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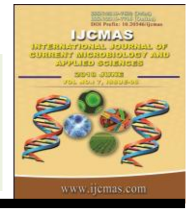

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Effect of Integrated Nutrient Management on Growth and Yield Attributes of Potato (*Solanum tuberosum* L.)

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A B S T R A C T

Effect of integrated nutrient management on growth, quality and yield of potato (kufri pukhraj) were studied in alluvial soil at experimental farm of lovely professional university 2017-2018. The experiment was laid out in Randomized complete block design with eleven treatments were set and each replicate three times. Totally eleven treatments in which one control, two treatments consist 100% RDF and 75% RDF alone and remaining eight treatments consist combination of inorganic fertilizers and organic manures. Growth attributes and yield attributes were recorded at the time of harvest. Integrated use of synthetic fertilizers, organic manures and biofertilizers showed the significant impact on growth and yield attributes of potato. Result indicate that the application of 75% RDF + 2tonnes ha^{-1} FYM + 1tones ha^{-1} Vermicompost + 20kg ha^{-1} Sulphur + 20kg ha^{-1} Zinc sulphate + Azotobacter (seed treatment) showed significant positive impact on fresh weight ($plant^{-1}$), tuber weight ($plant^{-1}$), tuber numbers ($plant^{-1}$) and tuber yield (tonnes ha^{-1}) as compared to 100% RDF and control. The application of 100% RDF + 2tonnes ha^{-1} FYM + 1tones ha^{-1} Vermicompost + 20kg ha^{-1} Sulphur + 20kg ha^{-1} Zinc sulphate showed positive impact on dry weight. Application of 75% RDF + 2tonnes ha^{-1} FYM + 1tones ha^{-1} Vermicompost + 20kg ha^{-1} Sulphur + 20kg ha^{-1} Zinc sulphate + Azotobacter (seed treatment) was more remunerative for sustainable production of potato.

Introduction

Potato (*Solanum tuberosum* L.) is a most important tuber crop of the world, belong to family Solanaceae. It is also known as king of tuber crops and poor man's food. The origin place of potato is South America (Peru). It is the fourth most important food crop in the world after rice, wheat and maize. Next to the cereals, it is the only crop, which could supplement the needs of food of our country. About 90% of potato in India is grown under short day conditions during winter months. Out of this, about 85% accounts under the Indo-Gangetic plains comprising the states of UP, Bihar, West Bengal, Punjab and Haryana.

It occupies an area of 1.93 million tones ha-^{1} in country with a production of 42.43 million tonnes ha^{-1} (Anonymous 2013). Potato being a shallow rooted crop is more responsive to the application of nitrogen, phosphorus and potassium as compared to other solanaceous crops like tomato and pepper (Perrenoud, 1999).

Inorganic fertilizer is the main source of nutrients use for potato cropping. However, continuous application of Inorganic fertilizer causes nutritional imbalance and adverse effects on physic-chemicals and biological properties of soil. On the other hand, the price of inorganic fertilizers has increased to an extent that those are out of reach of the small and marginal farmers. So it has become difficult for farmers to apply such expensive inputs for a crop of marginal returns.

The use of biofertilizers and organic in such situation is, therefore, a practically paying proposal. Integrated application of half of the recommended dose of fertilizer + biofertilizer could produce more or less the same economic yields, besides a saving of half of the recommended dose of N and P (Kumar and Shivay 2010). Thus, the integrated nutrient management could be a key factor for producing and maintain high level of tuber yield in sustain manner.

Materials and Methods

Location of experimental site

The experiment was conducted at the experimental Farm of the Department of Agriculture, Lovely Professional University, Jalandhar, Punjab (India) during 2017-18. The latitude 31˚ 22'31.81'N and 75˚23'03.02 E longitude with altitude of 252 m above sea level, which falls under the central plain zone of Agra climate zone of Punjab. The soil was sandy loam with pH 7.5. The available N, P and K content of soil were 230, 14.2 and 278.4 kg ha-^{1}, respectively with organic carbon 0.58 (%) and Electrical conductivity 0.26 (dSm-^{1}).

Experimental detail

The experiment was laid out in Randomized complete block design with eleven treatments were set and each replicate three times. Totally eleven treatments in which one control, two treatments consist 100% RDF and 75% RDF alone and remaining eight treatments consist combination of inorganic fertilizers, organic manures. Table 1 show the detail of treatments.

Agronomic practices

Potato variety Kufri Pukhraj was used in this research work. In addition to this, half dose of nitrogen and full dose of phosphorus and potassium were also applied as per treatment through urea, SSP and muriate of potash, respectively. The remaining half dose of nitrogen was applied at the time of earthing up. Potato tubers were planted in the ridge 60 cm apart with plant to plant distance of 20 cm in the October, 2017. The 100% RDF contained 180 kg N, 65 kg phosphorous, 65 kg Potassium per hectare and 75% RDF contained 135 kg N, 16.3 kg phosphorous and 16.3 kg potassium per hectare.

Data collection

The growth attributes (fresh weight and dry weight) and yield attributes (tuber number, tuber weight and tuber yield) were taken at harvesting i.e. 80 days after planting.

Statistical analysis

Data were analyzed by Duncan's Multiple Range Tests (DMRT) for separation of means with a probability $p< 0.05$. Difference between mean values were evaluated by Analysis of

Variance (ANOVA) using the software SPSS 16.

Results and Discussion

Growth attributes

Fresh weight (gram plant^{-1})

The maximum fresh weight (126.07 g plant^{-1}) was recorded with application of 75% RDF + 2 tonnes ha^{-1} + 20 kg ha^{-1} Sulphur + 20 kg ha^{-1} Zinc sulphate + 1 tonnes ha^{-1} Vermicompost + Azotobacter (seed treatment) superior to 100% RDF and control (Table 2). This might be due to integration of inorganic fertilizer, organic manure and biofertilizers because vermicompost influence the nitrification inhibition properties of soil and biofertilizer fix atmospheric nitrogen in soils which enhance the vegetative growth of plant. Similar result was recorded by Baishya *et al.*, (2013) and Solanke *et al.*, (2009).

Dry weight (gram palnt^{-1})

The dry weight of plant was found maximum (25.76g plant^{-1}) with the application of 100% RDF + 2 tonnes ha^{-1} + 20 kg ha^{-1} sulphur + 20 kg ha^{-1} zinc sulphate + 1 tonnes ha^{-1} vermicompost superior to 100% RDF and control (Table 2). This might be due to integrated use of organic manures and biofertilizer along with inorganic fertilizers. Organic manure and biofertilizer increase the efficiency of nitrogen and phosphorous which assimilate more photosynthates and better trancolation resulting in higher vegetative growth. Similar result was observed by Baishya *et al.*, (2013) and Banjare *et al.*, (2012).

Yield attributes

Tuber numbers (plant^{-1})

The highest (16.86) number of tubers is recorded with the application of 75% RDF + 2 tonnes ha^{-1} + 20 kg ha^{-1} sulphur + 20 kg ha^{-1} zinc sulphate + 1 tonnes ha^{-1} vermicompost + Azotobacter (seed treatment) which was superior to 100% RDF and control (Table 3). This might be due to use of organic sources along with inorganic fertilizers because organic sources of nutrients improved the soil aeration, root development and increased microbial and biological activities in the rhizosphere. Similar result found was found by Solanke *et al.*, (2009) and Jaipaul *et al.*, (2011).

Table.1 Treatment detail

T0	**Control**
T1	100% RDF
T2	100% RDF + 2 tonnes ha^{-1} FYM + 20 kg ha^{-1} Sulphur
T3	100% RDF + 2 tonnes ha^{-1} FYM + 20 kg ha^{-1} Sulphur + 20 kg ha^{-1} Zinc sulphate
T4	100% RDF + 2 tonnes ha^{-1} FYM + 20 kg ha^{-1} Sulphur + 20 kg ha^{-1} Zinc sulphate + 1 tonnes ha-1 Vermicompoist
T5	100% RDF + 2 tonnes ha^{-1} FYM + 20 kg ha^{-1} Sulphur + 20 kg ha^{-1} Zinc sulphate + 1 tonnes ha^{-1} Vermicompoist + Azotobacter (seed treatment)
T6	75 % RDF
T7	75% RDF + 2 tonnes ha^{-1} FYM + 20 kg ha^{-1} Sulphur
T8	75% RDF + 2 tonnes ha^{-1} FYM + 20 kg ha^{-1} Sulphur + 20 kg ha^{-1} Zinc sulphate
T9	75% RDF + 2 tonnes ha^{-1} FYM + 20 kg ha^{-1} Sulphur + 20 kg ha^{-1} Zinc sulphate + 1 tonnes ha^{-1} Vermicompoist
T10	75% RDF + 2 tonnes ha^{-1} FYM + 20 kg ha^{-1} Sulphur + 20 kg ha^{-1} Zinc sulphate + 1 tonnes ha^{-1} Vermicompoist + Azotobacter (seed treatment)

RDF – Recommended dose of NPK

Table.2 Effect of integrated nutrient management on growth attributes of potato

Treatments	Fresh weight (g plant-1)	Dry weight (g plant-1)
T0	91.9^{f} ± 0.2	15.93^{e} ± 0.88
T1	115.53^{d} ± 1.48	24.26^{abc} ± 0.46
T2	113.8^{de} ± 0.34	24.93^{ab} ± 0.33
T3	115.13^{d}± 0.58	25.36^{a} ± 0.74
T4	122^{c} ± 0.46	25.76^{a} ± 0.44
T5	124.13^{abc} ± 0.3	24.30^{abc} ± 1.36
T6	111.93^{e} ± 0.88	21.26^{d} ± 0.52
T7	122.67^{bc} ± 0.63	22.36^{d} ± 0.23
T8	122.6^{bc} ± 0.69	22.86^{bcd} ± 0.76
T9	124.6^{ab} ± 0.64	24.30^{abc} ± 0.58
T10	126.07^{a} ± 0.54	25.43^{a} ± 0.27

The mean followed by different letters are significantly different at $p < 0.05$, according to DMRT (Dun can's Multiple Range Test) for separation of means.

Note - T0 – control, T1 – (100% RDF, T2 – 100% RDF + 2tonnes FYM/ha + 1tonnes + 20kg Sulphur/ha), T2 – (100% RDF + 2t FYM/ha + 20kg S/ha + 20kg ZnSO4/ha), T4 – (100% RDF + 2t FYM/ha + 20kg S/ha + 20kg ZnSO4/ha + 1t vermicompost/ha), T5 – (100% RDF + 2t FYM/ha + 20kg S/ha + 20kg ZnSO4/ha + 1t vermicompost/ha + Azotobacter (Seed treatment)), T6 – 75% RDF, T7 – (75% RDF + 2t FYM/ha + 20 kg S/ha), T8 – (75% RDF + 2t FYM/ha + 20 kg S/ha + 20kg ZnSO4/ha), T9 – (75% RDF + 2t FYM/ha + 20 kg S/ha + 20kg ZnSO4/ha + 1t vermicompost/ha), T10 – 75% RDF + 2t FYM/ha + 20 kg S/ha + 20kg ZnSO4/ha + 1t vermicompost/ha + Azotobacter (Seed treatment).

Table.3 Effect of integrated nutrient management on yield attributes of potato

Treatments	Tuber numbers (plant-1)	Tuber weight (g plant-1)	Yield (tonnes ha-1)
T0	5.73^{e} ± 0.17	125.27^{h} ± 3.44	9.02^{h} ± 0.24
T1	13.20^{c} ± 0.5	267.26^{e} ± 6.44	19.24^{e} ± 0.46
T2	13.20^{c} ± 0.52	296.25^{d} ± 2.16	21.33^{d} ± 0.15
T3	13.93^{c} ± 0.24	297.50^{cd} ± 1.25	21.42^{cd} ± 0.09
T4	15.40^{b} ± 0	311.06^{bc} ± 2.8	22.39^{bc} ± 0.2
T5	16.06^{ab} ± 0.06	325.27^{b} ± 4.33	23.42^{b} ± 0.31
T6	11.40^{d} ± 0.72	207.38^{g} ± 7.72	14.93^{g} ± 0.55
T7	13.26^{c} ± 0.35	249.30^{f} ± 5.36	17.95^{f} ± 0.38
T8	13.66^{c} ± 0.33	254.91^{ef} ± 6.86	18.35^{e} ± 0.49
T9	15.66^{b} ± 0.06	320.27^{b} ± 3.2	23.06^{b} ± 0.23
T10	16.86^{a} ± 0.06	350.55^{a} ± 4.33	25.24^{a} ± 0.31

The mean followed by different letters are significantly different at $p < 0.05$, according to DMRT (Dun can's Multiple Range Test) for separation of means.

Note - T0 – control, T1 – (100% RDF, T2 – 100% RDF + 2tonnes FYM/ha + 1tonnes + 20kg Sulphur/ha), T2 – (100% RDF + 2t FYM/ha + 20kg S/ha + 20kg ZnSO4/ha), T4 – (100% RDF + 2t FYM/ha + 20kg S/ha + 20kg ZnSO4/ha + 1t vermicompost/ha), T5 – (100% RDF + 2t FYM/ha + 20kg S/ha + 20kg ZnSO4/ha + 1t vermicompost/ha + Azotobacter (Seed treatment)), T6 – 75% RDF, T7 – (75% RDF + 2t FYM/ha + 20 kg S/ha), T8 – (75% RDF + 2t FYM/ha + 20 kg S/ha + 20kg ZnSO4/ha), T9 – (75% RDF + 2t FYM/ha + 20 kg S/ha + 20kg ZnSO4/ha + 1t vermicompost/ha), T10 – 75% RDF + 2t FYM/ha + 20 kg S/ha + 20kg ZnSO4/ha + 1t vermicompost/ha + Azotobacter (Seed treatment).

Tuber weight (gram plant^{-1})

The highest (350.55 g plant^{-1}) tuber weight was recorded with the application 75% RDF + 2 tonnes ha^{-1} + 20 kg ha^{-1} sulphur + 20 kg ha^{-1} zinc sulphate + 1 tonnes ha^{-1} vermicompost + Azotobacter (seed treatment) which was superior to 100% RDF and control (Table 3). This might be due to combined use of organic and inorganic fertilizers, which provide balance nutrition to plant. Similar result was found by Kate *et al.,* (2005).

Yield (tonnes ha^{-1})

The highest (25.24 tonnes ha^{-1}) tuber yield was recorded with the application 75% RDF + 2 tonnes ha^{-1} + 20 kg ha^{-1} sulphur + 20 kg ha^{-1} zinc sulphate + 1 tonnes ha^{-1} vermicompost + Azotobacter (seed treatment) which was superior to 100% RDF and control (Table 3). This might be due to application of fertilizers in combination with organic manure which increased the nutrient-use efficiency through modification of soil physical condition, and resulted in higher total uptake of nutrients because of better root penetration leading to better absorption of nutrients and moisture. Similar result was found by Narayan *et al.,* (2013) and Khurana *et al.,* (2005).

Based on the present study it was concluded that the integrated use of inorganic fertilizers and organic manures was significantly improve the vegetative growth of plant and increase the production of potato in sustain manner. Integrated nutrient management play a key role in sustainable agriculture.

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