the effect of potassium and boron on quality parameters of carrot. The experiment was laid out in Randomized Block Design with 16 treatments and 3 replications using New Improved Kuroda variety of carrot. Trial data showed that varied rate of application of boron and potassium had significant effect on quality parameters of carrot. Significantly highest carotene (4.56 mg $100g^{-1}$) ascorbic acid (2.70mg $100g^{-1}$) and total sugar content (7.60%) were found in the treatment T_{12}.The highest TSS was obtained from T_{16} (9.80 °Brix) followed by T_{12} (9.43 °Brix) and T_8 (9.03 °Brix).In all the cases minimum amount of carotene(2.88 mg $100g^{-1}$), ascorbic acid (0.25mg $100g^{-1}$), TSS (6.03°Brix) and total sugar content (4.28 %) of the carrot root were obtained in control plots which received no fertilizers. It was concluded that application of potassium and boron at higher doses had a significant and positive effect on quality root production of carrot.

*Corresponding author

INTRODUCTION

Vegetables are important source of minerals, vitamins and plant proteins in human diet. Carrot (*Daucus carota* L.) is the most economically important vegetable crop in the world, among the top-ten vegetables in terms of both area of production and market value.It is a best source of carotene,the precursor of vitamin A. The popularity of carrot is increasing day by day in India especially among the urban people because of its high nutritive value and possible diversified use in making different palatable foods. Macronutrients as well micronutrients are of primary importance in our agriculture system but due to rapid area expansion under hybrid or high yielding varieties of vegetables and unawareness of our farmers, Indian soils are becoming deficient in micronutrients. The micronutrients act as catalyst and enhance the chemical composition of fruits and are also vital for the physiological activities within the plant (Abo Hamad *et al.*,2014). Boron is one of those micronutrients which are rapidly becoming deficient in soils (Tahir *et al.*, 2009). Boron plays important role in physiological processes like carbohydrates metabolism, translocation and development of cell wall and translocation of sugar and carbohydrates (Siddiky *et al.*, 2007). On the other hand among macronutrients potassium is now also becoming limiting factor for crop production in today's agriculture. Regmi *et al.* (2002) suggested that because of inadequate K application, soil K imbalance in agricultural ecosystem and stagnation of yield will become more pronounced with time. In contrast to N, potassium application has been neglected by majority of farmers in our country resulting in continual depletion of soil K (Ladha *et al.*, 2003 and Lal *et al.*, 2007). All the vegetable crops specially root crops respond to liberal applications of potassium. Potassium helps in the root development and is essential for photosynthesis and translocation of starch from source to sink.

The production of carrot, especially in Gangetic plains of West Bengal, is still in the hand of marginal farmers. On the other hand soils of Indo Gangetic plains of West Bengal is mostly sandy-loam in nature with low organic matter coupled with high annual precipitation (300-350cm^{-1}annum). This leads to leaching of macro and micronutrients. The carrot growers of this zone only concentrate upon bumper yield of this root crop at the cost of quality. Considering this situation an attempt was made for quality production of carrot with judicious application of boron and potassium which will in turn help them for having good quality produce for better marketing and healthy livelihood.

MATERIALS AND METHODS

The experiment was carried out at Horticultural Experimental field, Mondouri, Department of Vegetable Crops, Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal (23.5ºN latitude and 89.0ºE longitude and 9.75m above MSL) during Rabi season of 2014-2015 in Randomized Block Design with 3 replications and 16 treatments. The New Improved Kuroda variety of carrot was selected for investigation. The soil of the experiment site was sandy loam and slightly acidic in nature with pH 6.87. The soil had total organic carbon of 0.41%, total Nitrogen of 0.05%, available

Phosphorus of 21.1 kg ha^{-1} and available Potassium of 78.8 kg ha^{-1}. The experimental site is under tropical humid climate with range of average temperature of 31.72ºC and 12ºC during experimental period of October to February. Forty-eight individual plots of size $6m^2$ each with a spacing of 50 cm × 40 cm were demarcated. All the plots except the control one under study received recommended uniform dose of Nitrogen and Phosphorous @ 80 kg and 50 kg ha^{-1}respectively.The treatment combination used was as follows: T_1: Control; T_2: 80:50:0 kg ha^{-1} NPK+5 kg B ha^{-1}; T_3: 80:50:0 kg ha^{-1} NPK +10kg B ha^{-1}; T_4: 80:50:0 kg ha^{-1} NPK+15 kg B ha^{-1}; T_5: 80:50:50 kg ha^{-1} NPK+0 kg B ha^{-1}; T_6: 80:50:50 kg ha^{-1} NPK+5 kg B ha^{-1}; T_7: 80:50:50 kg ha^{-1}NPK+10 kg B ha^{-1}; T_8: 80:50:50 kg ha^{-1} NPK+15 kg B ha^{-1}; T_9: 80:50:75 kgha^{-1} NPK+0 kg B ha^{-1}; T_{10}: 80:50:75 kg ha^{-1} NPK+5 kg B ha^{-1}; T_{11}: 80:50:75 kg ha^{-1} NPK+10 kg B ha^{-1}; T_{12}: 80:50:75 kg ha^{-1} NPK+15 kg B ha^{-1}; T_{13}: 80:50:100 kg ha^{-1} NPK+0 kg B ha^{-1}; T_{14}: 80:50:100 kg ha^{-1} NPK+5 kg B ha^{-1}; T_{15}: 80:50:100 kg ha^{-1} NPK+10 kg B ha^{-1}; T_{16}: 80:50:100 kg ha^{-1} NPK+15 kg B ha^{-1}.The quality parameters of the carrot root were estimated after following standard procedures. The β-carotene (mg $100g^{-1}$)content of carrot root was analysed spectrophotometrically by the procedure postulated by Ranganna(1997). Composite pulp of sampled roots per replication from all the treatments were used to estimate ascorbic acid content in the fresh roots following standard biochemical methods of Sadasivam and Manickam (1996). Total Soluble solid (TSS) was determined with the help of digital refractometer (Mishra *et al.,* 2014). Total Sugar was estimated by Lane and Eynon's method in terms of reducing, non-reducing and total sugars (Ranganna, 1997). The data were statistically analysed using standard statistical procedures according to Panse and Sukhatme (1961) and Gomez and Gomez (1983).

RESULTS AND DISCUSSION

Quality attributing characters

Effect on carotene (mg $100g^{-1}$)

From the experimental data it was clear that soil application of boron and potassium in higher rates had significant effect for increase in carotene content of carrot root. After perusal of data presented in Table 1 showed that significantly highest level of carotene was found in the treatment T_{12} (4.56 mg 100 g^{-1}) which was closely followed by T_{16} (4.21mg $100g^{-1}$) and T_{11} (4.18 mg 100 g^{-1}) respectively, whereas the lowest content of beta carotene was obtained from control *i.e.* (2.88 mg $100g^{-1}$).Similar results were also obtained by Lyngdoh (2001), Ali *et al.* (2003) and Anjaiah and Padmaja (2006) who found that total carotenes content increased with increasing levels of potassium. The improvements of the carotenes in roots as a result of potassium and boron application may be due to photosynthetic activity by boron and enzymatic reaction triggered off by potassium and ultimately leading to carbohydrates transformation for carotene synthesis.

Effect on ascorbic acid(mg $100g^{-1}$)

Data presented in Table 1 revealed that significantly maximum content of ascorbic acid was found from the treatment T_{12} (2.70 mg $100g^{-1}$) which was closely followed by T_{16} (2.18mg $100g^{-1}$) and T_{15}(2.00mg $100g^{-1}$) respectively, whereas the lowest content of ascorbic acid(0.25 mg $100g^{-1}$) was obtained from control plots. Ananthi *et al.* (2004) while observing the effect of potassium on quality parameters of chilli found that application of 75 kg $K_2O$$ha^{-1}$ as sulphate of potash has resulted in highest ascorbic acid content (117.96 mg $100g^{-1}$), which was significantly superior over application of 45 kg $K_2O$$ha^{-1}$. Acharya *et al*. (2015) while interpreting the effect of micronutrients on quality parameters of onion at the experimental Farm of Department of Vegetable Crops, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore found that soil application of potassium at higher rate recorded maximum value (16.17 mg $100g^{-1}$) of ascorbic acid of onion bulb.Similar findings were also reported by Ballabh and Rana (2012); Manna (2013); Trivedi and Dhumal (2013) in onion. On the other hand Poornima *et al. (*2015) recorded highest ascorbic acid (198.79 mg $100g^{-1}$) content of chilli with application of higher dose of potassium (100 kg K_2O ha^{-1}) compared to control. Increase in the ascorbic acid content of carrot with supply of potassium and boron at an elevated level may be due to the close relationship between the carbohydrates metabolism and the

Table 1: Effect of Potassium and boron on carotene,TSS, total sugar and ascorbic acid content of carrot

Treatments		Carotene (mg $100g^{-1}$)	TSS (°Brix)	Total sugar (%)	Ascorbic acid (mg$100g^{-1}$)
T1	(K_OB_O)	2.88	6.03	4.28	0.25
T2	(K_OB_1)	3.08	6.33	4.77	0.33
T3	(K_OB_2)	3.17	6.46	4.88	0.42
T4	(K_0B_3)	3.55	7.00	5.04	0.53
T5	(K_1B_0)	3.86	7.20	5.73	0.66
T6	(K_1B_1)	3.92	7.46	5.89	0.82
T7	(K_1B_2)	3.67	7.60	6.04	1.12
T8	(K_1B_3)	4.00	9.03	6.66	1.86
T9	(K_2B_0)	3.56	8.00	5.99	1.22
T10	(K_2B_1)	3.78	8.10	6.44	1.20
T11	(K_2B_2)	4.18	8.13	7.02	1.66
T12	(K_2B_3)	4.56	9.43	7.60	2.70
T13	(K_3B_0)	4.03	8.43	6.07	1.49
T14	(K_3B_1)	3.44	8.86	6.33	1.66
T15	(K_3B_2)	3.76	9.00	6.54	2.00
T16	(K_3B_3)	4.21	9.80	7.03	2.18
S.E.(m)		0.05	0.02	0.13	0.09
CD at 5%		0.16	0.07	0.37	0.26

formation of ascorbic acid. Since both boron and potassium play very important role in photosynthetic activities of plant.

Effect on total soluble solids (°Brix)

After perusal of data, presented in Table 1, regarding total soluble solids (TSS) content of carrot root, it was evident that total soluble solids (TSS) content was maximum and varied significantly with the higher concentrations of potassium and boron over control. The highest TSS was obtained from T_{16} (9.80 °Brix) followed by T_{12} (9.43 °Brix) and T_8 (9.03 °Brix) in addition the lowest has been recorded from T_1 (control) i.e. (6.03°Brix).This result was in accordance with the findings of Deshpande *et al.*(2013) who recorded highest TSS (8.34° Brix) with the application of 100 kg K_2O ha^{-1}, significantly higher than 7.19° Brix obtained with control.

Potassium has a prominent role in translocation of photo-assimilates, sugars and other soluble solids which are responsible for increased TSS (Kumar *et al.,* 2015). Trivedi *et al*. (2012) reported that higher TSS might be contributed to the efficient translocation of photosynthates to the fruit by the regulation of boron.

Effect on total sugar (%)

Threadbare interpretation of data, presented in Table 1, related to total sugar content of carrot root as influenced by different rates of boron and potassium showed that there was significant effect of these two nutrients upon total sugars content over control. Significantly highest amount of total sugar content of carrot root was obtained with T_{12} (7.60%) which was closely followed by T_{16} (7.03%) and T_{11} (7.02%). Present results were in agreement with the findings of Javaria *et al*. (2012). Deshpande *et al*. (2013) while conducting a research trial on onion also found that application of potassium significantly increased total sugar content of bulb from 5.89 % in control to 7.32 % where it received 100 kg of K_2O ha^{-1}.The reason of enhanced sugar content could be the role of potassium and boron in biosynthesis and transfer of sugars (Karam *et al.,* 2009). Thus, it can be concluded that application of potassium and boron at higher rates like 75 -100 kg $ha^{-1}$and 15 kg ha^{-1}respectively may be suggested for quality root production of carrot in Indo gangetic plains of west Bengal.

REFERENCES

Abo Hamad, S. A. and El-Feky, S. S. 2014. Effect of boron on growth and some physiological activities of tomato plant. *Life Sci. J.* **11(7):** 404-408.

Acharya, U., Sharma, R., Venkatesan, K., Saraswathi, T. and Subramanian, K. S. 2015. Response on growth, yield and quality parameters of Multiplier Onion (*Allium cepa* L. var. aggregatum Don.) var. CO (On) 5 with different doses and method of Zinc and Boron application. *Int. J. Agronomy and Agri.Research.* **6(4):** 59-67.

Ali, M. A., Hossain,M.A.,Mondal M. F. and Farooque, A. M. 2003. Effect of nitrogen and potassium on yield and quality of carrot. *Pak. J. Biol. Sci.*, **6 (18):** 1574-1577.

Ananthi, S., Veeraragavathatham, D. and Srinivasan, K. 2004. Influence of sources and levels of potassium on quality attributes of chilli (*Capsicum annuum* L.). *South Indian Hort*. **52(1-6):** 152-157.

Anjaiah, T. and Padmaja, G. 2006. Effect of potassium and farm yard manure on yield and quality of carrot. *J. Research*. **34 (2):** 91-93.

Ballabh, K. and Rana, D. K. 2012. Response of micronutrients on qualitative and quantitative parameters of onion (*Allium cepa* L.). *Progressive Hort*. **44:** 40-46.

Deshpande, A. N., Dhage, A. R., Bhalerao, V. P. and Bansal, S. K. 2013. Potassium Nutrition for Improving Yield and Quality of Onion. *International Potash Inst. E-ifc***. 36:** 16-28.

Gomez, K. A. and Gomez, A. A. 1983. Statistical procedures for agricultural research. Published by John Wiley and sons, New York. P. 1-623.

Javaria, S., Khan, M. Q. and Bakhsh, I. 2012. Effect of potassium on chemical and sensory attributes of tomato Fruit. *The J. Animal and Plant Sci*. **22(4):** 1081-1085.

Karam, F., Rouphacl, Y., Lahoud, R., Breidi, J. and Coll, G. 2009. Influence of Genotypes and potassium Application Rates on Yield and potassium Use Efficiency of Potato. *J Agro*. **8(1):** 27-32.

Kumar, J., Kumar, R., Rai, R. and Mishra, D. S. 2015. Response of 'pant prabhat' guava trees to foliar sprays of zinc, boron, calcium and potassium at different plant growth stages.*The Bioscan.* **10(2):** 495-498.

Ladha, J.K., Dave, D., Pathak, H., Padre, A.T., Yadav, R.L., and Singh, B. 2003. How extensive are yield declines in long-term rice-wheat experiments in Asia. *Field Crops Res*. **81**: 159-180.

Lal, K., Swarup, A. and Singh, K. N. 2007. Potassium balance and release kinetics of non-exchangeable K in a typic natrustalf as influenced by long term fertilizer use in rice-wheat cropping system. *Agro. Chem*. **51:** 95-104.

Lyngdoh, G. B. S. 2001. Response of carrot to different levels of nitrogen, phosphorus and potassium. *Hort. J.* **14(2):** 163-169.

Manna, D. 2013. Growth, yield and bulb quality of onion (*Allium cepa* L.) in response to foliar application of boron and zinc. *SAARC J. Agriculture*. **11:** 149-153.

Mishra, P. K., Pathak, S., Singh, R. K., Sahay, S., Tiwari, D. K., Shrivastava, P. and Rashmi, K. 2014. Evaluation of mango (*Mangifera indica* L.) cultivars for preparation of osmo-dehydrated product. *The Bioscan*. **9(4):** 1495-1498.

Panse, V. G. and Sukhatme, P. V. 1961. Statistical methods for Agricultural workers. *2nd Edition ICAR*, New Delhi. p.361.

Poornima, K. S., Mamatha, N. and. Ramesh, H. S. 2015. Effect of potassium and sulphur on quality parameters of onion and chilli intercrops in avertisol. *Adv. Research J. Crop Improvement*. **6(2):**16-169.

Ranganna, S. 1997. Plant pigment In: Handbook of analysis and quality control for fruits and vegetable products. *Tata McGrew Hill Pub. Co Ltd.,* New Delhi. pp. 11-12.

Regmi, A. P., Ladha, J. K., Pasuquin, E., Pathak, H., Shrestha, L. L., Gharti, D. B. and Duveiller, E. 2002. The role of potassium in sustaining yields in a long-term rice-wheat experiment in the Indo-Gangetic Plains. *Biol. Fert. Soils*. **36:** 240-47.

Sadasivam, S. and Manickam, A. 1996. Biochemical methods. 2nd edition, New Age International (p) Ltd. Publisher, New Delhi. P.179–186.

Siddiky, M. A., Halder, N. K., Ahammad, K. U., Anam, K. and Rafiuddin, M. 2007. Response of brinjal to zinc and boron fertilization. *Int. J. Sustainable Agri.Tech*. **3:** 40-45.

Tahir, M., Tanveer, A., Shah, T. H., Fiaz, N. and Wasaya, A.2009. Yield response of wheat (*Triticum aestivum* L.) to boron application at different growth stages. *Pak. J. of Life and Social Sci*. **7(1):** 39-42.

Trivedi, N., Singh, D., Bahadur, V., Prasad, V.M. and Collis, J. P. 2012. Effect of foliar application of zinc and boron on yield and fruit quality of guava (*Psidium guajava* L). *HortFlora Research Spectrum* **1(3):** 281-283.

Trivedi, A. P. and Dhumal, K. N. 2013. Effect of soil and foliar application of zinc and iron on the yield and quality of onion (*Allium cepa* L.). *Bangladesh J. Agril. Ressearch*. **38:** 41-48.