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# Effect of integrated nutrient management on yield of potato (*Solanum tuberosum* L.)

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**Abstract**
A field experiment was conducted during the *Rabi* season of the year 2017-18 on potato with variety *Kufri Ashoka* to test the recommended dose of fertilizers (RDF) levels (0, 50, 75, 100, 125, 150%) with two organic manures (vermicompost 5 t/ha and mustard oil cake 2.5 t/ha) at research farm of Tirhut college of Agriculture Dholi, Muzaffarpur, Bihar. The experiment was carried out in randomized block design (RBD) with twelve treatments and replicated thrice. The soil of experimental plot was *Entisols*, sandy loam in texture under low available in N, P and K with pH 8.3. Among the bulking rate, grade wise yield and yield were recorded higher with the application of treatment $T_{11}$ - 150% RDF + 5.0 t/ha vermicompost which was significantly superior over $T_1$, $T_2$, $T_3$, $T_4$, $T_5$ and $T_6$ but was statistically at par with treatments, $T_7$, $T_8$, $T_9$, $T_{10}$ and $T_{12}$.

**Keywords:** Recommended dose of fertilizers, vermicompost, mustard oil cake and *Kufri Ashoka*

## 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. In India, during 2015-16, potato is grown over an area of 2.11 million hectare with an annual production of 43.41 million tonnes with an average yield of 20.5 t/ha. Almost 85% of total production comes from north India plain *viz*. Uttar Pradesh, West Bengal and Bihar. In world scenario, India has got second position after China with respect to production. Bihar is the third largest potato producer state of the country, occupying 5% area of total cultivated land *i.e*. 0.31 million hectare with a production of 6.34 million tonnes and productivity 19.88 t/ha (Horticultural statistics at a glance 2017). Potato is one of the common food crops of the world. They are also used in various industries for starch production, alcohol production, etc. Potato is the main input to agro based industries. Dried chips, papad, mixture, fingerlings are prepared and packaged products fetched many fold profit as compared to the sale of raw potato tubers, thus a source of great employment.

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 imbalance and adverse effects on physico-chemicals and biological properties of soil. 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 Baishya *et al.*, 2012) [1, 18].

Potato is highly responsive to application of organic manures (Mondal *et al*., 2005). Among organic manures, mustard oil cake contains higher amount of nutrients such as 4.93% N, 0.53% $P_2O_5$ and 0.65% $K_2O$ (FAO, 1986) [4]. Though mustard oil cake costs fairly higher than other organic manures, it supplies essential nutrients slowly and thus plants get nutrients for a longer period of time. It has been mentioned that mustard oil cake increases potato yield to a large extent in association with potassium (Hossain *et al*. 2003) [8].

Vermicompost has found to effectively enhance the root formation, elongation of stem and production of biomass in potato crop. Using of vermicompost is now a global movement for the second green revolution that emphasizes on composting. Ghosh *et al*. (1999) [5]. Observed that integration of vermicompost with inorganic fertilizers tends to increase the yield of potato crop. Vermicompost has higher level of nitrogen (1.6%), phosphorus (0.7%) and potassium (0.8%), Calcium (0.5%), magnesium (0.2%) (Buchanan *et al*., 1988) [3].

The productivity of potato can be increased and sustained by adoption of integrated nutrient management. Keeping this point in view the present investigation has been carried out.

## Materials and Methods

The field experiment was laid out during *Rabi* season in year 2017-18 at the research farm of Tirhut College of Agriculture, Dholi (Muzaffarpur) which is situated on the southern bank of the river *Burhi Gandak* at an altitude of 52.18 meter above mean sea level and lies at 25º.98' N latitude and 85º.6' E longitude.

**Table 1:** Chemical properties of experimental soil

| S. N. | Particulars | Values | Method adopted |
|---|---|---|---|
| 1. | Organic carbon (%) | 0.45 | Walkley and Black method (1934) [24] |
| 2. | pH (1:2.5) | 8.30 | Buckman pH meter (Jackson, 1967) [9] |
| 3. | Electrical conductivity (m. mhos /cm at 25 $^0$C) | 0.34 | Systronics electrical conductivity meter (Richards, 1954) [19] |
| 4. | Available Nitrogen (kg N /ha) | 220.40 | Alkaline permanganate method (Subbiah and Asija, 1956) [23] |
| 5. | Available Phosphorus (kg $P_2O_5$ /ha) | 17.88 | Olsen's method (0.5 N $NaHCO_3$ extractable) (Olsen *et al.*, 1954) [16] |
| 6. | Available Potassium (kg $K_2O$ /ha) | 120.02 | Flame photometric method (Jackson, 1967) [9] |

Field experimental was laid out in Randomized Block Design with twelve treatments *viz.*, $T_1$ - absolute control, $T_2$ - 100% RDF, $T_3$ - 50% RDF + 5.0 t/ha vermicompost, $T_4$ - 50% RDF + 2.5 t/ha mustard oil cake, $T_5$ - 75% RDF + 5.0 t/ha vermicompost, $T_6$ - 75% RDF + 2.5 t/ha mustard oil cake, $T_7$ - 100% RDF + 5.0 t/ha vermicompost, $T_8$ -100% RDF + 2.5 t/ha mustard oil cake, $T_9$ - 125% RDF + 5.0 t/ha vermicompost, $T_{10}$ - 125% RDF + 2.5 t/ha mustard oil cake, $T_{11}$ - 150% RDF + 5.0 t/ha vermicompost and $T_{12}$ - 150% RDF + 2.5 t/ha mustard oil cake and replicated thrice.

### Description of experimental variety

***Kufri Ashoka*** - *Kufri Ashoka* developed through clonal selection from the segregating population of the hybrid EM/C-1021 x CP-1468. Central Potato Research Institute, Shimla, released this variety in 1996.

### Bulking rate of tubers (g/day/plant)

Increase in tuber weight at 15 days (45-60, 60-75 DAP and at harvest) interval was obtained on fresh weight basis by dividing the difference in weight of two successive stages by number of days between these increases in weight of tubers. Therefore, bulking rate was determined in g/day/plant.

## Results and discussion

A critical analysis of mean data revealed that different treatments had significant effect on bulking rate of potato at all the successive growth stage. Maximum bulking rate was observed under treatment $T_{11}$ - 150% RDF + 5.0 t/ha vermicompost which was significantly superior such as treatments $T_1$, $T_2$, $T_3$, $T_4$, $T_5$ and $T_6$ and statistically at par with treatment $T_7$, $T_8$, $T_9$, $T_{10}$ and $T_{12}$. The minimum bulking rate was found under the treatment $T_1$- control at all the growth stage. Application of organic source of nutrients to potato crop enhanced the tuber formation and tuber bulking rate. This might be attributed due to slow mineralization of plant nutrients under low temperature condition and in addition provide macro and micro nutrients to crops during plant growth and development stage (Singh *et al*. 2007) [21], Moinuddin (2005) [14] and Meena *et al*. (2016) [13].

Application of organic and inorganic source of fertilizer significantly influenced number of tuber per plant (g) grade wise of potato. Maximum number of tuber per plant (<25 g) was recorded under $T_1$ – control. Treatment $T_{11}$ - 150% RDF + 5.0 t/ha vermicompost (25-50, 50-75, >75 g and total) recorded higher number of tubers per plant which was significantly superior such as treatments $T_1$, $T_2$, $T_3$, $T_4$, $T_5$ and $T_6$ but statistically at par with treatment $T_7$, $T_8$, $T_9$, $T_{10}$ and $T_{12}$. The result emphasized the need of integrated use of chemical fertilizer and organic manures for enhancing tuber formation and tuber bulking in potato. This finding also confirm that higher inputs of nitrogen, phosphorus and potassium play an important role in increasing the number of tuber per plant significantly in comparison to lesser application of RDF (NPK) dose in the categories, 25-50 g, 50-75 g, >75 g and total number of tuber per plant. This result supports the finding by Patel (2013) [17], Banjare (2012) [2] and Kumar *et al*. (2008) [10].

Mean data of different treatments had significant effect on weight of tubers. Maximum tuber weight (<25 g) was recorded under $T_1$ – control. Treatment $T_{11}$ - 150% RDF + 5.0 t/ha vermicompost (25-50, 50-75, >75 g and total) recorded higher weight of tubers/plant whereas minimum weight was recorded under treatment $T_1$ - absolute control. Application of organic and inorganic source of nutrients might be owing to increase in availability of NPK and built up of organic carbon. Weight of tuber yield is influenced to great extent by growth, nutrients and moisture supply. Nitrogen forms theconstitute of chlorophyll for the plants and hence promotes photosynthesis. These results are also in conformity with the finding of Kumar *et al*. (2013) [12], Sood (2007) and Kumar *et al*. (2008) [10].

Under present investigation they worked influenced of various INM treatments was noticed on the grade wise tuber yield. Highest grade-wise tuber yield (25-50, 50-75, >75 g and total) was recorded $T_{11}$ - 150% RDF + 5.0 t/ha vermicompost whereas minimum under $T_1$ – control. The increase in the yield of vines was due to the increase in the levels of N, P and K at each successive level. The nitrogen applied at higher levels was found to be beneficial since hydrolysis of urea have made the nutrient easily available to the plant root thus resulting in higher yield of vines. The application of phosphorus and potassium also behaved like nitrogen and increased plant height helped in increasing leaf area index as a result increase in the rate of photosynthesis and translocation of photosynthates which ultimately increased the yield of potato vines. This is in conformity with result of Gupta and Pal (1989) [6]. Similar results had also been reported by Roy and Sharma (2001) [20] and Kumar and Sharma (2002) [11].

**Table 2:** Bulking rate (g/day/plant) at different growth stages as affected by different treatments

| Treatment | Bulking rate (g/day/plant) | | |
|---|---|---|---|
| | 45-60 DAP | 60-75 DAP | 75 DAP- harvest |
| $T_1$ - Control | 3.82 | 4.35 | 1.32 |
| $T_2$ -100% RDF | 6.78 | 7.83 | 2.14 |
| $T_3$ - 50% RDF + 5.0 t/ha vermicompost | 4.99 | 5.33 | 1.67 |
| $T_4$ - 50% RDF + 2.5 t/ha mustard oil cake | 4.73 | 5.23 | 1.78 |
| $T_5$ - 75% RDF + 5.0 t/ha vermicompost | 5.86 | 6.32 | 1.93 |
| $T_6$ -75% RDF + 2.5 t/ha mustard oil cake | 5.43 | 5.98 | 2.01 |
| $T_7$ -100% RDF + 5.0 t/ha vermicompost | 7.75 | 8.83 | 2.21 |
| $T_8$ -100% RDF + 2.5 t/ha mustard oil cake | 6.93 | 8.15 | 2.18 |
| $T_9$ -125% RDF + 5.0 t/ha vermicompost | 7.98 | 9.17 | 2.32 |
| $T_{10}$ -125% RDF +2.5 t/ha mustard oil cake | 7.54 | 8.23 | 2.23 |
| $T_{11}$ -150% RDF + 5.0 t/ha vermicompost | 8.75 | 9.37 | 2.35 |
| $T_{12}$ - 150% RDF +2.5 t/ha mustard oil cake | 7.98 | 8.67 | 2.32 |
| S Em (±) | 0.24 | 0.26 | 0.08 |
| CD (*p=0.05*) | 0.70 | 0.77 | 0.24 |

**Table 3:** Effect of different treatments on number of tuber per plant (g) grade wise (25, 25-50, 50-75 and >75 g)

| Treatment | Number of tuber per plant (g) grade wise | | | | |
|---|---|---|---|---|---|
| | <25 g | 25-50 g | 50-75 g | >75 g | Total |
| $T_1$ - Control | 2.71 | 1.99 | 1.30 | 0.92 | 6.92 |
| $T_2$ -100% RDF | 2.33 | 2.94 | 3.24 | 1.36 | 9.87 |
| $T_3$ - 50% RDF + 5.0 t/ha vermicompost | 2.54 | 2.34 | 2.18 | 2.12 | 9.18 |
| $T_4$ - 50% RDF + 2.5 t/ha mustard oil cake | 2.66 | 2.44 | 2.68 | 2.04 | 9.82 |
| $T_5$ - 75% RDF + 5.0 t/ha vermicompost | 2.34 | 2.74 | 3.09 | 2.88 | 11.05 |
| $T_6$ - 75% RDF + 2.5 t/ha mustard oil cake | 2.48 | 2.71 | 3.00 | 2.74 | 10.93 |
| $T_7$ - 100% RDF + 5.0 t/ha vermicompost | 2.14 | 3.18 | 3.84 | 3.50 | 12.66 |
| $T_8$ - 100% RDF + 2.5 t/ha mustard oil cake | 2.24 | 3.07 | 3.65 | 3.36 | 12.32 |
| $T_9$ -125% RDF + 5.0 t/ha vermicompost | 2.04 | 3.29 | 3.94 | 3.65 | 12.92 |
| $T_{10}$ -125% RDF +2.5 t/ha mustard oil cake | 2.15 | 3.19 | 3.81 | 3.48 | 12.63 |
| $T_{11}$ -150% RDF + 5.0 t/ha vermicompost | 2.02 | 3.34 | 3.98 | 3.72 | 13.06 |
| $T_{12}$ - 150% RDF +2.5 t/ha mustard oil cake | 2.08 | 3.25 | 3.86 | 3.54 | 12.73 |
| S Em (±) | 0.09 | 0.10 | 0.12 | 0.10 | 0.36 |
| CD (*p=0.05*) | 0.26 | 0.30 | 0.35 | 0.30 | 1.06 |

**Table 4:** Effect of different treatments on weight of tuber per plant (g) grade wise (25, 25-50, 50-75 and >75 g)

| Treatment | weight of tuber per plant (g) grade wise | | | | |
|---|---|---|---|---|---|
| | <25 g | 25-50 g | 50-75 g | >75 g | Total |
| $T_1$ - Control | 62.43 | 33.17 | 30.34 | 28.37 | 154.31 |
| $T_2$ -100% RDF | 47.16 | 60.57 | 72.24 | 78.44 | 258.41 |
| $T_3$ - 50% RDF + 5.0 t/ha vermicompost | 56.00 | 52.44 | 48.52 | 42.63 | 199.59 |
| $T_4$ - 50% RDF + 2.5 t/ha mustard oil cake | 58.64 | 40.13 | 42.63 | 35.44 | 176.84 |
| $T_5$ - 75% RDF + 5.0 t/ha vermicompost | 49.33 | 53.94 | 56.84 | 60.72 | 220.83 |
| $T_6$ - 75% RDF + 2.5 t/ha mustard oil cake | 52.31 | 48.97 | 53.12 | 55.45 | 209.85 |
| $T_7$ -100% RDF + 5.0 t/ha vermicompost | 44.05 | 72.37 | 84.00 | 89.89 | 290.31 |
| $T_8$ -100% RDF + 2.5 t/ha mustard oil cake | 46.57 | 70.58 | 81.72 | 84.63 | 283.5 |
| $T_9$ -125% RDF + 5.0 t/ha vermicompost | 43.22 | 75.63 | 88.22 | 92.05 | 299.12 |
| $T_{10}$ -125% RDF +2.5 t/ha mustard oil cake | 44.76 | 72.45 | 84.67 | 89.35 | 291.23 |
| $T_{11}$ -150% RDF + 5.0 t/ha vermicompost | 42.63 | 83.64 | 90.27 | 94.87 | 311.41 |
| $T_{12}$ - 150% RDF +2.5 t/ha mustard oil cake | 43.89 | 80.34 | 87.25 | 91.51 | 302.99 |
| S Em (±) | 2.10 | 2.61 | 2.86 | 2.99 | 10.56 |
| CD (*p=0.05*) | 6.16 | 7.66 | 8.40 | 8.77 | 30.99 |

**Table 5:** Effect of different treatments on grade-wise tuber yield (q/ha) of potato

| Treatment | Tuber yield (q/ha) | | | | |
|---|---|---|---|---|---|
| | <25 g | 25-50 g | 50-75 g | >75 g | total |
| $T_1$ - Control | 50.07 | 23.73 | 20.16 | 17.33 | 111.28 |
| $T_2$ -100% RDF | 35.55 | 63.78 | 67.98 | 65.98 | 233.30 |
| $T_3$ - 50% RDF + 5.0 t/ha vermicompost | 49.30 | 63.37 | 52.81 | 44.76 | 210.24 |
| $T_4$ - 50% RDF + 2.5 t/ha mustard oil cake | 49.93 | 60.29 | 54.07 | 42.73 | 207.02 |
| $T_5$ - 75% RDF + 5.0 t/ha vermicompost | 47.78 | 67.49 | 59.64 | 62.32 | 237.23 |
| $T_6$ - 75% RDF + 2.5 t/ha mustard oil cake | 48.18 | 68.65 | 58.82 | 59.93 | 235.58 |
| $T_7$ -100% RDF + 5.0 t/ha vermicompost | 39.93 | 63.25 | 77.66 | 81.17 | 262.00 |
| $T_8$ -100% RDF + 2.5 t/ha mustard oil cake | 40.64 | 64.12 | 76.99 | 77.91 | 259.67 |
| $T_9$ -125% RDF + 5.0 t/ha vermicompost | 40.89 | 65.61 | 82.06 | 83.89 | 272.45 |
| $T_{10}$ -125% RDF +2.5 t/ha mustard oil cake | 39.37 | 68.91 | 79.48 | 81.47 | 269.23 |
| $T_{11}$ -150% RDF + 5.0 t/ha vermicompost | 34.04 | 69.30 | 85.51 | 87.30 | 276.15 |
| $T_{12}$ - 150% RDF +2.5 t/ha mustard oil cake | 35.67 | 67.39 | 83.85 | 86.97 | 273.87 |
| S Em (±) | 1.61 | 2.20 | 3.18 | 3.40 | 7.65 |
| CD (*p=0.05*) | 4.72 | 6.47 | 9.33 | 9.98 | 22.43 |

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