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Effect of integrated nutrient management on growth, yield and quality of sweet potato [*Ipomoea batatas* (L.) Lam]

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Abstract

The effect of different levels of integrated nutrient sources and bio-fertilizers on growth, yield and quality parameters of sweet potato was evaluated at RHRS farm Navsari, Gujarat. The application of 50 % RDN through inorganic fertilizers + 50 % RDN through vermicompost (T_2) had shown significant impact on growth parameters studied like vine length at 60, 90 DATP and at harvest (78.98 cm, 120.17 cm and 175.87 cm, respectively) and the highest number of leaves at harvest i.e. 138.80 per vine. Both of these characters were at par with T_3 treatment (50 % RDN through inorganic fertilizers + 50 % RDN through FYM). Highest total and marketable tuber yield per hectare (34.47 t and 32.67 t, respectively) and yield attributes *viz.,* number of tuberous roots per vine (5.10), fresh weight of tubers per vine (0.512 kg), tuber girth (15.94 cm) and tuber length (24.34 cm) were recorded significantly highest in T_2 treatment and were also at par with the treatment T_3. The marketable tuber yield per hectare recorded 21.81 % increase in T_2 treatment over the lowest yield noted in T_1 treatment. Application of different nutrient sources did not show significant influence on any of the quality parameters recorded. The application of bio-fertilizers also gave significantly the highest results for all the parameters discussed with respect to organic and inorganic sources application. The treatment which received 50 % RDN through FYM along with combination of bio-fertilizers T_3B_1 realized highest benefit: cost ratio followed by the treatment receiving 50 % RDN through biocompost along with combination of bio-fertilizers (T_4B_1).

Keywords: Integrated nutrient sources, bio-fertilizers, sweet potato

Introduction

Among different tuber crops, sweet potato [*Ipomoea batatas* (L.) Lam] is an important tuber crop belongs to family Convolvulaceae. It is a natural hexaploid (2n=6x=90), having basic chromosome number x=15. It's origin is South America. It is also known as a famine relief crop as it had played a pivotal role in aviating the Bengal famine of 1942. It is a herbaceous perennial but cultivated as annual. It is vegetatively propagated by vine cuttings taken from freshly harvested vines grown in secondary nursery (Selvakumar, 2014) [1].

Asia is the largest producer of sweet potato having 92 % of production and 80 % of area in the world. China and India are the leading sweet potato growing countries in the world. Uttar Pradesh, Bihar, Tamil Nadu, Odisha, Kerala, Karnataka, West Bengal, Madhya Pradesh, Assam, Maharashtra and Gujarat are the leading states of sweet potato cultivation. In Gujarat it is commercially cultivated in the districts of Mehsana, Ahmedabad, Kheda, Anand, Surat, Tapi, Dangs, Valsad and Navsari.

It was widely perceived that inorganic fertilizers were a viable means of increasing land productivity in the low fertile soils. It is also one of the most important inputs of increasing the productivity of crops (Anon., 1997) [2]. In order to obtain good yield, modern varieties of different crops require relatively huge quantity of fertilizer compared to the traditional cultivars. However, it has been repeatedly confirmed that continuous sole and imbalanced use of chemical fertilizers deteriorates soil health and ecological balance which leads to decrease in nutrient uptake efficiency (Saravaiya *et al*., 2010) [3]. Soils that receive plant nutrients only through chemical fertilizers are showing decline in productivity and deficiency in secondary and micronutrients.

Unlike chemical fertilizers, organic manures are available locally at cheaper rates and used by farmers to provide nutrients for the crop plants. Organic manure is one of the most important inputs for increasing the productivity of crop (Anon., 1997) [2]. Crop production potential also relates to soil physical and chemical properties and revolve around the dynamics of organic matter decomposition by soil micro-organisms. Use of bio-fertilizers helps to increase soil micro-flora and fauna, which ultimately increases the decomposition rate, productivity and sustainability of the soils. They provide organic acids that help to dissolve soil nutrients and make them available for the plants. Organic manures like farm yard manure, bio-compost, poultry manure, neem cake, vermicompost *etc.* were regarded as important, but it was obvious that they were not available in sufficient quantity to drastically increase food production. Therefore, maximizing the usage of organic waste combining it with chemical and bio-fertilizers in the form of integrated manner found to be the best alternative. Biofertilizers are not alternatives to chemical fertilizers but can play a supplementary role. It supplies nitrogen to specific crops under specific soil conditions. Nitrogen fixing micro-organisms i.e., non-symbiotic and symboitic cyanobacteria and phosphate-solubilising micro-organisms, are the main type of biofertilizers that are being used in India.

An integrated nutrient management strategy recognizes that soils are the storehouse of most of the plant nutrients essential for plant growth and that the way in which nutrients have managed will have a major impact on plant growth, soil fertility and sustainability (Janssen, 1993) [5]. There is an ample scope for organic production in tuber crops as they respond well to organic manures (Suja *et al*., 2009) [6]. Thus, the use of inorganic fertilizers in conjunction with organic manures is essential for getting sustainable and profitable yield of sweet potato.

Material and methods

The experiment was arranged over 8 treatment combinations comprising 4 levels of integrated nutrient sources laid out in a Randomized Block Design (Factorial concept) with three replications.

T_1: RDF- 75: 50: 75 NPK kg ha^{-1} + 15 t FYM ha^{-1}

T_2: 50 % RDN + 50 % N from vermi-compost along with RDF of P & K

T_3: 50 % RDN + 50 % N from FYM along with RDF of P & K

T_4: 50 % RDN + 50 % N from bio-compost along with RDF of P & K) and 2 levels of bio-fertilizers

B_0: without bio-fertilizers

B_1: with bio-fertilizers i.e. combination of *AZ*, PSB and KMB each at 5 liters ha^{-1}.

Cuttings were planted on 22th Nov, 2015 and required intercultural operations were carried out time to time. With respect to fertilizer application, nitrogen was substituted on the basis of N content of different organics. FYM was incorporated at the time of soil preparation in T_1 treatment. 50% of N in the form of organics will be applied at the time of planting. 100% P_2O_5 and 50% K_2O will be applied at 10 DAP in all the treatment combinations. 50% of N for T_1 treatment in the form of chemical fertilizers was applied at 10 DAP. 25% N and K_2O (in form of CF) was applied at 30 DAP all the treatment combinations. Remaining 25% of N and K_2O (in form of CF) will be applied 60 DAP all the treatment combinations. Bio-fertilizers (PSB, *AZ* and KMB) was applied at the rate of 5 kg ha^{-1} each. The harvesting of the crop was done on 15th Mar, 2016.

The tuberous roots after harvest were bought to the laboratory for bio-chemical analysis. In which the starch, total sugar, dry matter content of root and moisture content of tuberous roots was analyzed with the procedure given by Rangana *et al.* (1979) [7].

Result and discussion

Growth parameters like vine length at 60 DAP, 90 DAP, at harvest and number of leaves per vine at harvest were significantly influenced by application of organics, inorganics and bio-fertilizers. Data presented in Table 1 revealed significant differences in vine length at different growth stages at 60 DAP, 90 DAP and at harvest. At 60 DATP, 90 DATP and at harvest maximum vine length (78.98 cm, 120.17 and 175.87 cm, respectively) was recorded in treatment T_2 - 50 % RDN + 50 % N from vermi-compost along with RDF of P & K. Which was at par with both T_3 – (50 % RDN + 50 % N from FYM along with RDF of P & K) treatment and T_4 – (50 % RDN + 50 % N from biocompost along with RDF of P & K) treatment at 60 DATP and 90 DATP while at harvest it was at par only with T_3 treatment. The above discussed results are in conformity with Halavatau *et al*. (1998) [8]. This was mainly because after 60 DATP, the grand growth period involving high physiological activity synchronized with maximum nutrient uptake, which may have aided to increase the vine length. Highest number of leaves per vine at harvest was found in T_2 treatment (138.80) and was at par with T_3 treatment recording 129.80 leaves per vine. Application of bio-fertilizers also showed significant influences on vine length at 60 DATP, 90 DATP, at harvest and number of leaves per vine at harvest. Maximum vine length of 76.83 cm, 117.03 cm and 170.98 cm at 60 DATP, 90 DATP and harvest was recorded with application of bio-fertilizers. The highest number of leaves per vine at harvest (133.03) was also recorded highest with the application of bio-fertilizers as compared to without bio-fertilizer application. This may be attributed to the fact that rapid availability of nutrients, especially nitrogen through inorganics and production of growth promoting hormones through *Azospirillum* (Tien *et al*., 1979) [18]. The nitrogen fixing capacity of the *Azospirrillum*, increased mobility of phosphorous and potassium by PSB and KMB might also have helped in increasing the growth by exerting its synergistic effect with inorganic and organic manures.

Application of organics, inorganics and bio-fertilizers gave significant differences on yield and yield attributing characters like number of tuberous roots per vine, fresh weight of tubers per vine, tuber girth, tuber length and tuber yield per ha (Table 2). Treatment T_2 that received - 50 % RDN + 50 % N from vermi-compost along with RDF of P & K revealed the highest number of tubers per vine (5.10) and was at par with T_3 and T_4 treatments. Maximum fresh weight of tubers per vine 0.512 kg was produced in the treatment T_2 and was statistically remained at par with treatment T_3 and T_4. The highest tuber length and tuber girth of 24.34 cm and 15.94 cm, respectively was produced from treatment T_2 and remained at par with treatment T_3 and T_4. The highest total tuber yield of 34.47 t ha^{-1} and marketable yield of 32.67 t ha^{-1} was obtained by the treatment T_2 which was closely followed by T_3 and T_4 treatments. George and Mittra (2001) [9], Rahul *et al.* (2011) [10] and Panwar and Wani (2014) [11] have also reported higher yields by application of organic sources which are similar to the findings of present investigation. Incorporation of organic manures provide conducive physical environment mainly by improving the bulk density of soil (Arriage and Lowery, 2003) [3] which helps in better root extension, tuber bulking and absorption of nutrients from the soil as well as from nutrient sources. According to Laxminarayana (2013) [13], highest nutrient absorption from FYM and vermicompost had recorded higher tuber yield of sweet potato. The highest yield in INM treatments may also due to strong positive association of the growth and yield attributes with the tuber yield (Amanullakhan, 1997) [14].

While the application of bio-fertilizers also produced maximum number of tuberous roots per vine (4.81), fresh weight of tubers per vine (0.495 kg), tuber length (23.15 cm), tuber girth (15.47 cm), total tuber yield per ha (32.88 t ha^{-1}) and marketable yield per ha (31.04 t ha^{-1}). The findings are in conformity with Saad *et al.* (1999) [15]. The reason being that the application of vermi-compost and FYM had favored the activity of soil microflora, physical conditions besides supplementing the nutrients (Saravaiya *et al*. 2010) [3]. By applying 50 % N with inorganic fertilizers had met the plant nutrient requirement at initial stages of growth leading to increased vegetative growth and remaining 50 % N replaced through different organic sources had slowly satisfied the nutrient requirement of the plant at later stages of the growth mainly during corm development (Pillai *et al*., 1987) [16]. So the supplement of nutrients through both inorganic and organic sources had conjointly helped the plants to produce higher yields (Saravaiya *et al*., 2010, Bairagi and singh, 2013) [3, 17].

The tuber quality attributes as influenced by the INM treatments studied in the present investigation (table 3) such as starch content, total sugar content, dry matter content of tuber and moisture content had shown non significant results. However, higher starch content (14.43 %) and higher sugar content (2.97 %) was obtained in treatment T_2 receiving 50 % RDN + 50 % N from vermicompost. Higher dry matter content of tuber (31.33 %) and lower moisture content of tuber (68.67 %) was found in treatment T_3 receiving 50 % RDN + 50 % N from FYM. The application of bio-fertilizers had also shown non significant effect on starch content, total sugar content, dry matter content and moisture content of tubers.

Table 1: Effect of different organic nutrient sources and bio-fertilizers on growth parameters of sweet potato

Treatments	Growth Parameters				
	Vine length (cm)				Number of leaves per vine at harvest
	30 DATP	60 DATP	90 DATP	At Harvest	
T_1	34.73	68.50	105.67	157.13	119.05
T_2	39.17	78.98	120.17	175.87	138.80
T_3	38.97	73.50	116.00	165.97	129.80
T_4	38.03	72.83	110.73	160.10	125.78
SEm ±	1.150	2.325	3.307	4.516	3.720
C. D. (@ 5 %)	NS	7.051	10.030	13.697	11.283
B_0	36.55	70.08	109.25	158.55	123.66
B_1	38.90	76.83	117.03	170.98	133.06
SEm ±	0.813	1.644	2.338	3.193	2.630
C. D. (@ 5 %)	NS	4.986	7.092	9.685	7.979
T×B	NS	NS	NS	NS	NS
SEm ±	1.626	3.288	4.677	6.386	5.261
C. D. (@ 5 %)	NS	NS	NS	NS	NS

Table 2: Effect of integrated nutrient management on yield parameters of sweet potato

Treatments	Yield parameters					
	No. of tuberous roots	Weight of tubers per vine (kg)	Tuber length (cm)	Tuber girth (cm)	Total tuber yield t/ha	Marketable tuber yield t/ha
T_1	4.30	0.451	21.09	14.08	28.62	26.82
T_2	5.10	0.512	24.34	15.94	34.47	32.67
T_3	4.60	0.485	22.59	15.02	31.44	29.57
T_4	4.37	0.466	21.37	14.49	30.10	28.29
SEm ±	0.162	0.011	0.648	0.431	1.161	1.160
C. D. (@ 5 %)	0.49	0.034	1.966	1.307	3.521	3.518
B_0	4.38	0.462	21.55	14.30	29.44	27.63
B_1	4.81	0.495	23.15	15.47	32.88	31.04
SEm ±	0.115	0.008	0.458	0.305	0.821	0.820
C. D. (@ 5 %)	0.35	0.024	1.390	0.924	2.490	2.488
T×B	NS	NS	NS	NS	NS	NS
SEm ±	0.229	0.016	0.917	0.609	1.642	1.640
C. D. (@ 5 %)	NS	NS	NS	NS	NS	NS

Table 3: Effect of different organic nutrient sources and bio-fertilizers on quality parameters of sweet potato

Treatments	Quality Characters			
	Starch content (%)	Starch content (%)	Starch content (%)	Starch content (%)
T_1	13.70	13.70	13.70	13.70
T_2	14.43	14.43	14.43	14.43
T_3	13.99	13.99	13.99	13.99
T_4	13.58	13.58	13.58	13.58
SEm ±	0.413	0.413	0.413	0.413
C. D. (@ 5 %)	NS	NS	NS	NS
B_0	13.52	13.52	13.52	13.52
B_1	14.33	14.33	14.33	14.33
SEm ±	0.292	0.292	0.292	0.292
C. D. (@ 5 %)	NS	NS	NS	NS
T×B	NS	NS	NS	NS
SEm ±	0.584	0.584	0.584	0.584
C. D. (@ 5 %)	NS	NS	NS	NS

Conclusion

The replacement of 50 % RDN with vermi-compost along with recommended dose of fertilizers (T_2) and application of bio-fertilizers were very effective for improving vegetative, and yield characteristics. It has also been observed that integrated nutrient sources (mainly vermi-compost, FYM and biocompost) and bio-fertilizers were effective in improving the growth parameters which had reflected in producing higher number of tuberous roots per vine, tuber weight and ultimately producing the highest yield. It can be concluded from the present investigation that the integrated use of organic manures, bio-fertilizers and inorganic fertilizers is efficient than application of inorganic fertilizers alone in improving growth and yield in sweet potato cultivation.

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