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Research Article

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# Growth yield and Quality Attributes of Potato (solanum tuberosum l.) as Influenced by Integrated Nutrient Management

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***Abstract***

*An experiment was carried out during rabi season 2011 at Post Graduate Centre, University of Horticultural Sciences, Campus, Gandhi Krishi Vignana Kendra, Bangalore to study the effect of integrated nutrient management on growth, yield and quality of potato (Solanum tuberosum L.). Application of 50% RDF + 50% FYM + Azotobacter + Phosphobacteria recorded maximum plant height (77.76 cm), number of leaves plant$^{-1}$ (103.65), number of stems plant$^{-1}$ (9.11), stem girth (3.74cm), fresh weight accumulation (2.01 kg plant$^{-1}$), dry weight (255.3 g plant$^{-1}$), number of tuber plant$^{-1}$ (7.87), total tuber yield ha-1 (34.14 t ha$^{-1}$), tuber dry matter (21.67%), starch content (78.20%) and total sugars (1.74%) which was on par with T4 and T3. The maximum net income per hectare (282909 Rs.) was recorded in plants provided with 50% RDF + 50% FYM + Azotobacter + Phosphobacteria ($T_2$) and the highest benefit: cost ratio (1:2.25) was recorded in plants provided with STCR targeted yield ($T_3$).*

**Key Words:** Potato, Vermicompost, Azotobacter, Phosphobacteria and Kufri Jyoti

## Introduction

Potato (*Solanum tuberosum L.*) is consumed by more than one billion people the world over and has emerged as fourth most important food crop in the world after rice, wheat and maize. Nutritionally, potato is a wholesome food and deserves to be promoted as a potential high quality vegetable cum food crop and it may prove useful to achieve the nutritional security of the nation [1]. India produces more than 26.53 millions tons of potatoes from an area of 1.37 million hectares with an average yield of 19.37t ha-1, which made the country as a major producer of potatoes along with China, Russia, Netherlands and Poland [2]. In Karnataka, potato occupies an area of 49,300 hectares with an annual production of 6.14 lakh tones and productivity of 12.45 tones ha$^{-1}$ grown mainly as rainfed crop. Modern nutrient management strategy has shifted its focus towards the concept of sustainability and ecofriendlyness. Intensive use of only chemical fertilizers to achieve high production has created a various problems. Continuous application of heavy doses of chemical fertilizers without organic manures or bio-fertilizers has lead to a deterioration of soil health in terms of physical and chemical, properties of soil, declining of soil microbial activities, reduction in soil humus, increased pollution of soil, water and air. Hence, integrated supply of nutrients through organic, inorganic and bio-fertilizers is the need of the hour for sustainable productivity and to maintain better soil health. The present study was, therefore, envisaged with the assumption that potato growth and development of tubers will be enhanced as a result of the effect of integrated use of inorganic fertilizers, organic manures and bio-fertilizers.

## Material and Methods

The experiment was carried out at Post Graduate Centre, University of Horticultural Sciences, Campus, Gandhi Krishi Vignana Kendra, Bangalore during *Rabi* 2011. The soil of the experimental field was sandy loam having pH of 6.28 to 7.16 and the plot size of 3.15 x 2.0 m with a spacing of 45 x 20 cm. The experiment was laid out in Randomized Completely Block Design with three replications involving 10 treatments viz,100% recommended dose of fertiliser (125:100:125 kg NPK ha$^{-1}$) ($T_1$) ;100% RDF + 100% FYM (25t ha$^{-1}$) ($T_2$) ; Soil Test Crop Response targeted yield (155:150:129 kg NPK ha$^{-1}$) (T3) ; 50% RDF + 100% FYM + Azotobacter (12 kg ha$^{-1}$) + Phosphobacteria (kg ha$^{-1}$) ( $T_4$) ; 75% RDF + VC (1.5t ha$^{-1}$) + Azotobacter (12 kg ha$^{-1}$)+ Phosphobacteria (12 kg ha$^{-1}$) (T5) ; 50%

RDF + Azotobacter (12 kg ha-1)+ Phosphobacteria (12 kg $ha^{-1}$) ($T_6$) ; 50% RDF + 50% FYM + VC (1.5t $ha^{-1}$) + Azotobacter (12 kg $ha^{-1}$)+ Phosphobacteria (12 kg ha-1)+ ($T_7$) ; 100% FYM + 50% Nitrogen supplied through neem cake (62.5 kg ha-1) +Azotobacter (12 kg $ha^{-1}$) ( T8) ; 100% FYM + 50% nitrogen supplied through poultry manure (1.5t $ha^{-1}$) + Azotobacter (12 kg $ha^{-1}$) ( $T_9$) and 100% FYM + 50 % FYM supplied through vermicompost (1.5t $ha^{-1}$) + Azotobacter (12 kg $ha^{-1}$) ($T_{10}$).

Fifty percent of N and full dose of P and K were applied in the furrows as per treatments and were thoroughly mixed in soil. The remaining half of the nitrogen was top dressed at 30 days after planting. The variety used in this study was Kufri Jyoti; it is a most popular variety in Eastern dry zone of Karnataka. The observations on growth, yield and quality parameters such as plant height (cm), number of leaves plant-1, stem girth (cm), number of stems plant-1, chlorophyll content (mg g-1), fresh weight accumulation (kg plant-1), dry weight (g plant-1), number of tuber plant-1, tuber weight plant-1, tuber yield plot-1and tuber yield ha-1, dry matter of tubers (%), starch content (%), reducing, non-reducing and total sugars (%) were recorded and analysed.

## Results and Discussion

For plant height, highest plant height (77.76 cm) was recorded with 50% RDF + 50% FYM + AZT + PSB (T7) which was followed by T3 (72.97 cm), T4 (72.67 cm) and T5 (66.90 cm) respectively (Table1).

The combination of organic manure, inorganic fertilizers and biofertilizers facilitate in better availability and uptake of nutrients by the plants. Azotobacter and Phosphobacteria could produce bio-active substances having similar effect as that of growth hormones which promotes better vegetative growth. Integration of nutrients results in saving of chemical fertilizers up to 50 per cent without affecting the crop growth. also reported that integration of organic and inorganic sources of nutrients influenced plant height and number of tubers per plant positively [3]. The results are in agreement with the findings of and in potato [4-7].

For number of leaves per plant, the highest number of leaves per plant (103.65) was recorded with 50% RDF + 50% FYM + AZT + PSB (T7) which was on par with T3 – STCR yield target (102.12) followed by T4 (95.91) and T5 (87.14). While lowest number of leaves (66.18) was noticed in plants provided with 100% FYM + 50% N supplied through neem cake + AZT (T8) during rabi 2011 (Table 1). This increased plant height in T7 is due to balanced nutrition and easy availability of nitrogen, which helped in increasing chlorophyll content in leaf and better synthesis of carbohydrate in the plants and which is utilized in building of new cells. Thus it leads to production of more number of leaves per plant. Increased number of leaves are also related to bio-fertilizers applied which might have produced bioactive substances having similar effects as that of growth regulators which in turn has resulted in increased the number of leaves. The results are in conformity with the findings of in “Kufri Badashash”, in potato [8-10].

With regard to number of stems per plant, maximum number of stems (9.11) was recorded in plants fertilized with 50% RDF + 50% FYM + AZT + PSB (T7) which was on par with T3 (8.53) followed by T4 (7.64) and T5 (7.57), while, lowest number of stems (5.60) was observed in plants fertilized with 100% FYM + 50% N supplied through neem cake + AZT (T8) during rabi 2011 (Table 1). The increased number of stems could be attributed to better growth, balanced C: N ratio and availability of nutrients from the soil. Increase of the soil nutrients can encourage the increase haulm growth which increases the photosynthetic rates and assimilation rates. Similarly, findings were also observed by in potato and in sweet potato [11-13]. For stem girth, the highest stem girth (3.74 cm) was recorded with 50% RDF + 50% FYM + AZT + PSB (T7) followed by T4 (3.55 cm), T5 (3.42 cm) and T3 (3.36 cm). While, lowest stem girth (3.08 cm) was noticed in plants provided with 100% FYM + 50% N supplied through neem cake + AZT (T8) during rabi 2011 (Table 1).

This might be due to combined effect of organic and inorganic sources of nutrients that prolonged the availability of nutrients by better accumulation of photosynthates which in turn increased the stem girth. It was also related to the hormones like substances produced by the biofertilizers and better availability of phosphorous through phosphobacteria. This might be also due to improved fertility status and better utilization of nutrients by potato crop. Similar findings were reported by in ‘Kufri Chipsona-1’ [14]. The results obtained are also in agreement with Singh and Gupta (2010) in potato. For the yield characters, highest number of tuber per plant (7.87), tuber yield per plant (363.33g plant-1) and total yield (34.13 t ha-1) were recorded in plants fertilized with 50% RDF + 50% FYM + AZT + PSB (T7) which were on par with T3, T4 and T5. While the lowest number of tuber per plant (4.73), tuber yield per plant (184.67g plant-1) and total yield (20.00 t ha-1) were observed in plants provided with 100% FYM + 50% N supplied through neem cake + AZT (T8) during rabi 2011 (Table 2).

**Table 1: Effect of integrated nutrient management on plant height, number of leaves per plant, number of stems per plant and stem girth at different stages of potato growth**

| Treatments | Plant height (cm) | | | | No of leaves per plant | | | | No of stems per plant | | | | Stem girth (cm) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Days after planting (DAP) | | | | | | | | | | | | | | | |
| | 30 | 45 | 60 | 75 | 30 | 45 | 60 | 75 | 30 | 45 | 60 | 75 | 30 | 45 | 60 | 75 |
| $T_1$ | 25.67 | 46.33 | 52.73 | 57.97 | 40.39 | 54.17 | 66.04 | 73.70 | 3.20 | 4.82 | 5.19 | 5.42 | 2.14 | 2.45 | 2.70 | 2.98 |
| $T_2$ | 30.06 | 51.53 | 57.97 | 62.00 | 46.80 | 57.03 | 67.22 | 75.43 | 3.50 | 5.61 | 5.92 | 6.34 | 2.54 | 2.79 | 3.02 | 3.17 |
| $T_3$ | 41.80 | 60.80 | 68.00 | 72.97 | 52.65 | 75.76 | 84.90 | 102.12 | 4.90 | 7.64 | 8.11 | 8.53 | 2.51 | 2.89 | 3.20 | 3.36 |
| $T_4$ | 40.86 | 59.60 | 66.50 | 72.67 | 51.71 | 72.26 | 82.63 | 95.91 | 4.61 | 7.51 | 7.84 | 7.64 | 2.67 | 3.04 | 3.33 | 3.55 |
| $T_5$ | 34.80 | 56.07 | 62.60 | 67.90 | 51.38 | 64.76 | 76.18 | 87.14 | 4.52 | 6.80 | 7.18 | 7.57 | 2.67 | 3.02 | 3.24 | 3.42 |
| $T_6$ | 34.07 | 55.67 | 61.80 | 66.07 | 50.70 | 63.27 | 74.47 | 84.52 | 4.14 | 6.25 | 6.64 | 6.91 | 2.57 | 2.82 | 3.02 | 3.24 |
| $T_7$ | 45.20 | 62.93 | 72.73 | 77.76 | 52.72 | 80.80 | 91.35 | 103.65 | 5.40 | 8.22 | 8.70 | 9.11 | 2.79 | 3.11 | 3.52 | 3.74 |
| $T_8$ | 27.53 | 43.47 | 51.67 | 58.27 | 40.07 | 46.60 | 61.29 | 66.18 | 2.92 | 4.23 | 5.03 | 5.60 | 2.32 | 2.60 | 2.79 | 3.08 |
| $T_9$ | 32.93 | 55.00 | 61.33 | 66.60 | 48.35 | 58.10 | 70.12 | 78.82 | 3.53 | 5.70 | 6.07 | 6.51 | 2.54 | 2.76 | 2.98 | 3.20 |
| $T_{10}$ | 32.47 | 50.33 | 57.17 | 62.70 | 46.67 | 55.10 | 68.23 | 73.51 | 3.32 | 5.17 | 5.50 | 5.82 | 2.42 | 2.70 | 2.95 | 3.17 |
| SE m± | 2.07 | 1.76 | 2.08 | 1.67 | 1.88 | 2.18 | 2.16 | 2.17 | 0.22 | 0.59 | 0.83 | 0.46 | 0.08 | 0.08 | 0.10 | 0.12 |
| CD at 5% | 4.36 | 3.70 | 4.38 | 3.51 | 3.96 | 4.56 | 4.53 | 4.56 | 0.45 | 1.23 | NS | 0.98 | 0.16 | 0.17 | 0.21 | 0.25 |
| CV (%) | 7.41 | 3.99 | 4.19 | 3.07 | 4.61 | 4.25 | 3.57 | 3.15 | 6.61 | 11.64 | 9.50 | 7.98 | 3.68 | 3.49 | 3.98 | 4.42 |

**Table 2: Effect of integrated nutrient management on number of tubers, tuber yield per plant, plot yield and total yield of potato at harvest**

| Treatments | | Tuber yield | | |
|---|---|---|---|---|
| | No. of tuber plant-1 | Yield plant$^{-1}$ (g) | Plot yield (kg) | Total yield (t ha$^{-1}$) |
| $T_1$ | 5.00 | 243.33 | 14.51 | 23.03 |
| $T_2$ | 5.33 | 250.00 | 15.87 | 25.19 |
| $T_3$ | 6.87 | 330.00 | 20.63 | 32.74 |
| $T_4$ | 6.73 | 299.33 | 17.33 | 27.55 |
| $T_5$ | 6.67 | 283.00 | 16.83 | 26.71 |
| $T_6$ | 6.13 | 272.33 | 16.08 | 25.52 |
| $T_7$ | 7.87 | 363.33 | 21.50 | 34.13 |
| $T_8$ | 4.73 | 184.67 | 12.40 | 20.00 |
| $T_9$ | 5.33 | 260.33 | 15.36 | 24.38 |
| $T_{10}$ | 5.27 | 244.67 | 14.59 | 23.16 |
| SE m ± | 0.71 | 45.39 | 2.38 | 2.26 |
| CD at 5% | 1.49 | 95.37 | 5.01 | 4.75 |
| CV (%) | 14.64 | 20.33 | 16.64 | 9.07 |

These increases could be attributed to increased vegetative growth observed due to balanced nutrient levels, which stimulated initiation of more stolons, thus increasing the number of tubers per plant and thereafter total yield. It is also attributed to the synergistic interactions between vermicompost, biofertilizers, FYM and inorganic fertilizers, improvement of soil physical conditions, the increased availability of nutrients resulting from the decomposition of vermicompost and increased translocation of photosynthates from leaves to the tubers leading to increase in the number of tubers per plant, tuber yield per plant and total tuber yield in addition to tuber length and girth. It was also related to the maximum uptake of NPK nutrients due to the influence of biofertilizers which provide favourable conditions around the root rhizosphere resulted in better absorption of nutrients. These findings are in line with Mrinal Saikia and in potato, in cassava [3,15,16].

For the quality attributes, highest tuber dry matter (21.67%), starch content (78.20%), non reducing sugar (0.84%) and total sugars

(1.74%) were noticed in plants fertilized with 50% RDF + 50% FYM + AZT + PSB (T7) which were on par with T3, T4 and T5. While the lowest dry matter (15.32%), starch content (68.96%), non reducing sugar (0.58%) and total sugars (1.40%) were recorded in plants provided with 100% FYM + 50% N supplied through neem cake + AZT (T8) during rabi 2011 (Table 3).

**Table 3: Effect of integrated nutrient management on quality parameters of potato**

| Treatments | Tuber dry matter (%) | Starch (%) | Reducing sugars (%) | Non-reducing sugars (%) | Total sugars (%) |
|---|---|---|---|---|---|
| $T_1$ | 16.64 | 70.46 | 0.85 | 0.58 | 1.43 |
| $T_2$ | 17.81 | 72.32 | 0.83 | 0.59 | 1.42 |
| $T_3$ | 20.53 | 73.31 | 0.87 | 0.75 | 1.62 |
| $T_4$ | 19.79 | 73.88 | 0.87 | 0.78 | 1.65 |
| $T_5$ | 19.19 | 73.21 | 0.87 | 0.74 | 1.61 |
| $T_6$ | 18.42 | 72.91 | 0.86 | 0.64 | 1.50 |
| $T_7$ | 21.67 | 78.20 | 0.90 | 0.84 | 1.74 |
| $T_8$ | 15.32 | 68.96 | 0.82 | 0.58 | 1.40 |
| $T_9$ | 18.55 | 71.99 | 0.85 | 0.60 | 1.45 |
| $T_{10}$ | 16.87 | 70.53 | 0.83 | 0.58 | 1.41 |
| SE m ± | 0.75 | 1.50 | 0.03 | 0.06 | 0.07 |
| CD at 5% | 1.58 | 3.16 | NS | 0.12 | 0.15 |
| CV (%) | 7.50 | 2.53 | 4.39 | 10.82 | 5.57 |

Increased dry matter, starch content and sugars might be related to better uptake of nutrients due to the influence of biofertilizers supplied along with chemical fertilizers and organic manures. This effect might be also due to bacterial activity that enhanced the crop growth during the advanced phase. The increase in starch content could be due to increased supply of nutrients in general and potassium in particular. Potassium plays an important role in the activation of starch synthetase, and also helps in translocation of starch from leaves to tubers. The results obtained agree with those reported [1, 17,18].

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