Research Article

Effect of NPK, FYM and Vermicompost on Growth, Yield and Quality of Sweet Potato (*Ipomoea batatas* Lam.)

Sunita Koodi[1]*, S.P Singh[1], Manoj Kumar Rolaniya[1],Suman Gathala[2], and Rajbala Choudhary[1]

[1]Department of Horticulture, S. K. N. Agriculture University, Jobner, Jaipur -303329, Rajasthan, India
[2]Maharana Pratap University of Agriculture and Technology, Udaipur - 313001,Rajasthan, India

Abstract

A field experiment was carried out during *kharif* season 2015-2016 to determine the effect of NPK, FYM and vermicompost on growth, yield and quality of sweet potato under randomized block design. Vine length, leaf area, chlorophyll content in leaves, tuber weight, tuber length, tuber diameter, tuber yield (kg/plot), tuber yield (q/ha), NPK content, starch, protein, TSS and ascorbic acid content were significantly differed at different fertility levels. The maximum vine length (172.9 cm), leaf area(185.3 cm^2), chlorophyll content (1.178 mg/g), tuber weight (323.62 g), tuber length (15.20 cm), tuber diameter (8.57cm), tuber yield (12.32 kg/plot), tuber yield (228.16 q/ha), TSS content (4.56%), NPK content (0.348%, 0.310% and 0.646%, respectively), starch (13.03%), protein (2.17%) and ascorbic acid content (43.49 mg/100g) were found in F3 (100% RDF + 2.5 t VC/ha) fertility level.

Keywords: Sweet potato, NPK, FYM, Vermicompost, Growth, Quality, Yield

***Correspondence**
Author: Sunita Koodi
Email: sunitakoodi100@gmail.com

Introduction

Sweet potato (*Ipomoea batatas* Lam.) belongs to the family Convolvulaceae and historically played an important role in the quest for food and the struggle for human survival in several countries. It is popularly known as "*SakarKand*" in India. It originated from Central America and spread to other parts of the world. Sweet potato is an important starchy food crop grown through out the tropical and sub-tropical countries. It is a warm-season crop and grows best in abundant sunshine, temperatures above 24°C, sandy loam soil and a well-distributed rainfall of 850-900 mm per annum. It matures in of 3-9 months duration or longer depending on the variety [1].

In India, sweet potato occupying an area over 106 hectares with production of 1088 million tonnes. Sweet potato is widely cultivated throughout India except Jammu and Kashmir. The main growing states of sweet potato are Bihar, Orissa, Uttar Pradesh, Madhya Pradesh, Maharashtra and Karnataka. In state like Rajasthan it is occupying an area over 643 hectares with production of 1979 tonnes and productivity are 3038 kg per hectare [2].

Sweet potato is a very nutritive vegetable, producing substantially high edible energy per hectare per day as compared to rice, wheat, maize and cassava. It contains starch (12.7 g), sugar (4.2 g), vitamin A (709 µg) and protein (1.6 g) per 100 g of edible part.

It is well documented that growth and yield of plants are greatly influenced by a wide range of nutrients. An approach involving chemical fertilizers, organic manures and biofertilizers to bridge this gap between nutrient demand and supply for giving a boost to crop production is only the solution. The situation further aggravates for the light soils of Rajasthan where nutrient use remains much lesser than the removal [3]. [4], most of the farmers usually do not apply any fertilizer or just apply a small amount of urea or organic manures of unspecified quantity. This may be one of the reasons that is why yields obtained by local farmers are lower than yields obtained elsewhere. [5] reported that potato crop has strict requirement for a balanced fertilization without which growth and development of the crop are poor and yield and quality of tubers are also diminished.

Among macro nutrients required by the crop nitrogen is found to be deficient in most of the Indian soils [6]. Availability of nitrogen is of prime importance for growing plants, it is one of the major and indispensable constituents of protein, nucleic acid and integral part of chlorophyll molecules which are responsible for photosynthesis. Phosphorus is also indispensable constituents of nucleic acid, phosphor lipids and several enzymes.

Potassium imparts increased vigour and disease resistant to plant, it also regulates water loss from the plant by maintaining the balance between metabolism, respiration and transpiration.

As with the other most root crops, sweet potato has a high requirement for potassium relative to nitrogen. However due to unavailability of straight K fertilizer in the market, wood ash could be an alternative and cheaper source of K that is available. The K_2O concentration in the wood ash was analyzed and discovered to be about 3 percent. Thus, ash could be an important source of potassium for sweet potato production [7].

In India, the mixed farming system with livestock raising is an integral part of crop production. The availability of large quantity of FYM being rich in organic matter need for supplementing the nutrients. The organic manure (FYM) not only provides nutrient to the plant but also improves the soil texture by binding effect to soil aggregates. Organic manure increases CEC, water holding capacity and phosphate availability of the soil besides improving the fertilizer use efficiency and microbial population of soil, it reduces nitrogen loss due to slow release of nutrients.

In recent years, use of vermicompost has been advocated in integrated nutrient management (INM) system in vegetable crops. Vermicompost means a mixture of worm casting, organic materials, humus, living earthworms, their cocoons and other organisms. Vermicompost is a slow releasing and organic manure which have most of the macro as well as micro nutrients in chelated form and fulfill the nutrient requirement of plant for longer period. Vermicompost helps in reducing C:N ratio, increased humic acid content, cation exchange capacity and water soluble carbohydrates [8]. It also contains biological active substance such as plant growth regulators.

Materials and Methods

The field experiment was conducted at Horticulture Farm, S.K.N. College of Agriculture (S.K.N. Agriculture University) Jobner, District Jaipur during *kharif* season of 2015. The experiment area is situated at 26° 05' North latitude and 75° 28' East longitude at an elevation of 427 metres above mean sea level, in Jaipur district of Rajasthan. This region falls under agroclimatic zone III-A (Semi-Arid Eastern Plain Zone) of the state. The climate of this region is typically semi-arid, characterized by extremes of temperatures during both summer and winter. During summer, the temperature may go as high as 48℃ while in winters, it may be fall and down as low as -1℃. The average annual rainfall of this tract ranges between 300- 400 mm. The soil was sandy loam with a pH value 8.1. Soil samples were collected randomly from a depth up to 0 - 15 cm of the experimental plot and analyses were done and showed nitrogen 132.75 kg ha^{-1}, phosphorus 17.84 kg ha^{-1}, potassium 161.50 kg ha^{-1} soil and organic carbon 0.13%. Different fertility levels are to be followed :

F_1- 100 % RD of NPK (100:60:100 kg/ha), F_2- 50 **%** RD of NPK + VC (5 t/ha),F_3- 100 % RD of NPK + VC (2.5 t/ha),F_4- 50 **%** RD of NPK + FYM (15 t/ha) and F_5- 100 % RD of NPK + FYM (7.5 t/ha).

The experiment was laid out in Randomized Block Design (RBD) with three replications. The whole experimental area was 24.5 m x 19.9 m, which was divided into three blocks. Each block was again divided into 20 plots and hence there were 60 (20 × 3) unit plots. The treatments were assigned randomly in each block separately. The size of unit plot was 2.40 m × 2.25 m. The distance between two adjacent blocks and plots were 1.0 m and 0.5 m. Land preparation, manuring and intercultural operations were done properly. Five plants in each plots were used for taking observation. Yield and quality parameters were recorded after harvesting and growth parameters like leaf area and chlorophyll content recorded 45 and 50 days after sowing, respectively.

Result and Discussion

Growth parameters

The growth characters were significantly influenced by the different combination of the fertilizers (**Table 1**). In the present investigation, it was observed significant increase in source of organic fertilizers with chemical fertilizers, corresponding increased vine length, leaf area and total chlorophyll content. The maximum vine length (172.9 cm), leaf area (185.3 cm^2) at 45 days after planting and total chlorophyll content (1.178 mg/g) at 50 days after planting were observed in F_3 treatment (100 % RD of NPK + VC (2.5 t/ha). Vermicompost may influence plant growth directly through the supply of plant growth regulating substances (PGRs) proposed by [9], [10], [11]. When number of leaves are increase it also helps to increase the leaf area. The above findings are in consonance with the results of Cortez [12] and [13]. When FYM and vermicompost applied it increased plant growth attributes due to organic manures not only provided plant nutrients but also improved the physical condition of soil in respect of granulation,

friability, porosity and developed a balanced nutritional environmental to both soil *rhizosphere* and plant system. [14], [15].

Table 1 Effect of fertility levels on vine length at harvest, average leaf area at 45 DAP and total chlorophyll content at 50 DAP of sweet potato

Treatments	Vine length (cm)	Leaf area (cm^2)	Total chlorophyll content (mg/g)
Fertility levels			
F_1	146.1	134.4	0.878
F_2	163.6	172.4	1.076
F_3	172.9	185.3	1.178
F_4	161.6	170.7	1.074
F_5	171.8	184.4	1.166
SEm±	2.6	4.3	0.032
CD (P=0.05)	7.5	12.4	0.091

Yield parameters

The treatment combination of organic and inorganic fertilizers recorded the higher value(Table 2) for fresh weight of tuber (323.62 g), maximum length of tuber (15.20 cm) the increase in length of root might be due to increase in nutrient use efficiency by the organic fertilizer along with chemical fertilizer. Vermicompost increased weight, length and finally yield of tuber because it contains higher amount of nutrients than FYM and other compost. This finding is in accordance with the results of [16], [17]. Maximum diameter (8.57 cm) might be due to good root extension and bulking capacity of soil. Highest tuber yield (12.32 kg) and tuber yield (228.16 q/ha) obtained in F_3 treatment. This was in consonance with the findings of [18] that the yield of sweet potato is significantly depressed if potassium is missing. Furthermore, the key factors for increased sweet potato yield are the careful regulation of N levels and liberal supply of K to increase sink capacity and photosynthesis.

Table 2 Effect of fertility levels on length, weight,diameter and yield of tuber of sweet potato

Treatments	Tuber length (cm)	Tuber weight (g)	Diameter of tuber (cm)	Tuber yield (kg/plot)	Tuber yield (q/ha)
Fertility levels					
F_1	10.05	211.17	5.06	6.85	126.93
F_2	14.28	303.53	8.11	11.55	213.94
F_3	15.20	323.62	8.57	12.32	228.16
F_4	14.19	301.36	8.02	11.42	211.47
F_5	15.13	321.16	8.47	12.17	225.36
SEm±	0.30	3.80	0.12	0.17	3.98
CD (P=0.05)	0.86	10.88	0.35	0.50	11.39

Quality parameters

The total soluble solid of tuber increased as the source of organic fertilizers increased in combination with inorganic fertilizers in **Table 3**. The treatment F_3 recorded the highest T.S.S content (4.56 %). The highest T.S.S content in tuber might be due to maximum moisture content, dry weight of root because organic fertilizers carry almost all micro and macro nutrients that are required for the plants growth [19]. NPK content (0.348%, 0.310% and 0.646%, respectively) The highest and most significant tuber production was found from the plots treated with inorganic fertilizer and vermicompost which was as a result of high potassium content of the inorganic fertilizer used. Also comparative higher level of potassium was also found in the organic fertilizer under consideration too (Kareem, 2013) [18]. Maximum starch (13.03%), protein (2.17%) and ascorbic acid content (43.49 mg/100g) were found in F_3 (100% RDF + 2.5 t VC/ha) fertility level. It was significantly higher over rest of the treatments.

Table 3 Effect of fertility levels on quality attributes of sweet potato

Treatments	TSS (%)	N content (%)	P content (%)	K content (%)	Starch content (%)	Protein content (%)	Ascorbic acid (mg/100g)
Fertility levels							
F_1	3.95	0.214	0.274	0.540	10.80	1.23	34.62
F_2	4.21	0.299	0.296	0.591	12.23	1.87	40.39
F_3	4.56	0.348	0.310	0.646	13.03	2.17	43.49
F_4	4.15	0.293	0.293	0.588	11.74	1.83	37.73
F_5	4.50	0.329	0.308	0.639	12.97	2.06	42.80
SEm±	0.11	0.008	0.004	0.016	0.27	0.05	0.78
CD (P=0.05)	0.31	0.022	0.013	0.047	0.78	0.13	2.24

Conclusion

On the basis of result obtained in the present investigation, it may be concluded that application of NPK and vermicompost enhanced the growth, yield and quality of sweet potato. Among these treatments 100% RDF of NPK + 2.5 t VC/ha registered higher values of growth, yield and quality of sweet potato.

References

[1] CIP (International Potato Center) Lima, Peru 2003. Sweet potato. Treasure for the poor in sweet potato main page 25.

[2] Anonymous, 2014. Indian Horticulture Database-2014. National Horticultural Board, Gurgaon.

[3] Gupta, A.K. 2001. Nutrient mixing in agro-clmiatic zones of Rajasthan. Fertilizer News 46 (9) : 39-46.

[4] Mohamed, M. 1984. Effects of bed preparation and nitrogen fertilization on growth yield and quality of sweet potato (Ipomoea batatas). Acta Horticulture, 143 : 311-318.

[5] Patricia, I. and Bansal, S.K. 1999. Potassium and integrated nutrient management in potato. Proceedings of the Global Conference on Potato, December 6-11-1999, New Delhi, India : 1-3.

[6] Arkeri, H.R., Chalan, G.V., Satyanarayan, P. and Dona-hue, R.L. 1956. Soil management in India. Asian Publishing house, Bombay.

[7] Tsuno, Y. and Fujise, K. 1965. Studies on the dry matter production of sweet potato. Crop Science Society of Japan Proceedings, 31: 285-288.

[8] Talashilkar, S.C., Bhangarath, P.P. and Mehta 1999. Changes in chemical properties during composting of organic residues as influenced by earthworm activity. Journal of the Indian Society Soil Science, 47 (1): 50-53.

[9] Tomati, U., Galli, E., Grapppelli, A. and Dihena, G. 1990. Effect of earthworm casts on protein synthesis in radish (Raphanus sativum) and lettuce (Lactuca sativa) seedlings. Biology and Fertility of Soils, 9: 288-289.

[10] Grappelli, A., Galli, E. and Tomati, U. 1987. Earthworm casting effect on Agaricus bisporus fructification. Agrochimica, 31(4-5): 457-461.

[11] Tomati, U. and Galli, E. 1995. Earthworms, Soil Fertility and Plant Productivity. Proceedings of the International Colloquium on Soil Zoology. Acta Zoologica Fennica,196:11-14.

[12] Cortez jaun, W., Filho Arthur, B. and Countinho edson, L. 2010. Cattle manure and N-urea in radish crop (Raphanus sativus). Ciencia e Investigacion Agraria, 37 (1): 45-53.

[13] Maurya, A.N. and Muthoo, A.K. 1986. A note on the effects of foliar spray of urea on the growth characters and yield cv. Pusa Rashmi. Haryana Journal of Horticultural Sciences, 15 (1/2): 149-150.

[14] Marimuthu, R., Babu, S., and Vairavan 2000. Uitility of different sources of vermicompost and in nutrient status on the growth and yield of nutrient of groundnut cv. VRI 2. Legume Research, 25: 266-269.

[15] Surrender Rao, S. and Sitaramaya, M. 2000. Performance of alternate organic nitrogen sources in an inceptisol under rice. In proceedings of International Conference Managing atural Resources for sustainable Agricultural Production in the 21st Century, New Delhi, 3, 1464-1465.

[16] Asghar, H.N., Ishaq, Z.A., Zahir, Z.A., Khalid, M. and Arshad, M. 2006. Response of radish to integrated use of nitrogen fertilizer and recycled organic waste. Pakistan Journal of Botany, 38 (3): 691-700.

[17] Velmurugan, M., Balakrishnamoorthy, G. and Ananthan. M. 2005. Studies on organic farming practices on growth, yield and quality of radish (Raphanus sativus L.) cv. Pusa Chetki. South Indian Horticulture, 53 (1-6): 337-339.
[18] Kareem, I. 2013. Fertilizers treatment effects on yield and quality parameters of sweet potato (Ipomoea batatas). Research Journal of Chemical and Environmental Sciences, 1: 40-49.
[19] Desuki,El-M., Salman, S.R., El-Nemr, M.A. and Abdel Mawgoud, M.R. (2005). Effect of plant density and nitrogen application on the growth, yield and quality of radish (Raphanus sativus L.). Journal of Agronomy, 4: 225-229.

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