Research Article

Comparative Effect of Organic and Inorganic Sources of NPK and Bio-fertilizer on Growth Attributes and Yield of Sweet Potato *cv*. IGSP-14

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Abstract

A field experiment was conducted to study the comparative effect of organic and inorganic sources of NPK and bio-fertilizer on growth attributes and yield of sweet potato (*Ipomoea batatas* Lam.) during Kharif season 2016 at Horticulture Farm, S.K.N. College of Agriculture, Jobner (Jaipur). The experiment consists of 16 treatment combinations *viz.*, organic and inorganic sources of NPK (Control, 100 % RDF, 100 % FYM, 50% RDF + 50 % FYM, 100 % vermicompost, 50 % RDF + 50 % vermicompost, 100 % poultry manure and 50 % RDF + 50 % poultry manure) and bio-fertilizer (Control and *Azotobacter*) were tested in randomized block design with three replications. Result shows that combined application of 50 % RDF and 50 % vermicompost + inoculation with *Azotobacter* and 50 % RDF and 50 % poultry manure + inoculation with *Azotobacter* both proved to be most superior treatment combinations in terms of vine length (cm) and number of branches per vine whereas the combined application of 50 % RDF and 50 % vermicompost + inoculation with *Azotobacter* proved to be most superior treatment combination in terms of leaf area (cm^2), tuber yield per plot and tuber yield per hectare.

Keywords: Sweet Potato, comparative effect, organic/inorganic sources of NPK, Growth attributes and yield.

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Introduction

Sweet potato (*Ipomoea batatas* Lam., family convolvulaceae) historically played an important role in the quest for food and the struggle for human survival in several countries. It is popularly known as "*Sakar Kand*" in India. It was originated in Central America and spread to other parts of the world. Sweet potato is an important starchy food crop grown throughout the tropical and sub-tropical countries. In India, sweet potato occupies an area over 111 thousand hectares with production of 1338 thousand tonnes. Sweet potato is cultivated throughout India but the main sweet potato growing states are Bihar, Orissa, Uttar Pradesh, Madhya Pradesh, Maharashtra and Karnataka. In Rajasthan it cultivates over an area of 790 hectares with production of 2240 tonnes and productivity 3040 kg per hectare [1]. 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 used as boiled and fried vegetable as well as for canning, dehydration and flour manufacturing. Tubers are good source of vitamin A, B, C and minerals like phosphorus, iron and calcium. Yellow and orange flesh varieties of sugarbeet have more carotene content [2].

In India, the mixed farming system with livestock raising is an integral part of crop production. The farm yard manure is rich in organic matter content and used to supplement the nutrients for plants. The organic manure (FYM) not only provides nutrients to the plants but also improves the soil texture by binding of soil aggregates. Organic manure increases CEC, water holding capacity and phosphate availability of the soil besides improving the fertilizer use efficiency and microbial population in the soil as well as also reduces nitrogen loss by slow release of nitrogen in the soil. In recent years, use of vermicompost has been advocated in vegetable crops. Vermicompost is a mixture of worm casting, organic materials, humus, living earthworms, their cocoons and other organisms. Vermicompost is a slow nutrient releasing organic manure which have most of the macro as well as micro nutrients in chelated form and fulfill the nutrient requirement of plants for longer period. Vermicompost helps in reducing C:N ratio, increased humic acid content, cation exchange capacity and water soluble carbohydrates [3]. It also contains biologically active substance such as plant growth regulators. Poultry manure is valuable manure and can serve as a suitable alternate to chemical fertilizers. Poultry manure application registered over 53 per cent increases of N level in the soil, from 0.09 per cent to 0.14 per cent and exchangeable cations also increased with the application of poultry manure [4]. In agriculture, the main reason for applying poutry manure is to add of organic amendment to the soil and to provide nutrients in sufficient quantity to the crops through organic source [5].

Bio-fertilizer liberates growth promoting substances and vitamins and helps in maintaining the soil fertility. They acts as antagonists and suppress the incidence of soil borne plant pathogens and thus, helps in the bio-control of diseases. *Azotobacters* are free-living bacteria that fix atmospheric nitrogen in cereal crops without any symbiosis and they do not need a specific host plant. *Azotobacters* are abundant in well drained, neutral soil. They can fix 15-20 kg/ha N per year. *Azotobacter species* can also produce antifungal compounds to fight against many plant pathogens. They also increase germination of seeds and vigour in young plants leading to improved crop stands [6].

Materials and Methods

Experimental details

A field experiment was conducted to study comparative effect of organic and inorganic sources of NPK and bio-fertilizer on growth attributes and yield of sweet potato (*Ipomoea batatas* Lam.) *cv.* IGSP-14 during Kharif season 2016 at Horticulture Farm, S.K.N. College of Agriculture, Jobner, Jaipur (Rajasthan). The experiment consists of 16 treatment combinations *viz.*, organic and inorganic sources of NPK (Control, 100 % RDF, 100 % FYM, 50% RDF + 50 % FYM, 100 % vermicompost, 50 % RDF + 50 % vermicompost, 100 % poultry manure and 50 % RDF + 50 % poultry manure denoted by symbols I_0, I_1, I_2, I_3, I_4, I_5, I_6 and I_7) and bio-fertilizer (Control and *Azotobacter* denoted by symbols B_0 and B_1) were tested in randomized block design with three replications. The vine cuttings were cut for transplanting to the nursery beds when they have six to eight well developed leaves and a good root system. The vines were planted on 20th August, 2016. The doses of organic and inorganic sources of N P K are FYM @ 20 t/ha, Poultry manure @ 5 t/ha, Vermicompost @ 7 t/ha and recommended dose of N P K is 100, 60 and 120 kg per ha respectively. The dose of *azotobacter* is 400 ppm.

Application of treatments

NPK application

As per the treatments nitrogen, phosphorus and potassium were applied through urea, single super phosphate and murate of potash, respectively in the experiment. The recommended dose of NPK was 100 : 60 : 120 kg ha^{-1}.

FYM

As per the treatment well rotten FYM was applied @ 20 t ha^{-1} and 10 t ha^{-1} and spreaded and incorporate uniformly in the beds. For the bed size of 2.40 m × 2.25 m, its quantity was calculated and applied after laying out the field before planting of vines.

Poultry Manure

As per the treatment poultry manure was applied @ 6.6 t ha^{-1} and 3.3 t ha^{-1} and spreaded uniformly and incorporated in the beds. For the bed size of 2.40 m × 2.25 m, its quantity was calculated and applied after laying out the field before planting of vines.

Vermicompost

The vermicompost was applied @ 5 t ha^{-1} and 2.5 t ha^{-1} as per the treatments and spreaded uniformly and incorporated in the beds. For the bed size of 2.40 m × 2.25 m, its quantity was calculated and applied after laying out the field before planting of vines.

Statistical analysis

To test the significance of variance in the data obtained from the various growth characters and yield the technique of analysis of variance was adopted as suggested by [7] for randomized block design. Significance of difference in the treatment effect was tested through 'F' test at 5 percent level of significance and CD (critical difference) was calculated, wherever the results found significant.

Results and Discussion

Comparative effect of organic and inorganic sources of NPK and bio-fertilizer on growth attributes

The data presented in **Table 1** and depicted in **Figures 1** and **2** clearly indicated significance of the combined effect of organic and inorganic sources of NPK and bio-fertilizer on vine length, number of branches per vine and leaf area.

Data indicated that the treatment combination I_5B_1 resulted in significantly maximum vine length (97.06 cm), number of branches per vine (6.39) and leaf area (16609.30 cm^2) while, the minimum vine length (40.81 cm), number of branches per vine (3.36) and leaf area (6193.24 cm^2) was recorded under treatment combination I_0B_0. However, I_5B_1 treatment combination was statistically at par to I_7B_1 treatment combination, which was 92.97 cm and 6.29 in case of both vine length and number of branches per vine.

Table 1 Comparative effect of organic and inorganic sources of NPK and bio-fertilizer on length of vine (cm) at 45 DAP, number of branches per vine and leaf area at 50 DAP of sweet potato

Treatment	**Organic and inorganic sources of NPK**								
Bio-fertilizer	**I_0**	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**	**I_6**	**I_7**	**Mean**
Length of vine (cm) at 45 DAP									
B_0	40.81	56.72	49.81	59.40	54.39	64.24	51.86	61.53	54.84
B_1	61.67	85.70	75.27	89.76	82.19	97.06	78.36	92.97	82.87
Mean	51.24	71.21	62.54	74.58	68.29	80.65	65.11	77.25	
SEm±			**1.75**						
CD (p=0.05)			**5.07**						
Number of branches per vine									
B_0	3.36	4.39	3.78	4.58	4.02	5.59	3.88	5.51	4.39
B_1	3.84	5.01	4.32	5.22	4.58	6.39	4.42	6.29	5.01
Mean	3.60	4.70	4.05	4.90	4.30	5.99	4.15	5.90	
SEm±			0.048						
CD (p=0.05)			**0.139**						
Leaf area at 50 DAP									
B_0	6193.24	8824.47	8061.94	9953.08	8665.15	13091.10	8397.51	11271.34	9307.23
B_1	7857.66	11196.03	10228.56	12627.94	10993.89	16609.30	10654.33	14300.48	11808.52
Mean	7025.45	10010.25	9145.25	11290.51	9829.52	14850.20	9525.92	12785.91	
SEm±			261.49						
CD (p=0.05)			**755.24**						

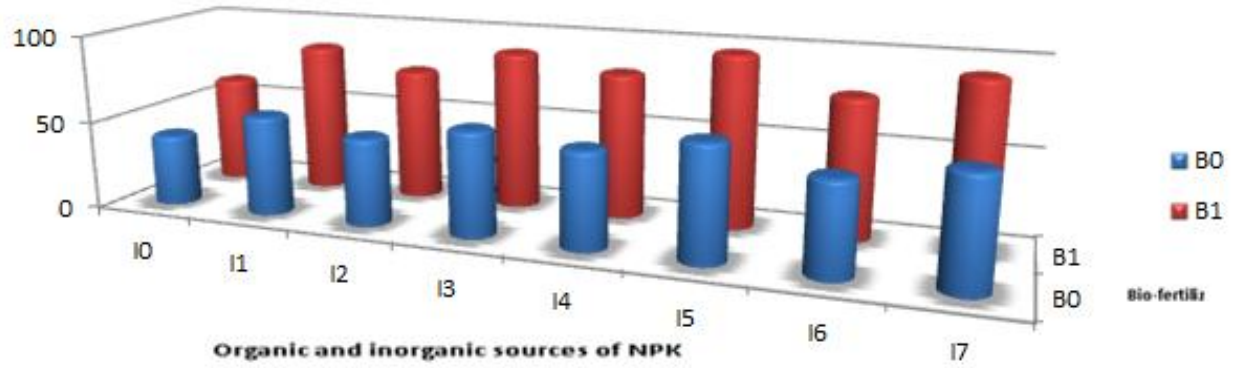

Figure 1 Interactive effect of organic and inorganic sources of NPK and bio-fertilizer on length of vine (cm) at 45 DAP of sweet potato

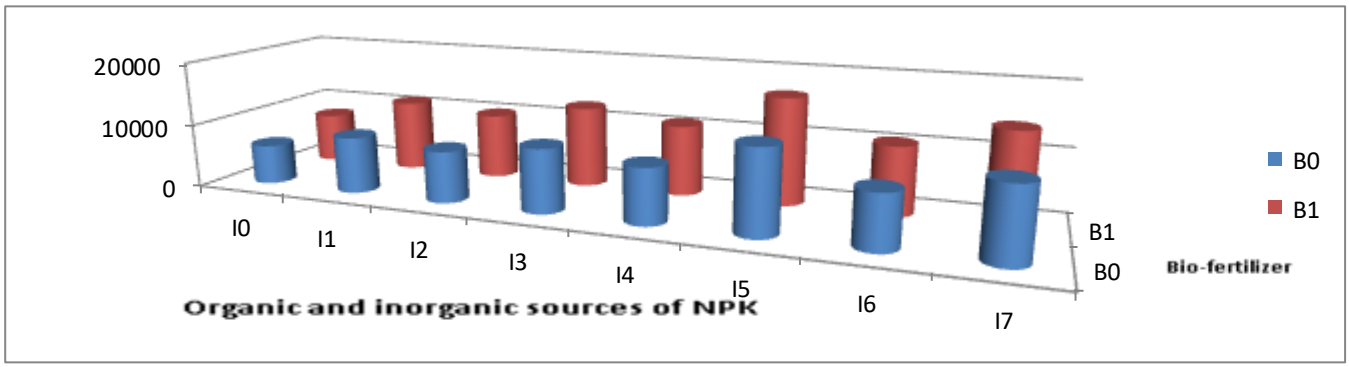

Figure 2 Interactive effect of organic and inorganic sources of NPK and bio-fertilizer on leaf area (cm^2) at 50 DAP of sweet potato

The increase in plant growth attributes with the application of poultry manure and vermicompost might be due to the fact that organic manures not only provided nutrients to the plant but also improved the physical condition of soil in respect of granulation, friability, porosity and developed a balanced nutritional environmental in both soil *rhizosphere* and plant system. The increase in plant growth characters with the application of vermicompost, poultry manure *and azotobacter* in combination with 50% or 100% RDF might be due to better availability of plant nutrients and maintenance of balanced C:N ratio throughout the growing period of the crop [8] and [9].

Combined application of organic and inorganic sources of NPK and bio-fertilizer significantly enhanced the plant growth attributes and yield *viz.*, vine length, leaf area, number of branches per vine, tuber yield per plot and tuber yield per hectare. The significant increase in these attributes under the influence of application of organic and inorganic sources of NPK along with inoculation with bio-fertilizer (*Azotobacter*) was largely a function of improved growth and subsequent increase in yield and other yield attributes as described above. The interactive advantage of combined application of organic and inorganic sources of NPK and bio-fertilizer generally proved superior over the use of each component alone. These results of the present study clearly indicated that 50 % RDF + 50 % vermicompost applied with *Azotobacter* played a significant role in enhancing the growth of sweet potato. These findings clearly indicate that *Azotobacter* played a significant role in enhancing the growth attributes of sweet potato vines. *Azotobacter* liberates growth promoting substances and vitamins and helps to maintain soil fertility. *Azotobacters* are free-living bacteria that fix atmospheric nitrogen in vegetable crops without any symbiosis and they do not need a specific host plant [10].

Comparative effect of organic and inorganic sources of NPK and bio-fertilizer on tuber yield

The data presented in **Table 2** and depicted in **Figure 3** clearly indicated significant effect of combined application of organic and inorganic sources of NPK and bio-fertilizer on tuber yield kg/plot and q/ha. Data indicated that the treatment combination I_5B_1 resulted in significantly maximum tuber yield (17.68 kg and 327.35 q), while the minimum tuber yield (5.02 kg and 92.91q) was recorded under treatment combination I_0B_0. Such increase in yield and yield attributes with the application of vermicompost and poultry manure with integration of 50% and 100% RDF might be due to better utilization of nutrients like nitrogen for reproductive growth rather than for vegetative growth [11]. The increases in yield and yield attributes might be due to various plant metabolic processes that resulted in more production of carbohydrates due to higher uptake of nitrogen and ultimately helped in increasing yield and quality of sweet potato tubers.

Table 2 Comparative effect of organic and inorganic sources of NPK and bio-fertilizer on tuber yield (kg per plot and q/ha) of sweet potato

Treatment	**Organic and inorganic sources of NPK**								
Bio-fertilizer	**I_0**	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**	**I_6**	**I_7**	**Mean**
Tuber yield (kg) per plot									
B_0	5.02	7.54	6.30	8.50	7.35	9.79	6.82	9.06	7.55
B_1	9.06	13.61	11.38	15.34	13.27	17.68	12.31	16.35	13.62
Mean	7.04	10.58	8.84	11.92	10.31	13.73	9.56	12.71	
SEm±			0.43						
CD (p=0.05)			**1.25**						
Tuber yield q/ha									
B_0	92.91	139.67	116.70	157.42	136.09	181.35	126.25	167.77	139.77
B_1	167.72	252.12	210.65	284.16	245.67	327.35	227.90	302.84	252.30
Mean	130.32	195.90	163.68	220.79	190.88	254.35	177.08	235.31	
SEm±			8.00						
CD (p=0.05)			**23.10**						

The use of biofertilizer in integration with organic and inorganic sources of NPK helps in safeguarding the soil health and also improves the quality of crop products. They activate soil biologically and restore natural soil fertility and also provide protection against some soil born diseases, with replacing of chemical nitrogen and phosphorus by 25 per cent. A synergistic interaction between organic manures and biofertilizers has resulted in enhanced production of growth promoting substances like gibberellic acid, indole acetic acid and dihydrozeatin which have positive influence on the physiological processes in plant system [12] and [13], resulting in enhanced vine length, leaf area, number of branches per vine, tuber length, tuber weight, diameter of tuber, and ultimately increased tuber yield [14] and [15].

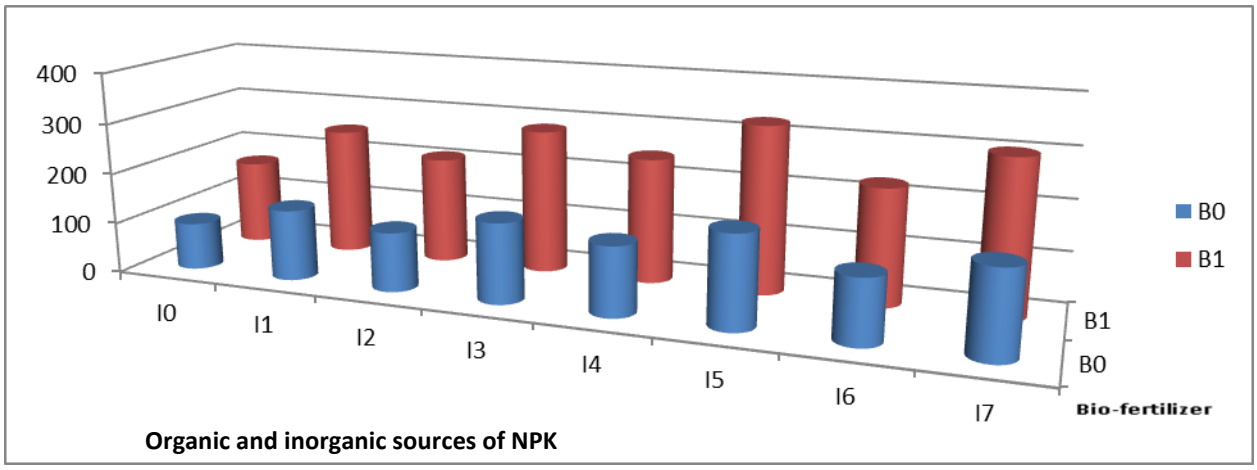

Figure 3 Interactive effect of organic and inorganic sources of NPK and bio-fertilizer on tuber yield per hectare (q) of sweet potato

Conclusion

On the basis of results obtained in present investigation, the application of 50% RDF + 50% vermicompost along with *Azotobacter* (I_5B_1) proved to be the most superior treatment in terms of the highest tuber yield (327.35 q ha^{-1}) and growth parameters of sweet potato. Therefore, the sweet potato growers are advised to apply 50% RDF + 50% vermicompost along with *Azotobacter* to get higher yield of better quality per unit area.

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