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Studies on the economic feasibility of sweet potato (*Ipomoea batata* L)

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Abstract
A field experiment was conducted at Main Experiment Station, Department of Vegetable Science, Narendra Deva, University of Agriculture & Technology, Narendra Nagar (Kumarganj), Faizabad (U.P.) during the *Rabi* season of 2015-16 to access the Response of different organic sources on growth and yield of sweet potato (*Ipomoea batatas* L.) cv. NDSP-65.The experiment was conducted with randomized block design replicated three times with eleven treatments viz., T_1 FYM @ 20 t/ha,T_2Poultry manure @ 5t/ha,T_3 Neem cake @ 4t/ha + Azospirillum5kg/ha + PSB5kg/ha, T_4 Vermicompost @ 5t/ha + Azospirillum5 kg/ha + PSB5kg/ha, T_5FYM @ 10t/ha + Vermicompost 2.5t/ha + Azospirillum5 kg/ha + PSB5kg/ha, T_6FYM @ 10 t / ha + Neem cake @ 1t/ha + Azospirillum(5 kg/ha)+PSB5kg/ha, T_7FYM @ 10t / ha + Poultry manure @ 2.5t/ha + Azospirillum5 kg/ha + PSB5kg/ha,T_8 Vermicompost @ 2.5t/ha + Neem cake @ 1t/ha + Azospirillum5 kg/ha + PSB5kg/ha,T_9 Vermicompost @ 2.5t/ha + Poultry manure 2.5t/ha + Azospirillum5 kg/ha + PSB5kg/ha,T_{10} 1/2 Recommended dose of Fertilizers + Azospirillum2.5 kg/ha + PSB2.5kg/ha,T_{11} Recommended dose of FYM and NPK 10t/ha & 50:25:50, The experimental results revealed that the use of T_{11} Recommended dose of FYM and NPK 10t/ha & 50:25:50 was found better with respect to all the growth parameters like no. leaves plant^{-1}, leaf area cm^2, foliage weight plant^{-1} (g), length of vine (cm), no. of branches vine^{-1}, inter nodel length (cm). The maximum net return Rs. (Rs 222343.5) and benefit: cost ratio 3.6 were recorded under Recommended dose of FYM and NPK (10t/ha & 50:25:50 This was found suitable remunerative treatment and help in taking decision for successful crop production of sweet potato from farmer's point of view.

Keywords: sweet potato, economic yield and dry matter

Introduction
The sweet potato [*Ipomoea batatas* (L.) Lam] belongs to family convolvulaceae, is one of the important tuber crops of tropical and sub-tropical regions of the world. Sweet potato is considered to be native of South America. In India, it is mainly cultivated in Bihar, Orissa, Uttar Pradesh, Madhya Pradesh, Maharashtra, Karnataka and approximately 80% of the world sweet potato is grown in Asia, 15% in Africa and about 5% in rest of the world.

The total area in India under sweet potato is estimated to be 0.111 M ha with the production of 1.45 million tonnes and the productivity of 13.06 tonnes per hectare respectively (Anonymous, 2015). The sweet potato constitutes the staple diet of tribal population due to hardiness and adaptability into diversified farming system. Sweet potato is used both for direct human consumption and manufacturing of industrial products such as starch, glucose pectin, sugar and alcohol etc. It is a rich source of carotene, ascorbic acid, thiamine, riboflavin, protein and energy.

It is a major source of carbohydrate for millions of people, especially in developing countries and consumed either as fresh vegetable or boiled or baked products. The yellow or orange fleshed varieties of sweet potato contain high level of *β*-carotene a precursor of vitamin A. and it is reported that weekly intake of 100g orange fleshed sweet potato could help in overcoming vitamin A deficiency in children, pregnant women and lactating mothers. This nutritional and economic importance of sweet potato shows importance to increase yield and quality. The plant is grown for its edible tuberous roots that contain about 27% carbohydrate and high concentrations of Vitamin A, Vitamin C, calcium and iron. Fresh sweet potatoes provide about 50% more calories than Irish potatoes. The leaves are used as leaf vegetable as well as good fodder value and much more industrial value.

Farm yard manure (FYM) influences the physico-chemical as well as biological properties of the soil, which in turn improves the soil fertility and productivity. It also improves the soil structure, porosity, aeration, drainage, water retention capacity and prevents the soil degradation.

Similarly neem cake has a higher lime nutrient content (7.8 % total) as compared to farm yard manure (1.2% total). It is also used for controlling nematodes and other soil borne organism and boost up the crop yield. It contains 5.22 % N_2, 1.08 % P_2O_5 and 1.48 % K_2O.

Nitrogen is the most limiting factor in Indian soils. It is known that about 4,000 million tonnes of nitrogen is present in atmosphere which comes about seventy seven thousand tonnes over an area of one hectare of land. Phosphorus is the next most important major primary nutrient after nitrogen from plant. However, examination of Indian soil indicated that low to medium in available phosphorus and not more than 30 per cent of applied phosphate is available to current crop, remaining part gets converted into relatively unavailable form (Marwaha, 1995)**.** Potassium is also one of the limiting nutrients of the soil of plain. Besides, nutritional effects, potassium improve the sweet potato yield by increasing resistance in the plant again stresses and diseases.

Bio-fertilizers contain agriculturally important beneficial viable-organisms which have ability to mobilize nutritionally important elements from non- usable to usable form through biological process. *Azospirillum* is considered to be an important growth promotive rhizobacteria that can improve the growth and yield of several plant including economically important cereals, vegetables and grasses. *Azospirillum* plant association leads to the enhanced development and increase yield of different host plant under appropriate condition (Singh, *et al.*2010). *Azospirillum* is known to be a very active nitrogen fixer under laboratory as well as soil condition providing fast growth, better health of the plant and higher yield (Kannan and Ponmurugan, 2010), organic fertilizer derived from animal matter, human excreta or vegetable matter (e.g. compost, manure) (Dittmar *et al.,* 2009). The bacteria induce the plant roots to secrete mucilage, which creates low oxygen environment and helps to fix atmospheric nitrogen in the soil. It fixes 10-40 kg/ha/season N_2 in many vegetable crops. Fertilizers cost is increasing day by day, therefore, the farmers are looking for an alternate source which reduces the cost of cultivation along with maintaining the fertility status of soil. The response of organic sources with or without chemical fertilizers on a large number of crops have been reported by several workers, however meager information is available on the sweet potato crop in this regard.

Material and Method

The experiment was carried out during 2015-2016, at Main Experiment Station, Department of Vegetable Science, N.D.U.A. & T., and Faizabad (U.P) India. The experimental site falls under sub-humid, subtropical climate and is located at 26.470 N latitude and 82.120 E longitudes on an elevation of 113 meters above mean sea level in the Indo-gangetic alluvial plains of eastern Uttar Pradesh. Maximum rainfall in this area is received from mid-June to end of September. The weekly maximum and minimum temperatures during the crop growth period ranged from 36.6 and 20.1 and 25.8 to 5.2, respectively. The total rainfall recorded during the crop period was 15.2 mm.

Observations recorded on five randomly selected plants from each genotype in each replication for growth and yield along with related characters viz., days to initiation of buds, number of leaves per plant, leaf area, foliage weight per plant, number of vine per plant, inter nodal length, tuber weight, number of tubers per plant, fresh weight of tuber per plant, length of tubers, diameter of tubers and yield per hectare. The collected data were averaged to get mean values of the respective characters that has been affected by various treatments integrated nutrient managements in sweet potato.

The data were subjected to the analysis of variance (ANOVA) appropriate the design and test of significance of the treatment difference was done on the basis of F test (Gomez and Gomez, 1984) [9]. The treatments were compared with the help of critical difference, following the techniques described by (Panse and Sukhatme, 1967) [2, 4] and results were evaluated at 5% level of significance.

Table 1: Different integrated organic treatments with their respective doses

Treatment	Doses
T1	FYM @ 20 t/ha
T2	Poultry manure @ 5t/ha
T3	Neem cake @ 4 t/ha + Azospirillum (5 kg/ha) + PSB (5 kg/ha)
T4	Vermicompost @5 t/ha + Azospirillum (5 kg/ha) + PSB (5 kg/ha)
T5	FYM @ 10 t/ha + Vermicompost 2.5 t/ha + Azospirillum (5 kg/ha) + PSB (5 kg/ha)
T6	FYM @ 10 t/ha + Neem cake @1 t/ha + Azospirillum (5 kg/ha) + PSB (5 kg/ha)
T7	FYM @ 10 t/ha + Poultry manure @2.5 t/ha + Azospirillum (5 kg/ha) + PSB (5 kg/ha)
T8	Vermicompost @ 2.5 t/ha + Neem cake @ 1 t/ha + Azospirillum (5 kg/ha) + PSB (5 kg/ha)
T9	Vermicompost @ 2.5 t/ha + Poultry manure 2.5 t/ha + Azospirillum (5 kg/ha) + PSB (5 kg/ha)
T10	1/2 Recommended dose of Fertilizers + Azospirillum (2.5 kg/ha) + PSB (2.5 kg/ha)
T11	Recommended dose of FYM and NPK (10 t/ha and 50:25:50 kg NPK/ha)

Result and Discussion

Data regarding TSS content were affected by various organic treatments under study have been presented in Table 2.

An examination of data indicated that the treatment T_7 (FYM @ 10 t / ha + RDF + 3 t/ha Neem cake) recorded maximum value of TSS (9.80) which was significantly superior over rest of the treatments. The minimum TSS (9.20) was noted under T_7 RDF NPK @ 50:25:50 kg/ha) treatment.

Data gathered on account of moisture content in tubers have been presented in Table 3.

It is evident from data that treatment T_1 (RDF, NPK @ 50:25:50 kg/ha) gave maximum moisture content (76.60%) which was significantly superior over rest of the treatments. However, least moisture content (75.10) was noted in treatment T_7 (FYM @ 10 t / ha + RDF + 3 t/ ha Neem cake).

Table 2: Response of different organic treatments on TSS, moisture content and dry matter content of sweet potato tubers

Treatment	TSS (%)	Moisture content (%)	Dry matter content (%)
T_1 = FYM @ 20 t/ha	11.50	76.17	23.83
T_2= Poultry manure @ 5 t/ha	11.33	76	24.00
T_3= Neem cake @ 4 t/ha + *Azospirillum* (5 kg/ha) + PSB (5 kg/ha)	11.83	75.47	24.53
T_4=Vermicompost @ 5 t/ha + *Azospirillum* (5 kg/ha) + PSB (5 kg/ha)	11.50	78.50	21.50
T_5 = FYM @ 10 t/ha + Vermicompost 2.5 t/ha + *Azospirillum* (5 kg/ha) + PSB (5 kg/ha)	11.97	75.50	24.50
T_6 = FYM @ 10 t / ha + Neem cake @1t/ha + *Azospirillum* (5 kg/ha) + PSB (5 kg/ha)	11.50	74.30	25.70
T_7 = FYM @ 10t / ha + Poultry manure @ 2.5t/ha + *Azospirillum* (5 kg/ha) + PSB (5 kg/ha)	11.20	75.50	24.50
T_8 = Vermicompost @ 2.5t/ha + Neem cake @ 1t/ha + *Azospirillum* (5 kg/ha) + PSB (5 kg/ha)	11.50	73.53	26.47
T_9 = Vermicompost @ 2.5t/ha + Poultry manure 2.5 t/ha + *Azospirillum* (5 kg/ha) + PSB (5 kg/ha)	11.50	75.23	24.77
T_{10}= 1/2 R]ecommended dose of Fertilizers + *Azospirillum* (2.5 kg/ha) + PSB (2.5 kg/ha)	11.30	76.00	24.00
T_{11}= Recommended dose of FYM and NPK (10 t/ha and 50:25:50 kg NPK/ha)	11.40	73.80	26.20
SEm	0.27	3.68	0.417
CD at 5%	NS	10.68	1.69

Data pertaining to dry matter content of tuber as influenced by different treatment have been presented in Table-2.

Data furnished in between the table indicated that T_7 (FYM @ 10 t / ha + RDF + 3 t/ ha Neem cake) produced maximum dry matter content of tubers (24.9%) and it was significantly superior over the rest of treatments. However, the least value of dry matter content (23.4%) was noted in T_1 (RDF, NPK @ 50:25:50 kg/ha).

With a view to accept any recommendation of results, it becomes essential to work out the economics of different organic treatments involved in crop production. Therefore, it was thought desirable to work out the cost of cultivation (Rs/ha), gross income (Rs/ha), net return (Rs/ha) and benefit: cost ratio, which have been presented in Table 3.

Table 3: Economics of different organic treatments

Treatment	Tuber yield q/ha	Cost of cultivation (Rs/ha)	Gross income (Rs/ha)	Net return (Rs/ha)	B:C
T_1	201.39	67940.5	241668	173727.5	2.56
T_2	176.73	72940.5	212076	139135.5	1.91
T_3	197.28	118940	236736	117795.5	0.99
T_4	182.20	83940.5	219480	135539.5	1.61
T_5	217.83	76440.5	261336	184955.5	2.42
T_6	224.0	78940.5	268800	189859.5	2.41
T_7	230.16	71440.5	276192	204751.5	2.87
T_8	193.17	86440.5	231804	145363.5	1.68
T_9	187.01	78940.5	224412	145471.5	1.84
T_{10}	209.61	60062.5	251532	191469.5	3.19
T_{11}	240.44	66184.5	288528	222343.5	3.36

Maximum cost of cultivation T_3 (Rs. 118940) followed by T_4 (Rs. 83940) and minimum cost of cultivation (Rs. 60062.5) was observed in T_{10} cost of cultivation gross return was maximum with treatment T_{11} (Rs. 288528). It was minimum (Rs. 212076) in treatment T_3 (Neem cake @ 4 t/ha + *Azospirillum* 5 kg/ha + PSB 5 kg/ha).

So for net return is concerned, it was maximum (Rs. 222343.5) in treatment T_{11} followed by T_{10} and T_7 respectively. It is clear from the data that the maximum B-C ratio (3.36) was found under treatment T_{11} recommended dose of FYM and NPK (10t/ha & 50:25:50 kg NPK/ha). Which is very much essential for taking the decision of successful crop production of sweet potato from farmer's point of view.

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