

Original Research Article

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Effect of Integrated Nutrient Management on Productivity and Nutrients Availability of Potato

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ABSTRACT

A field experiment was conducted at Agronomy Research Farm of N.D.U.A.&T. Kumarganj, Faizabad, during the *Rabi* season of 2012-13 to assess the growth, yield and nutrient availability as affected by integrated nutrient management of potato crop. The twelve treatments comprised with various levels of Tata Geo Green (as well matured compost prepared from byproducts of sugarcane industry) and Farm Yard Manure with 75% and 100% NPK fertilizers were tested against 100% fertilizers alone. Application of integrated use of Tata Geo Green @ 3.75 t/ha along with 75% recommended dose of NPK fertilizer (150:60:100) in potato was found superior for higher plant growth. The availability of N, P, K nutrients and organic carbon in soil increased at higher rate by applying TGG and FYM along with fertilizers as compared to chemical fertilizers alone. The application of Tata Geo Green @ 3.75 t/ha along with 75% recommended dose of chemical fertilizers provided highest net returns (Rs.133205) and Rs. /Re invested (1.34). It was concluded that application of TGG @ 3.75 with 75% RDF may be recommended for higher productivity and returns.

Keywords

Growth, Available nutrient, Economics, Potato.

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Introduction

Potato is the fourth most important food crop after rice, wheat and maize in the North-East plains of India. India is the second largest potato producing country in the world after China, with annual production of 42.48 million tonnes from area of 1.93 million hectare, while in Uttar Pradesh area, production and productivity of potato is 0.55 m ha, 13.57 m tonnes and 24.67 tonnes ha⁻¹, respectively (Anonymous, 2013). Being a heavy feeder of nutrients, potato required high amount of nitrogen, phosphorus and potassium.

Chemical fertilizer is the main source of nutrients use for potato cropping. However, continuous dependence of chemical fertilizer causes nutritional balance and adverse effects on physic-chemicals and biological properties of soil. Integrated nutrient management is a better approach for supplying nutrient or food to the crop by including organic and inorganic source of nutrient (Arora, 2008). Further imbalance and indiscriminate use of chemical fertilizers and pesticides resulted several harmful effects on soil, water and air causing

their pollution. This has reduced the productivity of the soil by deteriorating soil health in terms of soil fertility and biological activity. Excessive use of agrochemicals under intensive cultivation has disturbed the harmony which existed among soil, plant, biolife, animals and human beings. Thus, integrated approach of nutrient supply by chemical fertilizers along with organic manures is giving an importance especially in heavy feeder crops. Further, considerable improvement in quantity and quality of exhaustive and responsive crop like potato has been observed under integrated use of organic and inorganic fertilizers as compared to recommended dose of nutrients applied with inorganic fertilizers alone (Raghav *et al.*, 2009 and Bhaishya *et al.*, 2012).

Materials and Methods

The field experiment was conducted during *Rabi* season in 2012-13 at Agronomy Research Farm of NDU&T Kumarganj, Faizabad (U.P.). It lies at 26° 47' N latitude, 82° 12' E longitude and an altitude 113 m above the mean sea level. The available N, P and K content of the soil were 114.0, 13.5 and 246.0 kg ha⁻¹, respectively with bulk density 1.38 (Mg m⁻³), pH 8.30, EC 0.33 (dSm⁻¹) and OC-0.40%. Tata geo green free from weed seeds and disease causing microbes, having 2 to 2.5% nitrogen, 4% phosphorus, 3% calcium, 1% magnesium 1.25% sulphur, 100 ppm zinc and 300 ppm manganese and other micronutrients e.g. Cu, Bo, Fe. It also contains organic matter 30% of biomass, pH 6.5 to 7.5 and organic carbon 18-21%.

There were twelve treatment combinations viz. T₁- TGG 2.5 t ha⁻¹ +100% RDF, T₂ - TGG 3.75 t ha⁻¹+100% RDF, T₃- TGG 5t ha⁻¹+ 100% RDF, T₄- TGG 2.5 t ha⁻¹ +75% RDF, T₅- TGG 3.75 t ha⁻¹ + 75 % RDF, T₆- TGG 5 t ha⁻¹ +75% RDF, T₇- FYM 12.5 t ha⁻¹ + 100% RDF, T₈- FYM 25 t ha⁻¹ + 100%

RDF, T₉- FYM 12.5 t ha⁻¹ +75%RDF, T₁₀ - FYM 25 t ha⁻¹ 75% RDF, T₁₁- 100% RDF and T₁₂- Control were replicated thrice in a Randomized Block Design. Potato variety *Kufri Lalima* was used in this study. In addition to this, half quantity of nitrogen and full quantity of phosphorus and potassium were also applied as per treatment through urea, diammonium phosphate and muriate of potash, respectively. The remaining half quantity of nitrogen was top dressed in furrows at the time of earthing up. Potato tubers were planted in the ridge 45 cm apart with plant to plant distance of 10 cm in the November, 2012.

All the growth parameters were studied, plant height was measured from the base of the plants to the apex at 45 and 60 DAP, number of haulms per hill was counted at 60 days after planting. The yield parameters were collected at harvest *i.e.* 120 days after Planting. For determining specific gravity, the tubers of each grade were taken randomly from each plot. Tubers were weighed separately and then they were placed into measuring cylinder containing water. Thus, water which was replaced by the tubers was measured and specific gravity was calculated adopting the following formula:

Specific gravity =

$$\frac{\text{Weight of tubers (g)}}{\text{Volume of water replaced by the tubers (ml)}} \times 100$$

Chemicals analysis

Chemical properties of organic carbon was determined by Walkey and Black (1934), available N by alkaline Potassium Permanganate method (Subbiah and Asajia, 1956), available P by Olsen's method (Olsen *et al.*, 1954) and available K by Ammonium Acetate Extraction method (Jackson, 1973).

Statistical analysis

The analysis of variance methods (Snedecor and Cochran, 1967) was followed to statistically analyze the various data. The significance of different sources of variations was tested by Error mean square of Fisher Snedecor's 'F' test at probability level ($P = 0.05$). In the summary tables of the results, the standard error of mean ($Sem \pm$), the value of critical difference (CD) and coefficient of variation (CV) to compare the difference between the means have been provided.

Results and Discussion

Plant height (cm)

Highest plant height was recorded at 45 days after planting with TGG $5t\ ha^{-1} + 100\%$ RDF, which was significant higher than other treatments combination. The data showed that 60 DAP about 10-14 cm increase in plant height during 15 days (45 to 60 DAP) (Table 1). The maximum plant height (49.2cm) was recorded with treatments T_6 receiving TGG @ $5\ t\ ha^{-1}$ along with 75% RDF, which was remained at par to all the integrated nutrient management treatments receiving various levels of TGG (2.5, 3.75 and $5\ t\ ha^{-1}$) and FYM (12.5 and $25\ t\ ha^{-1}$) along with 75% and 100% RDF or 100% RDF alone. Plant height recorded at 45 days after planting (DAP) revealed that there was no significant difference among the treatments receiving various levels of Tata geo green (2.5, 3.75 and $5\ t/ha$) and farm yard manure (12.5 and $25\ t/ha$) along with 75 % and 100% recommended doses of NPK fertilizers (RDF) or 100% RDF alone. Pandey *et al.*, (2008) studied the various options of nutrient management in potato and reported that plant growth parameters (plant height) remains unaffected up to 50% replacement of inorganic by organics sources but yield decreased significantly.

Number of haulms hill⁻¹

The number of haulms/ hill at 60 days after planting (DAP) has been given in (Table 1) number of haulms hill⁻¹ were not influenced significantly due to application of various doses of Tata geo green (2.5, 3.75 and $5\ t\ ha^{-1}$) and farm yard manure (12.5 and $25\ t\ ha^{-1}$) along with 75 and 100% chemical fertilizers alone as compared to 100% recommended chemical fertilizers alone. The maximum number of haulms hill⁻¹ (5.26) was recorded in the treatment receiving farm yard manure $25\ t + 75\%$ RDF (T_{10}), which remained at par to all the manure treatments (T_1 to T_9 and T_{11}) in which the number of haulms hill⁻¹ varied from 4.90-5.26.

Haulms ($q\ ha^{-1}$)

The results showed (Table 1) significant variation in haulms production due to the different nutrient management practices. The highest haulms production was obtained with the application of FYM $25\ t\ ha^{-1} + 100\%$ RDF, but it was statistically at par with treatment T_3 , T_6 and T_2 . The application of organic manures *viz.*, TGG and FYM along with chemical fertilizers increased haulm (plant biomass) production significantly compared to chemical fertilizers alone. The increase in dose of FYM (12.5 to $25\ t\ ha^{-1}$) and Tata geo green (2.5 to $5.0t/ha$) also increased haulm production significantly similarly reported by Krishnamurthy *et al.*, (2002).

Specific gravity ($g\ cm^{-3}$)

Specific gravity of tubers increased significantly by applying organic manures *viz.*, Tata geo green and farm yard manure along with 75% and 100% recommended dose of NPK fertilizers as compared to 100% RDF alone. However, no significant variations were observed among the various

levels of organic manures (FYM and TGG). Similar results have been reported by Mandal *et al.*, (2005); Gauhar and Raghav (2008) and Bhaishya *et al.*, (2012).

Total Tuber Yield (q ha⁻¹)

The pooled yield data showed that application of Tata geo green and farm yard manure along with chemical fertilizers increased the total tuber yield significantly as compared to 100% chemical fertilizers alone (Table 1). Presence of plant growth influencing substances such as plant growth hormones and humic acid and organic manures might be a possible factor contributing to increase yield

(Das *et al.*, 2002). The increasing level of TGG from 2.5 t/ha to 3.75 t /ha increased the tuber yield significantly, but further increase in the dose of TGG (3.75 to 5t/ha) was not resulted a significant increase in tuber yield at both the levels of chemical fertilizers (75% and 100%). Similarly, the increase in the dose of FYM from 12.5 to 25t ha⁻¹ increased total tuber yield significantly at both the levels of recommended doses (75% and 100%) of fertilizers. Among the organic sources, Tata geo green was found more responsive than farm yard manure in terms of productivity of tubers.

Table.1 Effect of integrated nutrient management on plant height at 45 and 60 days after planting

Treatment		Plant height (cm)		Number of haulms / hill 60 DAP	Haulms (q/ha)	Specific gravity ³ (g/ cm)	Total Tuber Yield
		45 DAP	60 DAP				
T ₁	TGG _{2.5} + 100% RDF	36.1	46.8	4.96	96.4	1.05	282
T ₂	TGG _{3.75} + 100 %RDF	37.2	47.9	4.90	99.9	1.05	292
T ₃	TGG ₅ + 100% RDF	37.8	48.4	5.15	101.7	1.06	297
T ₄	TGG _{2.5} +75% RDF	36.4	47.6	5.00	95.3	1.05	276
T ₅	TGG _{3.75} + 75 % RDF	37.0	47.6	5.20	98.4	1.06	291
T ₆	TGG ₅ +75% RDF	35.9	49.2	4.90	100.5	1.06	293
T ₇	FYM _{12.5} + 100 % RDF	37.4	47.5	5.00	96.8	1.05	268
T ₈	FYM ₂₅ +100% RDF	38.4	48.3	5.20	102.4	1.06	281
T ₉	FYM _{12.5} +75%RDF	36.9	45.9	4.90	93.4	1.05	254
T ₁₀	FYM ₂₅ +75% RDF	35.7	46.7	5.26	97.2	1.06	270
T ₁₁	100% RDF	36.0	46.5	5.10	88.8	1.03	248
T ₁₂	Control	32.4	38.2	4.38	58.5	1.02	158
SEm±		0.94	1.1	0.16	1.26	0.006	3.00
CD at 5%		2.8	3.3	0.45	3.60	0.018	8.70

Table.2 Effect of integrated nutrient management on nutrients availability after harvest of potato

Treatment		O.C. (%)	Available N (kg/ha)	Available P (kg/ha)	Available K (kg/ha)
T ₁	TGG _{2.5} + 100% RDF	0.56	148	18.5	148
T ₂	TGG _{3.75} + 100 %RDF	0.59	153	19.8	153
T ₃	TGG ₅ + 100% RDF	0.60	160	22.0	160
T ₄	TGG _{2.5} +75% RDF	0.55	143	16.8	143
T ₅	TGG _{3.75} + 75 % RDF	0.58	148	18.5	148
T ₆	TGG ₅ +75% RDF	0.60	155	19.4	155
T ₇	FYM _{12.5} + 100 % RDF	0.54	148	18.9	148
T ₈	FYM ₂₅ +100% RDF	0.58	156	21.2	156
T ₉	FYM _{12.5} +75%RDF	0.53	144	17.8	144
T ₁₀	FYM ₂₅ +75% RDF	0.57	152	20.1	152
T ₁₁	100% RDF	0.49	134	17.2	134
T ₁₂	Control	0.42	118	13.0	118
SEm±		0.01	3.17	0.62	3.17
CD at 0.05%		0.03	9.2	1.8	9.2

Table.3 Economics of potato cultivation influenced by various nutrient combinations

Treatment	Gross income (Rs/ha)	Total cost of cultivation (Rs/ha)	Net income (Rs/ha)	BCR (Rs/Re invested)
T ₁	226400	96260	129340	1.34
T ₂	233600	101260	132340	1.31
T ₃	237600	106260	131340	1.24
T ₄	220800	94595	126205	1.33
T ₅	232800	99595	133205	1.34
T ₆	234400	104595	129805	1.24
T ₇	214400	94385	120015	1.27
T ₈	224800	102510	122290	1.19
T ₉	203200	92720	110480	1.19
T ₁₀	216000	100845	115155	1.14
T ₁₁	198400	86260	112140	1.30
T ₁₂	126400	79600	46800	0.59

Raghav *et al.*, (2009) reported maximum tuber yield of potato (270 q ha⁻¹) under the treatment receiving combinations of organic manures (FYM, poultry manure, vermicompost) which was 7.0% higher than 100% recommended doses of chemical fertilizers. Similar observations have also been noted by Singh *et al.*, (2008) and Islam *et al.*, (2013).

Effect on soil nutrient status after harvest

The data recorded on soil properties as influenced by various treatments have been given in table 2. Significantly higher values of organic carbon percentage, available N, P₂O₅ and K₂O content in soil were recorded in application of T₃- TGG 5t ha⁻¹+ 100% RDF. The organic carbon also increased significantly with increasing doses of TGG from 2.5 to 5 t/ha and FYM from 12.5 to 25 t/ha at both the levels (75% and 100%) of chemical fertilizers. This could be attributed to direct addition of organic substances in soil and due to better root growth, more plant residues after crop harvest and their indirect influence on physico-chemical characteristics of the soil (Kaushik *et al.*, 1984 and Ojha *et al.*, 2009).

It was also observed that available nitrogen increased significantly with increasing levels of TGG from 2.5 to 5t/ha. The increase in available nitrogen with increasing doses of FYM from 12.5 to 25t ha⁻¹ was also noticed but not to the extent of significance. The increase in soil nitrogen might be due to direct addition of N through fertilizer and organic materials and greater multiplication of soil microbes, which converts organically bound nitrogen to inorganic form (Bellakki and Badanur, 1997). Manjappa (1999) also founded that inclusion of organic manures such as FYM, vermicompost, cotton and safflower stalk enhanced the soil available nitrogen more as compared to recommended dose of fertilizers alone.

The application of higher quantity of Tata geo green (5t ha⁻¹) and farm yard manure (25t ha⁻¹) along with chemical fertilizers increased available phosphorus significantly as compared to 100% chemical fertilizers alone. Selvamani *et al.*, (2011) reported that phosphorus content in soil increased the significantly by application of organics and bio-inoculants in rice. Organic acids released during decomposition of organic manures increased availability of phosphorus. The organic materials form a protective cover on sesquioxide and thus also reduce the phosphate fixing capacity of soil and hence, increase available P status of soil (Singh *et al.*, 2006). The significant build up in available potassium was recorded with increasing levels of TGG from 2.5 to 5.0 t/ha. The application of Tata geo green increased more potassium than farm yard manure.

The application of organic manures (Tata geo green and farm yard manure) along with the chemical fertilizers increased available potassium significantly as compared to 100% chemical fertilizers alone. The significant build up in available potassium was recorded with increasing levels of TGG from 2.5 to 5.0 t/ha. The application of Tata geo green increased more potassium than farm yard manure. The organic manures have greater capacity to hold K in available form and reduced K-fixation due to interaction of organic matter with clay besides direct addition of potassium to the available pool of soil (Mathur, 1997). Selvamani *et al.*, (2011) reported maximum potassium content in soil with application of 50% RDF through inorganic fertilizers with FYM, vermicompost, neem cake and biofertilizers.

Economics

The data (Table 3) revealed that maximum net return (Rs. 133205 /ha) and benefit-cost ratio (1.34 Rs per Re invested) were obtained by applying Tata geo green @ 3.75 t ha⁻¹ along

with 75% recommended dose of chemical fertilizers. The application of TGG with fertilizers provided higher net returns as compared to FYM with fertilizers. The chemical fertilizers alone also provided higher benefit-cost ratio (Rs. 1.30 Rs per Re invested) as compared to 5 t TGG ha⁻¹, 12.5 t FYM ha⁻¹ and 25 t FYM ha⁻¹ along with fertilizers, similarly reported by (Chettri and Thapa, 2004).

In conclusion, the integrated use of Tata geo green @ 3.75 t/ha along with 75% recommended dose of NPK fertilizer (150:60:100) in potato was found superior and recommended for higher productivity and better marketable quality of tubers. The integrated application of Tata geo green @3.75 t/ha along with 75% recommended dose of chemical fertilizers provided maximum net returns and Rs per Re invested (benefit-cost ratio).

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