



## RESEARCH ARTICLE

## INTEGRATED NUTRIENT MANAGEMENT FOR POTATO PRODUCTIVITY AND SOIL HEALTH

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## ABSTRACT

Potatoes are rich in nutrition and a great economic crop. Integrated nutrient management (INM) is the best method for enhancing tuber yield and soil health. To investigate the effects of integrated nutrient management for higher potato output and better soil health, the experiment was conducted at the Regional Agricultural Research Station (RARS), Jamalpur, Bangladesh in 2022–2023 and 2023–2024. Six treatments were tested, including different compost (compost, kitchen waste compost, vermicompost and trichocompost) and STB dose at varying rates. The results showed that the combined use of chemical fertilizers and organic manure had a substantial impact on potato yield. In 2022-23, the highest tuber yield (35.94 t ha<sup>-1</sup>) was found in T<sub>5</sub> treatment (80 % STB + vermicompost @ 2.5 t ha<sup>-1</sup>). In 2023-24, the highest tuber yield (33.50 t ha<sup>-1</sup>) was also found in same treatment getting 80 % STB with vermicompost @ 2.5t ha<sup>-1</sup> compare to 100% STB (29.34 t ha<sup>-1</sup>) which indicated that plants could not receive adequate nutrients from chemical fertilizer alone. The maximum benefit cost ratio and maximum carbon accumulation were also found in vermicompost treated treatment. Conversely, the control treatment yielded the lowest tubers (19.09 t ha<sup>-1</sup> and 20.19 t ha<sup>-1</sup>, respectively). Therefore, 80 % STB and vermicompost @ 2.5 t ha<sup>-1</sup> may be recommended for higher tuber yield of potato and maintaining soil fertility.

## KEYWORDS

chemical fertilizers, substantial, carbon accumulation, management, soil health

## 1. INTRODUCTION

The potato (*Solanum tuberosum* L.), a member of the Solanaceae family, is known as the "poor man's friend" since it satisfies every need for a nutritious diet and has the potential to significantly reduce the world's food problem. Potatoes are the most popular vegetable in the world due to their high nutritional value (carbohydrate, protein, dietary fiber, vitamins, minerals, amino acids, etc.), ease of digestion, and ability to be produced in large quantities (Biswas and Dutta, 2019). The majority of the nutrients utilized in potato crops come from inorganic fertilizers. According to a high base dose of urea or another direct nitrogenous fertilizer can have a negative impact on potato emergence (Sahota and Sharma, 2005). Numerous beneficial soil microorganisms are suffering as a result of these unbalanced conditions (Chandini et al., 2019). Therefore, for a crop as extensive and responsive as potatoes, a thorough nutrition management scheme is necessary.

Integrated nutrient management (INM), which combines both organic and inorganic nutrient sources, is a more efficient way to feed or nourish the

crop (Narayan et al., 2013). Long term agricultural production depends on improved soil health, which necessitates the integrated use of all plant nutrient sources (chemical fertilizer, organic manures, and biofertilizer) in addition to raising crop output (Shubha et al., 2018). To achieve a good economic return with great soil health, on the other hand, a careful combination of organic and inorganic fertilizer sources may be helpful (Hensh et al., 2020).

## 2. MATERIALS AND METHODS

The experiment was laid out in a randomized complete block design (RCBD) having 3 replications. The unit plot size was 4m x 3m and the variety was BARI Alu-25. Treatments were T<sub>1</sub> = Control, T<sub>2</sub> = 100% Soil Test Based (STB) Fertilizer dose, T<sub>3</sub> = 80% STB + Compost @ 2.5 t ha<sup>-1</sup>, T<sub>4</sub> = 80% STB+Kitchen Waste Compost@2.5 t ha<sup>-1</sup>, T<sub>5</sub> = 80% STB+Vermicompost @ 2.5 t ha<sup>-1</sup> and T<sub>6</sub> = 80% STB+ Trichocompost @ 2.5 t ha<sup>-1</sup>. Nutrient status of initial soil and chemical composition of different compost are presented in Table 1 and Table 2.

Table 1: Initial soil status of the experimental soils

| Location       | pH      | OM (%) | Ca                     | Mg   | K     | Total N% | P   | S   | B                  | Cu   | Fe   | Mn   | Zn  |
|----------------|---------|--------|------------------------|------|-------|----------|-----|-----|--------------------|------|------|------|-----|
|                |         |        | meq 100g <sup>-1</sup> |      |       |          |     |     | µg g <sup>-1</sup> |      |      |      |     |
| RARS, Jam.     | 7.1     | 1.34   | 6.0                    | 1.9  | 0.092 | 0.041    | 8.7 | 7.5 | 0.35               | 2.6  | 25   | 4.0  | 1.2 |
| Critical level | -       | -      | 2.0                    | 0.5  | 0.12  | -        | 10  | 10  | 0.20               | 0.2  | 4    | 1    | 0.6 |
| Interpretation | Neutral | VL     | Opt.                   | Opt. | L     | VL       | L   | L   | M                  | Opt. | Opt. | Opt. | M   |

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**Table 2:** Chemical composition of different compost used for the experiment

| Name of the compost   | pH  | OC % | Ca   | Mg   | K    | Total N % | P    | S    | B     | Cu    | Fe   | Zn   |
|-----------------------|-----|------|------|------|------|-----------|------|------|-------|-------|------|------|
|                       |     |      | [%]  |      |      |           | [%]  |      |       |       |      |      |
| Compost               | 6.3 | 11.2 | 6.50 | 0.65 | 0.45 | 0.11      | 0.31 | 1.22 | 0.01  | 0.02  | 0.47 | 0.06 |
| Kitchen waste compost | 7.9 | 12.3 | 7.50 | 3.65 | 0.51 | 0.31      | 0.36 | 1.42 | 0.01  | 0.04  | 0.57 | 0.09 |
| Vermicompost          | 6.2 | 14.9 | 1.45 | 0.83 | 0.85 | 1.51      | 0.87 | 0.39 | 0.005 | 0.001 | 0.40 | 0.13 |
| Trichocompost         | 7.7 | 16.7 | 6.11 | 2.3  | 1.5  | 1.22      | 0.30 | 1.40 | 0.01  | 0.03  | 0.36 | 0.06 |

During the last stage of land preparation, several composts were used as an IPNS foundation together with chemical fertilizer. The seeds were sown in a spacing of 60 cm x 25 cm. Throughout the season, the necessary intercultural activities were carried out to ensure the crop's correct growth and development. At full maturity, the harvest was completed. We collected and analyzed yield and yield contributing character data. At the 5% probability level, means separation was done using least significant differences (LSD).

Carbon stock, Carbon accumulation and SOM % were calculated using following formula.

Carbon stock ( $t\ ha^{-1}$ ) = Carbon concentration (%) x bulk density ( $gcc^{-1}$ ) x depth (cm)

Carbon accumulation ( $t\ ha^{-1}$ ) = Final carbon stock ( $t\ ha^{-1}$ ) - Initial carbon stock ( $t\ ha^{-1}$ )

Soil Organic Matter Percentage (SOM %) = Soil Organic Carbon Percentage (SOC %) x 1.74

### 3. RESULTS AND DISCUSSION

The study aimed to determine the impact of varying irrigation intervals on

the growth, productivity, and quality of lemon crops. In our nation,

different irrigation intervals are used just for the production of agricultural products. In this endeavour, therefore, various irrigation intervals are used for yielding lemons in an equitable way.

#### 3.1 Effect of integrated nutrient management on yield and economics of potato

The better performance of potato yield was observed in integrated treatment compared to sole chemical treatment (Table 3). In 2022-23, the highest tuber yield of  $35.94\ t\ ha^{-1}$  was obtained in the treatment  $T_5$  (80% STB + vermicompost @  $2.5\ t\ ha^{-1}$ ). Treatment  $T_6$  (80% STB + trichocompost @  $2.5\ t\ ha^{-1}$ ) gave the second highest tuber yield ( $33.79\ t\ ha^{-1}$ ) which was statistically identical to  $T_4$  (80% STB + kitchen waste compost @  $2.5\ t\ ha^{-1}$ ). In 2023-24, the maximum tuber production of  $33.50\ t\ ha^{-1}$  and maximum BCR 3.45 were also observed in vermicompost treated treatment and it makes 14.17 % yield increase over STB dose. This result matched the findings of an earlier study, which found that the highest tuber yield of  $336\ q\ ha^{-1}$  was obtained when 75% NPK was applied using chemical fertilizers in conjunction with  $5\ t\ ha^{-1}$  vermicompost (Rajiv, 2014). Other studies, including also found the same thing. The control treatment had the lowest tuber yield ( $20.19\ t\ ha^{-1}$ ) (Meena *et al.*, 2013; Kumar *et al.*, 2011).

**Table 3:** Effect of integrated nutrient management on yield and yield attributes of potato

| Treat.     | Days to 1 <sup>st</sup> emergence | Plant height (cm) | Number of total tuber plot <sup>-1</sup> | Number of infested tuber plot <sup>-1</sup> | Yield ( $t\ ha^{-1}$ ) | Yield ( $t\ ha^{-1}$ ) | % increase over STB |
|------------|-----------------------------------|-------------------|--|---|------------------------|------------------------|---------------------|
|            |                                   |                   |  |   | 2022-23                | 2023-24                |                     |
| $T_1$      | 15.24 a                           | 48.43 d           | 410.40 e                                 | 154.43 a                                    | 19.09 e                | 20.19 d                | -                   |
| $T_2$      | 14.40 ab                          | 53.77 c           | 595.63 d                                 | 141.70 b                                    | 28.90 d                | 29.34 c                | -                   |
| $T_3$      | 13.87 bc                          | 55.47 b           | 623.23 c                                 | 132.43 c                                    | 30.11 c                | 31.20 b                | 6.33                |
| $T_4$      | 13.35 c                           | 55.50 b           | 740.53 b                                 | 130.47 d                                    | 33.65 b                | 31.36 b                | 6.88                |
| $T_5$      | 13.33 c                           | 62.47 a           | 768.37 a                                 | 94.63 e                                     | 35.94 a                | 33.50 a                | 14.17               |
| $T_6$      | 13.27 c                           | 62.27 a           | 745.60 b                                 | 81.33 f                                     | 33.79 b                | 32.52 ab               | 10.83               |
| CV%        | 6.77                              | 7.03              | 12.45                                    | 6.78  | 12.66                  | 11.34                  | -                   |
| LSD (0.05) | 1.04                              | 0.46              | 16.62                                    | 0.35  | 0.16                   | 1.53                   | -                   |

Means in a column followed by same letter(s) do not differ significantly at 5% level by LSD.

Note:  $T_1$  = Control,  $T_2$  = 100% STB,  $T_3$  = 80% STB + Compost @  $2.5\ t\ ha^{-1}$ ,  $T_4$  = 80% STB + Kitchen Waste Compost @  $2.5\ t\ ha^{-1}$ ,  $T_5$  = 80% STB + Vermicompost @  $2.5\ t\ ha^{-1}$ ,  $T_6$  = 80% STB + Trichocompost @  $2.5\ t\ ha^{-1}$

Input: Urea=22 Tk  $kg^{-1}$ , TSP= 22 Tk  $kg^{-1}$ , MoP = 15 Tk  $kg^{-1}$ , Gypsum = 12 Tk  $kg^{-1}$ , Zinc sulphate = 200 Tk  $kg^{-1}$ , Boric acid = 250 Tk  $kg^{-1}$ , Compost =10 Tk  $kg^{-1}$ , Kitchen waste compost =15 Tk  $kg^{-1}$ , Vermicompost=15 Tk  $kg^{-1}$ , Trichocompost=15 Tk  $kg^{-1}$

Output: Price range of potato is 15 to 25 Tk  $kg^{-1}$ , average price is 20 Tk  $kg^{-1}$

#### 3.2 Soil carbon accumulation in potato crop under integrated nutrient management

Following the addition of organic manure, the bulk density of the soil decreased (Table 4). While the pH of the soil dropped in the control and inorganic fertilizer treatments, it rose in the combined treatment. Organic

carbon in the soil ranges from 0.85% to 0.73%. Organic carbon levels were lowest (0.73%) in the control treatment and highest (0.85%) in the vermicompost @  $2.5\ t\ ha^{-1}$  + inorganic fertilizer treatment. However, vermicompost containing treatments exhibited higher amounts of total N and soil organic matter. These results agreed with who reported that maximum nutrient availability due to integrated use of organic and inorganic fertilizers increased nutrient uptake by the plant which in turn lead to dry matter production (Ogundare *et al.*, 2015). After two years, the post harvest carbon stock declined in both the control treatment and the solo chemical treatment compared to the initial stock. On the other hand, integrated treatment led to an increase in post harvest carbon stock. Compared to the other treatments, the vermicompost treated treatment collected  $1.25\ t\ ha^{-1}$  more carbon. When compared to the use of chemical fertilizers alone, the results showed that the use of both chemical fertilizers and organic manure treatments accumulated the most carbon.

Temperature, fertilization methods and the environment all affect carbon sequestration (West and Six, 2007).

**Table 4: Effect of integrated nutrient management on nutrient status and carbon accumulation**

| Treat.         | Bulk density (gcc <sup>-1</sup> ) | pH  | SOM (%) | SOC (%) | Total N (%) | Initial Carbon Stock (t ha <sup>-1</sup> ) | Post harvest Carbon Stock (t ha <sup>-1</sup> ) | Carbon accumulation (t ha <sup>-1</sup> ) |
|----------------|-----------------------------------|-----|---------|---------|-------------|--|---|---|
| T <sub>1</sub> | 1.51                              | 6.8 | 1.27    | 0.73    | 0.04        | 16.98                                      | 16.53   | - 0.45                                    |
| T <sub>2</sub> | 1.51                              | 6.9 | 1.28    | 0.74    | 0.06        | 16.98                                      | 16.76   | - 0.22                                    |
| T <sub>3</sub> | 1.45                              | 7.2 | 1.39    | 0.80    | 0.08        | 16.98                                      | 17.40   | 0.42                                      |
| T <sub>4</sub> | 1.44                              | 7.4 | 1.40    | 0.81    | 0.11        | 16.98                                      | 17.49   | 0.51                                      |
| T <sub>5</sub> | 1.43                              | 7.6 | 1.47    | 0.85    | 0.14        | 16.98                                      | 18.23   | 1.25                                      |
| T <sub>6</sub> | 1.43                              | 7.5 | 1.44    | 0.83    | 0.12        | 16.98                                      | 17.80   | 0.82                                      |
| Initial        | 1.49                              | 7.1 | 1.35    | 0.76    | 0.05        | -  | -   | -   |

Note: T<sub>1</sub>= Control, T<sub>2</sub>= 100% STB, T<sub>3</sub>= 80% STB + Compost @ 2.5 t ha<sup>-1</sup>, T<sub>4</sub>= 80% STB + Kitchen Waste Compost @ 2.5 t ha<sup>-1</sup>, T<sub>5</sub>= 80% STB + Vermicompost @ 2.5 t ha<sup>-1</sup>, T<sub>6</sub>= 80% STB + Trichocompost@ 2.5 t ha<sup>-1</sup>

### 3.3 Cost and return analysis

Table 5 showed the cost and return analysis of potato as influenced by

integrated application of different compost and chemical fertilizer. The highest gross return (Tk 670000 ha<sup>-1</sup>), gross margin (Tk 467000 ha<sup>-1</sup>) and MBCR (3.22) were recorded from T<sub>5</sub> (80% STB + vermicompost @ 2.5 t ha<sup>-1</sup>) treatment. Among the treatment, the lowest gross return (Tk 403800 ha<sup>-1</sup>) and gross margin (Tk 263800 ha<sup>-1</sup>) were recorded from control treatment.

**Table 5: Cost and return analysis potato of as influenced by integrated nutrient management**

| Treatment   | yield (t ha <sup>-1</sup> ) | Gross Return (Tk ha <sup>-1</sup> ) | Total variable cost (Tk ha <sup>-1</sup> ) | Marginal TVC (Tk ha <sup>-1</sup> ) | Gross margin (Tk ha <sup>-1</sup> ) | Marginal Gross Return (Tk ha <sup>-1</sup> ) | MBCR |
|---|-----------------------------|-------------------------------------|--|-------------------------------------|-------------------------------------|--|------|
| T <sub>1</sub> = Control                                | 20.19                       | 403800                              | 140000                                     | -                                   | 263800                              | -  | -    |
| T <sub>2</sub> = 100% STB                               | 29.34                       | 586800                              | 190500                                     | 50500                               | 396300                              | 132500                                       | 2.62 |
| T <sub>3</sub> = 80% STB + C @ 2.5 t ha <sup>-1</sup>   | 31.20                       | 624000                              | 195000                                     | 55000                               | 429000                              | 165200                                       | 3.00 |
| T <sub>4</sub> = 80% STB + KWC @ 2.5 t ha <sup>-1</sup> | 31.36                       | 627200                              | 201000                                     | 61000                               | 426200                              | 162400                                       | 2.66 |
| T <sub>5</sub> = 80% STB + VC @ 2.5 t ha <sup>-1</sup>  | 33.50                       | 670000                              | 203000                                     | 63000                               | 467000                              | 203200                                       | 3.22 |
| T <sub>6</sub> = 80% STB +TC @ 2.5 t ha <sup>-1</sup>   | 32.52                       | 650400                              | 205000                                     | 65000                               | 445400                              | 181600                                       | 2.79 |

Note: Input: Urea=22 Tk kg<sup>-1</sup>, TSP= 22 Tk kg<sup>-1</sup>, MoP = 15 Tk kg<sup>-1</sup>, Gypsum = 12 Tk kg<sup>-1</sup>, Zinc sulphate = 200 Tk kg<sup>-1</sup>, Boric acid = 250 Tk kg<sup>-1</sup>, Compost =10 Tk kg<sup>-1</sup>, Kitchen waste compost =15 Tk kg<sup>-1</sup>, Vermicompost=15 Tk kg<sup>-1</sup>, Trichocompost=15 Tk kg<sup>-1</sup>

Output: Average price of Potato is 20 Tk kg<sup>-1</sup>

## 4. CONCLUSIONS

The findings showed that when compared to conventional compost, treatments treated with vermicompost perform better. From economic point of view, this treatment was suitable and economically viable. So, it can be concluded that, treatment package consists of 80% STB with vermicompost @ 2.5 t ha<sup>-1</sup> may therefore be recommended as a better option for enhancing potato yield and promoting soil carbon buildup.

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