# A Study on Nutrient Management for Potato Based Cropping Systems

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**Abstract**

Nutrient availability is second only to water in determining crop yield over a given period and location. The function that a given nutrient plays in plant metabolic processes determines the extent to which that nutrient contributes to crop yield. Due to regional and temporal diversity in soil fertility, the current and generalised fertiliser recommendations made decades ago are becoming more irrelevant. In addition, the widespread depletion of macro and micro nutrients in the cultivated soil due to high crop removal and less addition of nutrients by farmers has led to the emergence of deficiency in soil and crops, resulting in a change in fertility from high to medium or medium to low nutrient status. Researchers investigate nutrient management for potato-based cropping systems in this work.

***Keywords:*** *Nutrient, Management, Potato, Cropping Systems, Farmers.*

**Tob Regul Sci. ™ 2021;7(5): 2357-2375**
**DOI: https://doi.org/10.52783/trs.v7i5.1341**

## 1. Introduction

Recent developments in the field of nutrient management have led to the development of a cutting-edge method for providing crop nutrients in response to spatial and temporal variations in soil need. The method used is known as "site specific nutrient management" (SSNM). SSNM is a new method that uses scientific concepts to guide the timed and precise administration of fertilisers to crops. Guidelines for making the most efficient use of native nutrients found in soil, plant wastes, manures, and irrigation water are provided, with recognition of the geographical variability inherent to soil throughout crop development. Thus, SSNM takes into account the soil's native nutrient supply and productivity, aiming for both the capacity to maintain increased yields and the guaranteed restoration of soil fertility.[1-2]

Current fertiliser recommendations tend to be administered in a blanket fashion across huge regions, regardless of the fact that the nutrient needs of crops vary greatly depending on factors like location and time of year. This explains why nitrogen fertiliser usage efficiency is often low, potassium fertiliser use is frequently unbalanced with crop needs and other nutrients, and profits are seldom maximised.[3-4]

Potassium is a macronutrient because it is required in large amounts by the crop and is involved in the transport of water, nutrients, and carbohydrates within plant tissues and the activation of enzymes that affect protein, starch, and adenosine triphosphate (ATP) production. Potassium plays an important role in many annual crops by controlling stomata, the openings in leaves that allow water vapour, oxygen, and carbon dioxide to enter and leave the plant. Stunted crop development and yield decrease are visible under deficit and insufficient supply of this nutrient; indirectly, this stomata control is useful in maintaining plant temperature, since many of the responses in the plant organs are temperature dependent.[5-6]

Even though most cultivated soils have a total K content of over 20,000 ppm (parts per million), and their supply from the soil is also quite large, only a small fraction of that is actually available for plant growth at any given time because most of the soil potassium is locked in the structural component of soil minerals. Even though it is provided by outside sources, such as fertilisers, its availability to crops might be affected by non-scientific advice and application practises.[7-8]

Results from a soil test that were previously thought to be adequate now show that the high rates of N and P being applied are unbalanced by the soil's potassium content. This is consistent with the recommendations of the International Plant Nutrition Institute (IPNI) in India. Therefore, innovative methods must be considered to guarantee that potassium is administered precisely when the crop needs it and that the provided potassium is fully used. The most promising strategy for success in this direction is site specific nutrition control, as described above.[9-10]

## 2. Material And Methods

### The Site of the Experiment

It is two km from the College of Agriculture (CoA), Lucknow to the experimental location. Results are interpreted using meteorological data collected at the closest station, which happens to be the College of Agriculture in Lucknow.

### Site-specific soil properties for an experiment

Following land preparation, in March 2021, soil samples were collected from each plot's four equidistant spots and the centre of the plot from 0 to 15 cm soil depth, composited, air dried, crushed to pass through a 2 mm sieve, and then analyzed for physical and chemical properties in order to better understand the soil characters. The table below details the initial soil physical and chemical parameters as well as the methodologies used in soil and plant examination.

Table 1: Soil physical and chemical characteristics at the 2021 ARS experiment site

| Particulars | Values | Status |
|---|---|---|
| I. **Physical properties** | | |
| 1. Sand (%) | 72.28 | - |
| 2. Silt (%) | 15.95 | - |
| 3. Clay (%) | 11.77 | - |
| 4. Soil type | Sandyloam | - |
| II. **Chemical properties** | | |
| 1. pH (1:2.5) | 7.05 | Neutral |
| 2. EC (1:2.5) ($dSm^{-1}$) | 0.18 | Low |
| 3. Organic carbon (%) | 0.38 | Low |
| 4. Available N (kg $ha^{-1}$) | 250.62 | Medium |
| 5. Available P2O5 (kg $ha^{-1}$) | 69.74 | High |
| 6. Available K2O (kg $ha^{-1}$) | 418.09 | High |
| 7. Exchangeable Calcium(C mol (p+) $kg^{-1}$ soil) | 2.31 | Medium |
| 8. Exchangeable Magnesium (C mol (p+) $kg^{-1}$ soil) | 1.03 | Medium |
| 9. Available Sulphur (mg $kg^{-1}$) | 8.05 | Low |
| 10. Zinc (mg $kg^{-1}$) | 0.95 | Medium |
| 11. Copper (mg $kg^{-1}$) | 1.21 | High |
| 12. Iron (mg $kg^{-1}$) | 17.95 | High |

| | | |
|---|---|---|
| 13. Manganese (mg $kg^{-1}$) | 18.54 | High |
| 14. Available Boron (mg $kg^{-1}$) | 0.31 | Low |

**Varietal characteristics that had a significant role in the study**

- **Potato variety: *Kufri Jyothi***

The meat of the huge, oval, flat tubers has a dull white tint, and the skin has white, fluttering eyes. A very versatile, fertilizer-responsive cultivar with excellent leaf late blight resistance and moderate tuber late blight resistance. Additionally, this displays modest resistance to the Cercospora leaf spot and resistance to the wart. Several Indian states, notably Karnataka, have recently advocated for its commercial production. In the hills, it needs 110–120 days to reach maturity, whereas in the plains, it just needs 100 days. It produces between 180 and 200 q ha-1 in the hills. Kufri Jyothi has a yield of 150–200 q ha-1 when irrigated and 75–100 q ha-1 when rainfed on the plains, including Karnataka. While tuber has many desirable traits, it may shatter when subjected to prolonged stress in flat areas. Therefore, on the plains, it is recommended to harvest it no later than 90 days after planting.

The average plant height was calculated by measuring the length of the five plants from the soil to the end of the longest main stem.

- **Number of leaves per plant**

during 30, 45, and 60 days after planting (DAP), as well as during harvest, the total number of leaves produced by each of the five randomly chosen plants was tallied and recoded.

- **Leaf area per plant**

At 30, 60, and 90 days post-planting, the total leaf area was measured by measuring the length and width of the fourth top leaf of the main branch (five randomly chosen potato plants). The leaf area was calculated using the formula: LA (cm2) = L x B Factor, where L and B are the average leaf length and width.

Graph paper was used to map the leaf, which yielded the factor used to determine leaf area. Which is why we took 30–40 leaves from each treatment at random and charted them out on our own. The average factor was calculated by counting the units (cm2) covered by the leaves and dividing that number by the length times the width of a single leaf.

- **Total dry matter production**

Five plants were picked at random from the border rows and dried in the air for two days. After recording the weight at 30, 60, and 90 days after planting (DAP), and at harvest, the plants were dried in an oven set at 65 degrees Celsius for two days until a steady weight was observed.

**Element yield and overall yield**

- **Number of tubers per plant**

Five plants were marked, and their tuber counts were tallied. The average number of tubers per plant was calculated using data from five plants.

- **Tuber yield**

Weights were recorded when tubers were sorted out of their net plots. The anticipated yield of tubers per acre was given in metric tonnes. The following formula was used to get the total yield per acre in metric tonnes:

$$\text{Tuber yield (t ha}^{-1}\text{)} = \frac{\text{Yield per net plot (kg)}}{\text{Net area of the plot (m}^2\text{)}} \times \frac{10000}{1000}$$

**Statistical analysis**

Fisher's technique of ANOVA, as explained, was used to conduct statistical analysis on the experimental data gathered. The F test was performed at a 5% level of significance. When the "F" test proved significant at the 5 percent level, the corresponding CD values are shown in the table. Felipe de Mendibur's (2020) AMMI approach was used to examine data from two years combined.

## 3. Results

**Potato growth characteristics**

Tables detail the effects of applying varying amounts of potassium via KCl, K2SO4, Bio-K, and their combinations at different stages of plant development as part of site-specific nutrient management on key potato growth parameters like plant height, branching, leaf count, leaf area, and leaf area index. The presented findings are based on data collected over a two-year period, and references to and discussions of established ideas and practises are provided whenever relevant.

- **Plant height**

Table shows how site-specific nutrient management affected the plant height of potatoes at various phases of crop development when potassium was supplied from a variety of different sources and at varying concentrations. At 30 DAP, the plant height of fields fertilised with 50% Bio-K + 50% K2SO4 + balance NP through fertilisers for a targeted yield of 25 t ha-1 (T10) was 31.68 centimetres, which was on par with fields fertilised with 100% Bio-K + balance NP through fertilisers for a targeted yield of 25 t ha-1 (T8: 30.90 centimetres), 100% K2SO4 + NP through fertilisers for a targeted yield of The maximum height of plants grown with only the (T11) recommended dosage of fertilisers was just 22.13 centimetres.

For a planned yield of 25 t ha-1, using 50% K through Bio-K + 50% K via K2SO4 + balance NP via fertilisers resulted in substantially taller plants (66.63, 77.19, and 72.94 cm, respectively, at 45 DAP, 60 DAP, and harvest).

**Table 2: The effect of site-specific nutrient management on the average height of potato plants at various growth stages in a potato-based sequential cropping system**

| Treatments | 30 DAP | | | 45 DAP | | | 60 DAP | | | At harvest | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2020 | 2021 | Pooled | 2020 | 2021 | Pooled | 2020 | 2021 | Pooled | 2020 | 2021 | Pooled |
| T1 | 23.06 | 24.13 | 23.60 | 48.50 | 50.65 | 49.58 | 56.17 | 59.33 | 57.75 | 52.00 | 54.30 | 53.15 |
| T2 | 23.86 | 25.45 | 24.66 | 50.18 | 53.54 | 51.86 | 58.12 | 62.01 | 60.07 | 53.80 | 57.40 | 55.60 |
| T3 | 24.58 | 25.74 | 25.16 | 51.69 | 54.14 | 52.92 | 59.87 | 62.38 | 61.12 | 55.49 | 58.14 | 56.81 |
| T4 | 23.37 | 24.75 | 24.06 | 49.49 | 52.05 | 50.77 | 56.94 | 60.29 | 58.62 | 52.71 | 55.51 | 54.11 |
| T5 | 25.68 | 25.47 | 25.58 | 54.01 | 53.51 | 53.76 | 62.55 | 61.98 | 62.27 | 57.90 | 57.37 | 57.64 |
| T6 | 26.55 | 27.54 | 27.05 | 55.85 | 57.92 | 56.89 | 64.69 | 66.75 | 65.72 | 59.78 | 62.09 | 60.94 |
| T7 | 30.13 | 31.35 | 30.74 | 64.65 | 67.13 | 65.89 | 73.39 | 76.39 | 74.89 | 67.94 | 70.71 | 69.33 |
| T8 | 30.31 | 31.49 | 30.90 | 65.25 | 66.23 | 65.74 | 73.84 | 76.71 | 75.28 | 68.35 | 71.01 | 69.68 |
| T9 | 29.66 | 30.57 | 30.12 | 60.67 | 69.09 | 64.88 | 71.79 | 74.60 | 73.20 | 67.73 | 70.33 | 69.03 |
| T10 | 31.20 | 32.16 | 31.68 | 65.62 | 67.63 | 66.63 | 76.00 | 78.38 | 77.19 | 70.36 | 75.51 | 72.94 |
| T11 | 22.0 | 22.1 | 22.13 | 46.1 | 46.6 | 46.43 | 54.0 | 55.2 | 54.65 | 51.0 | 52.8 | 51.95 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 8 | 8 | | 6 | 9 | | 2 | 8 | | 6 | 4 | |
| T12 | 23.01 | 24.26 | 23.64 | 49.25 | 51.12 | 50.19 | 57.94 | 59.11 | 58.53 | 52.86 | 55.23 | 54.05 |
| F-test | ** | ** | ** | ** | ** | ** | ** | ** | ** | ** | ** | ** |
| S.Em ± | 0.93 | 0.97 | 0.67 | 1.63 | 1.78 | 1.21 | 2.23 | 2.14 | 1.54 | 2.06 | 2.09 | 1.47 |
| C.D.@ 5% | 2.72 | 2.85 | 1.90 | 4.78 | 5.23 | 3.44 | 6.53 | 6.28 | 4.40 | 6.03 | 6.13 | 4.18 |

Because of its involvement in enzymatic activities that govern protein synthesis, glycogen production, cell development, and cell division, potassium may be responsible for the dramatic rise in plant height. During times of osmotic stress, the capacity of cells to take in or expel potassium plays a role in the control of cell volume.

- **Number of leaves per plant**

According to Table, the average number of potato leaves per plant grew over the whole crop cycle. Under site-specific nutrient management, the total number of leaves produced by potato plants varied dramatically in response to variations in the potassium supply. T10, which received 50% of its potassium from Bio-K and 50% from K2SO4 and the rest from fertilisers to achieve a yield of 25 tonnes per hectare, had the highest leaf count per plant at 30 days after planting (35.65), followed by T8, which received 100% of its potassium from Bio-K and 100% from K2SO4 and the rest from fertilisers to achieve a yield of 25 tonnes per hectare (34.77), T7, which received 100% of its potassium from KCl and 34 The (T11) recommended dosage of fertilisers alone resulted in a significantly reduced leaf yield per plant (24.62).

**Table 3: The effect of site-specific nutrient management in a sequential cropping system based on potatoes on the number of leaves produced at various stages of potato development**

| **Treatments** | **30 DAP** | | | **45 DAP** | | | **60 DAP** | | | **At harvest** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **2020** | **2021** | **Pooled** | **2020** | **2021** | **Pooled** | **2020** | **2021** | **Pooled** | **2020** | **2021** | **Pooled** |
| T1 | 25.95 | 27.10 | 26.53 | 77.15 | 80.97 | 79.06 | 63.39 | 64.17 | 63.78 | 12.11 | 12.65 | 12.38 |
| T2 | 26.85 | 28.65 | 27.75 | 80.14 | 86.10 | 83.12 | 63.49 | 68.34 | 65.92 | 12.53 | 13.37 | 12.95 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| T3 | 27.66 | 28.98 | 28.32 | 82.33 | 87.18 | 84.76 | 65.68 | 69.22 | 67.45 | 12.91 | 13.52 | 13.22 |
| T4 | 26.30 | 27.85 | 27.08 | 78.33 | 83.46 | 80.90 | 62.02 | 66.19 | 64.11 | 12.27 | 13.00 | 12.64 |
| T5 | 28.90 | 28.63 | 28.77 | 86.93 | 86.05 | 86.49 | 69.02 | 68.30 | 68.66 | 13.48 | 13.36 | 13.42 |
| T6 | 29.88 | 30.99 | 30.43 | 90.21 | 93.88 | 92.05 | 71.71 | 74.66 | 73.18 | 13.95 | 14.47 | 14.21 |
| T7 | 33.90 | 35.29 | 34.60 | 103.65 | 108.23 | 105.94 | 82.54 | 86.28 | 84.41 | 15.82 | 16.47 | 16.15 |
| T8 | 34.11 | 35.43 | 34.77 | 104.24 | 108.64 | 106.44 | 83.09 | 86.67 | 84.88 | 15.92 | 16.54 | 16.23 |
| T9 | 32.90 | 34.20 | 33.55 | 102.91 | 107.21 | 105.06 | 81.31 | 84.81 | 83.06 | 15.58 | 16.18 | 15.88 |
| T10 | 35.11 | 36.19 | 35.65 | 107.57 | 111.14 | 109.36 | 85.80 | 88.70 | 87.25 | 16.38 | 16.89 | 16.64 |
| T11 | 24.01 | 25.22 | 24.62 | 74.82 | 75.23 | 75.03 | 58.45 | 60.00 | 59.23 | 11.36 | 11.82 | 11.59 |
| T12 | 26.22 | 27.61 | 26.92 | 78.05 | 81.05 | 79.55 | 63.45 | 66.10 | 64.78 | 12.76 | 13.02 | 12.89 |
| F-test | ** | ** | ** | ** | ** | ** | ** | ** | ** | ** | ** | ** |
| S.Em ± | 1.30 | 1.07 | 0.84 | 2.67 | 2.75 | 1.92 | 2.14 | 2.32 | 1.58 | 0.50 | 0.44 | 0.33 |
| C.D. @ 5% | 3.80 | 3.13 | 2.39 | 7.83 | 8.06 | 5.46 | 6.26 | 6.80 | 4.49 | 1.47 | 1.29 | 0.95 |

+ NP through fertilisers to achieve a goal yield of 25 t ha-1 and 50% K via Bio-K + 50% K via KCl + balance NP via fertilisers to achieve a target yield of 25 t ha-1. The number of leaves per plant was much lower when just the appropriate amount of fertilisers was used.

“Because nitrogen is required for the formation of chlorophyll, phosphorus for the synthesis of nucleic acids, and similarly potassium is important for the growth and elongation probably due to its function as an osmotic and may react synergically with other nutrients, the differences in the number of branches and leaves may be attributed to the application of Bio-K through SSNM approach, which increased the input use efficiency, improved N, P, and K supplying capacity of soil, and resulted in In addition, a sufficient amount of N in the soil, in addition to a balance of other nutrients, is directly responsible for the emergence and growth of leaves." Subsequently, under corresponding subheadings, the positive impact of Bio-K and SSNM strategy of giving nutrients in preserving the optimal balance are explored to back up the findings achieved in this research.

- **Leaf area index**

Under site-specific nutrient management, the leaf area index of potatoes varied dramatically depending on the potassium supply. "Application of 50% K via Bio-K + 50% K via K2SO4 + balance NP via fertilisers for a targeted yield of 25 t ha-1 (T10) resulted in a significantly higher leaf area index (1.60) at 30 DAP compared to applications of 100% K via Bio-K + balance NP via fertilisers for a targeted yield of 25 t ha-1 (T8: 1.56), 100% K via K2SO4 + NP via fertilisers for a targeted yield of 25 The recommended dosage of fertilisers alone (T11, 1.15) resulted in a much lower leaf area index."

**Table 4: The effect of site-specific nutrient management on the leaf area index of potatoes grown in a sequential cropping system based on potatoes**

| Treatments | 30 DAP | | | 45 DAP | | | 60 DAP | | | At harvest | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2020 | 2021 | Pooled | 2020 | 2021 | Pooled | 2020 | 2021 | Pooled | 2020 | 2021 | Pooled |
| T1 | 1.17 | 1.22 | 1.19 | 3.47 | 3.64 | 3.55 | 2.75 | 2.90 | 2.82 | 0.54 | 0.57 | 0.56 |
| T2 | 1.21 | 1.29 | 1.25 | 3.60 | 3.87 | 3.74 | 2.85 | 3.07 | 2.96 | 0.56 | 0.60 | 0.58 |
| T3 | 1.24 | 1.30 | 1.27 | 3.73 | 3.92 | 3.82 | 2.95 | 3.11 | 3.03 | 0.58 | 0.61 | 0.59 |
| T4 | 1.18 | 1.25 | 1.22 | 3.52 | 3.75 | 3.64 | 2.79 | 2.98 | 2.88 | 0.55 | 0.58 | 0.57 |
| T5 | 1.30 | 1.29 | 1.29 | 3.91 | 3.87 | 3.89 | 3.10 | 3.07 | 3.09 | 0.61 | 0.60 | 0.60 |
| T6 | 1.35 | 1.39 | 1.37 | 4.06 | 4.22 | 4.14 | 3.22 | 3.36 | 3.29 | 0.63 | 0.65 | 0.64 |
| T7 | 1.52 | 1.59 | 1.56 | 4.66 | 4.86 | 4.76 | 3.71 | 3.88 | 3.80 | 0.71 | 0.74 | 0.73 |
| T8 | 1.53 | 1.59 | 1.56 | 4.69 | 4.88 | 4.79 | 3.74 | 3.89 | 3.81 | 0.72 | 0.74 | 0.73 |
| T9 | 1.52 | 1.55 | 1.54 | 4.65 | 4.85 | 4.75 | 3.68 | 3.84 | 3.76 | 0.70 | 0.72 | 0.71 |
| T10 | 1.58 | 1.63 | 1.60 | 4.84 | 5.00 | 4.92 | 3.86 | 3.99 | 3.92 | 0.74 | 0.76 | 0.75 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| T11 | 1.11 | 1.19 | 1.15 | 3.31 | 3.44 | 3.38 | 2.59 | 2.73 | 2.66 | 0.48 | 0.50 | 0.49 |
| T12 | 1.19 | 1.29 | 1.24 | 3.57 | 3.67 | 3.62 | 2.79 | 2.91 | 2.85 | 0.55 | 0.58 | 0.57 |
| F-test | ** | ** | ** | ** | ** | ** | ** | ** | ** | ** | ** | ** |
| S.Em ± | 0.04 | 0.04 | 0.03 | 0.12 | 0.12 | 0.09 | 0.10 | 0.10 | 0.07 | 0.03 | 0.03 | 0.02 |
| C.D. @ 5% | 0.12 | 0.12 | 0.09 | 0.35 | 0.36 | 0.25 | 0.30 | 0.30 | 0.20 | 0.09 | 0.10 | 0.07 |

"Compared to 100% K through Bio-K + balance NP through fertilisers for targeted yield of 25 t ha-1(4.79,3.81 and 0.73), 100% K through K2SO4 + NP through fertilisers for targeted yield of 25 t ha-1(4.79,3.81 and 0.73), and 100% K through Bio-K + balance NP through fertilisers for targeted yield of 25 t ha-1(4.79,3.81 and 0.73), significantly higher leaf area index (4.92, 3. The prescribed dosage of fertilisers alone resulted in a much reduced leaf area index (3.38, 2.66, and 0.49 correspondingly)."

- **Total dry matter production**

As can be shown in, the provision of potassium via various sources and amounts under site-specific nutrient management greatly impacted data pertaining to total dry matter production of potato.

"Total dry matter production was 9.27 g plant-1 at 30 DAP when compared to 100% K through Bio-K + balance NP through fertilisers for targeted yield of 25 t ha-1 (T8: 9.23 g plant-1), 100% K through K2SO4 + NP through fertilisers for targeted yield of 25 t ha-1 (T7: 9.19 g plant-1), and 50% K through Bio-K + 50% K2SO4 + balance NP through fertilisers for targeted yield of 25 t ha."

**Table 5: The effect of site-specific fertiliser management on total dry matter production (g plant-1) in potatoes over a sequence of cropping phases**

| Treatments | 30 DAP | | | 45 DAP | | | 60 DAP | | | At harvest | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2020 | 2021 | Pooled | 2020 | 2021 | Pooled | 2020 | 2021 | Pooled | 2020 | 2021 | Pooled |
| T1 | 6.56 | 6.85 | 6.71 | 66.92 | 69.77 | 68.35 | 70.88 | 74.01 | 72.45 | 71.40 | 74.56 | 72.98 |
| T2 | 6.78 | 7.24 | 7.01 | 69.13 | 73.76 | 71.45 | 73.33 | 78.24 | 75.79 | 73.87 | 78.81 | 76.34 |
| T3 | 6.99 | 7.32 | 7.16 | 71.2 | 74.5 | 72.91 | 75.5 | 79.1 | 77.33 | 76.1 | 79.7 | 77.90 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 2 | 9 | | 4 | 2 | | 0 | 0 | |
| T4 | 6.65 | 7.04 | 6.85 | 67.73 | 71.71 | 69.72 | 71.84 | 76.06 | 73.95 | 72.37 | 76.62 | 74.50 |
| T5 | 7.30 | 7.23 | 7.27 | 74.40 | 73.72 | 74.06 | 78.92 | 78.20 | 78.56 | 79.50 | 78.77 | 79.14 |
| T6 | 7.55 | 7.83 | 7.69 | 76.94 | 79.79 | 78.37 | 81.62 | 84.63 | 83.13 | 82.21 | 85.25 | 83.73 |
| T7 | 9.01 | 9.36 | 9.19 | 87.67 | 91.24 | 89.46 | 92.60 | 96.38 | 94.49 | 93.28 | 97.09 | 95.19 |
| T8 | 9.06 | 9.39 | 9.23 | 87.82 | 91.24 | 89.53 | 93.16 | 96.78 | 94.97 | 93.84 | 97.49 | 95.67 |
| T9 | 8.80 | 9.00 | 8.90 | 85.44 | 88.78 | 87.11 | 91.09 | 94.81 | 92.95 | 92.27 | 95.83 | 94.05 |
| T10 | 9.10 | 9.43 | 9.27 | 89.76 | 93.17 | 91.47 | 95.90 | 98.83 | 97.37 | 96.60 | 99.56 | 98.08 |
| T11 | 5.25 | 5.55 | 5.40 | 58.34 | 60.42 | 59.38 | 67.98 | 69.90 | 68.94 | 67.61 | 69.60 | 68.61 |
| T12 | 6.71 | 6.97 | 6.84 | 68.21 | 70.79 | 69.50 | 71.74 | 75.48 | 73.61 | 72.20 | 75.95 | 74.08 |
| F-test | ** | ** | ** | ** | ** | ** | ** | ** | ** | ** | ** | ** |
| S.Em ± | 0.59 | 0.59 | 0.42 | 3.37 | 4.71 | 2.89 | 3.17 | 3.83 | 2.97 | 2.76 | 3.58 | 2.26 |
| C.D. @ 5% | 1.72 | 1.74 | 1.19 | 9.88 | 13.80 | 8.25 | 9.31 | 11.24 | 8.91 | 8.11 | 10.51 | 6.45 |

Total dry matter output was significantly lower in (T11) when just the appropriate dosage of fertilisers was applied (5.40 g plant-1).

"In comparison to 100% K through Bio-K + balance NP through fertilisers for targeted yield of 25 t ha-1 total dry matter production was significantly higher with application of 50% K through Bio-K + 50% K through K2SO4 + balance NP through fertilisers at 45, 60 DAP, and harvest, respectively". Total dry matter production was significantly lower when just the prescribed dosage of fertilisers was used.

**Potato Production and Yield Characteristics**

Tables show the effects of applying different amounts of potassium via KCl, K2SO4, Bio-K, and their combinations on plant density, tuber yield, tuber girth, graded (A, B, C), and total tuber yield under site-specific nutrient management.

- **Number of tubers per plant**

Table detail the effect of site-specific nutrient management on the yield of potatoes in terms of tubers per plant and potassium supply. Significantly, the application of 50% K via Bio-K + 50% K via K2SO4 + balance NP via fertilisers for a targeted yield of 25 t ha-1 (T10: 5.03) resulted in the highest number of tubers per plant, matching the results of applications of 100% K via Bio-K + balance NP via fertilisers for a targeted yield of 25 t ha-1 (T8: 4.97), 100% K via K2SO4 + NP via fertilisers for a targeted yield The required dosage of fertilisers alone (T11) resulted in a much reduced tuber yield.

- **Tuber yield per plant**

Significantly higher tuber yield per plant (T10: 365.7 g plant-1) was recorded with application of 50% K through Bio-K + 50% K through K2SO4 + balance NP through fertilisers for targeted yield of 25 t ha-1 compared to 100% K through Bio-K + balance NP through fertilisers for targeted yield of 25 t ha-1 (T8: 352.5 g plant-1), 100% K through K2SO4 + NP through fertilisers for targeted yield of 25 t ha-1 ( There was a significant decrease in tuber production per plant (216.1 g plant-1) when just the appropriate amount of fertilisers was used (T11).

**Table 6: Number of tubers per plant, yield per plant, and tuber girth of potato in a sequential cropping system centred on potatoes as a staple crop as affected by site-specific nutrient management.**

| Treatments | Number of tubers plant-1 | | | Tuber yield (g plant-1) | | | Tuber girth (cm) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2020 | 2021 | Pooled | 2020 | 2021 | Pooled | 2020 | 2021 | Pooled |
| T1 | 3.13 | 3.33 | 3.23 | 221.4 | 234.6 | 228.3 | 10.2 | 10.7 | 10.4 |
| T2 | 3.86 | 3.93 | 3.90 | 235.1 | 255.1 | 245.6 | 10.8 | 11.3 | 11.0 |
| T3 | 4.00 | 4.06 | 4.03 | 252.8 | 270.4 | 261.8 | 11.0 | 11.4 | 11.2 |
| T4 | 3.80 | 3.86 | 3.83 | 225.3 | 245.3 | 235.5 | 10.5 | 11.0 | 10.7 |
| T5 | 3.93 | 4.00 | 3.97 | 248.2 | 266.2 | 257.3 | 11.1 | 11.3 | 11.2 |
| T6 | 4.00 | 4.06 | 4.03 | 259.5 | 273.1 | 266.2 | 11.5 | 11.6 | 11.5 |
| T7 | 4.86 | 4.93 | 4.90 | 340.6 | 359.8 | 350.1 | 12.0 | 12.3 | 12.2 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| T8 | 4.93 | 5.00 | 4.97 | 343.8 | 361.1 | 352.5 | 12.2 | 12.4 | 12.3 |
| T9 | 4.83 | 4.90 | 4.87 | 337.2 | 358.4 | 348.6 | 11.9 | 11.9 | 11.9 |
| T10 | 5.00 | 5.06 | 5.03 | 356.1 | 373.5 | 365.7 | 12.4 | 12.6 | 12.5 |
| T11 | 3.06 | 3.23 | 3.15 | 212.4 | 220.6 | 216.1 | 10.0 | 10.3 | 10.1 |
| T12 | 3.43 | 3.53 | 3.48 | 224.3 | 238.1 | 231.2 | 10.4 | 10.9 | 10.7 |
| F-test | ** | ** | ** | ** | ** | ** | ** | ** | ** |
| S.Em ± | 0.18 | 0.19 | 0.13 | 9.2. | 10.2 | 7.1 | 0.4 | 0.4 | 0.3 |
| C.D. @ 5% | 0.51 | 0.54 | 0.36 | 26.8 | 30.4 | 19.9 | 1.1 | 1.2 | 0.8 |

- **Total tuber yield per hectare**

Table shows how site-specific nutrient management affected the yield of tubers (t ha-1) when potassium was supplied from a variety of different sources and at varying concentrations. The highest tuber yield (T10:24.21 t ha-1) was achieved with the SSNM-recommended fertiliser application of 50% K via Bio-K + 50% K via K2SO4 + balance NP via fertilisers, which was on par with the 100% K via Bio-K + balance NP via fertilisers (T8: 23.61 t ha-1) and the 100% K via K2SO4 + NP via fertilisers (T7: 23.49 t ha-1) treatments. Table show that the yield of tubers was significantly reduced when just the prescribed amount of fertilisers was used in (T11). The percentage of nutrients in potato leaves, dry matter content, total carbs, specific gravity, and total yield were all improved by applying Bio-K to the soil or inoculating with tuber.

**Nutrient uptake by potato crop**

Due to the provision of potassium via KCl, K2SO4, and Bio-K and their combinations at varying amounts under site specific nutrient management in a potato based sequential cropping system, the findings related to total nitrogen, phosphorus, and potassium absorption by potato changed substantially.

- **Nitrogen uptake**

Table provide information on nitrogen uptake by potato (tubers, haulm, and total) in relation to the availability of potassium through various sources and levels under site specific nutrient management.

The application of 50% K via Bio-K + 50% K via K2SO4 + balance NP via fertilisers for targeted yield of 25 t ha-1 (T10: 115.73 kg ha-1) resulted in significantly higher total nitrogen uptake by the potato crop compared to 100% K via Bio-K + balance NP via fertilisers for targeted yield of 25 t ha-1 (T8: 106.87 kg ha-1) and 50% K via Bio-K + 50% K via KCl + balance (T1) 100% K through KCl + NP via fertilisers for aimed of 20 t ha-1 (76.97 kg ha-1) resulted in significantly reduced total nitrogen absorption. Increasing the amount of potassium applied to the soil makes more of that element available to the plant, which improves absorption, leaf size, and dry matter production, all of which have an effect on yield and quality.

- **Phosphorus uptake**

Table detail the effects of various potassium supplies and levels under site-specific nutrient management on the absorption of phosphorus by potato (tubers, haulm, and overall).

For a yield of 25 t ha-1 (T10: 31.83 kg ha-1), applying 50% K through Bio-K + 50% K via K2SO4 + balance NP via fertilisers resulted in significantly greater total phosphorus absorption by the potato crop than any of the other treatments. The prescribed amount of fertilisers alone (T11) resulted in significantly reduced total phosphorus absorption (15.25 kg ha).

- **Potassium uptake**

Table provide information on the effect of site-specific nutrient management on the potassium uptake by potato (tubers, haulm, and overall).

**Table 7: Nitrogen absorption (in kilogrammes per hectare) by potato tubers and haulm in a potato-based sequential cropping system as a result of site-specific nutrient management.**

| Treatments | Tubers | | | Haulm | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2020 | 2021 | Pooled | 2020 | 2021 | Pooled | 2020 | 2021 | Pooled |
| T1 | 67.59 | 71.22 | 69.40 | 7.33 | 7.80 | 7.56 | 74.92 | 79.01 | 76.97 |
| T2 | 68.88 | 74.66 | 71.77 | 7.73 | 8.17 | 7.95 | 76.61 | 82.83 | 79.72 |
| T3 | 73.88 | 76.14 | 75.01 | 8.23 | 8.69 | 8.46 | 82.11 | 84.82 | 83.47 |
| T4 | 71.94 | 77.35 | 74.64 | 7.95 | 8.42 | 8.19 | 79.89 | 85.77 | 82.83 |
| T5 | 80.21 | 78.95 | 79.58 | 8.88 | 8.95 | 8.91 | 89.09 | 87.89 | 88.49 |
| T6 | 80.39 | 84.74 | 82.56 | 8.89 | 9.22 | 9.05 | 89.28 | 93.95 | 91.62 |
| T7 | 89.78 | 92.74 | 91.26 | 10.18 | 10.68 | 10.43 | 99.95 | 103.42 | 101.68 |
| T8 | 94.04 | 98.41 | 96.23 | 10.49 | 10.80 | 10.64 | 104.53 | 109.21 | 106.87 |
| T9 | 92.30 | 96.81 | 94.55 | 10.37 | 10.98 | 10.68 | 102.67 | 107.79 | 105.23 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| T10 | 102.75 | 105.13 | 103.94 | 11.66 | 11.93 | 11.79 | 114.41 | 117.06 | 115.73 |
| T11 | 68.24 | 71.00 | 69.62 | 7.80 | 8.11 | 7.96 | 76.04 | 79.12 | 77.58 |
| T12 | 76.43 | 80.87 | 78.65 | 8.61 | 9.18 | 8.89 | 85.04 | 90.05 | 87.54 |
| F-test | ** | ** | ** | ** | ** | ** | ** | ** | ** |
| S.Em ± | 5.10 | 5.34 | 3.70 | 0.55 | 0.55 | 0.39 | 5.53 | 4.96 | 3.72 |
| C.D. @ 5% | 14.96 | 15.67 | 10.53 | 1.61 | 1.62 | 1.11 | 16.23 | 14.55 | 10.59 |

**Table 8: Phosphorus absorption (in kilogrammes per hectare) by potato tubers and haulm in a sequential cropping system based on potatoes as a crop**

| Treatments | Tubers | | | Haulm | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| | **2020** | **2021** | **Pooled** | **2020** | **2021** | **Pooled** | **2020** | **2021** | **Pooled** |
| T1 | 13.85 | 14.48 | 14.16 | 1.16 | 1.34 | 1.25 | 15.01 | 15.82 | 15.41 |
| T2 | 13.78 | 14.08 | 13.93 | 1.27 | 1.28 | 1.27 | 15.54 | 15.35 | 15.45 |
| T3 | 15.37 | 15.48 | 15.42 | 1.17 | 1.36 | 1.27 | 16.53 | 16.84 | 16.69 |
| T4 | 15.74 | 17.26 | 16.50 | 1.17 | 1.31 | 1.24 | 16.91 | 18.57 | 17.74 |
| T5 | 17.89 | 17.14 | 17.51 | 1.36 | 1.28 | 1.32 | 19.25 | 18.41 | 18.83 |
| T6 | 17.86 | 18.54 | 18.20 | 1.48 | 1.61 | 1.55 | 19.35 | 20.15 | 19.75 |
| T7 | 22.44 | 22.62 | 22.53 | 1.85 | 1.93 | 1.89 | 24.29 | 24.55 | 24.42 |
| T8 | 21.87 | 24.22 | 23.05 | 2.03 | 2.02 | 2.02 | 23.90 | 26.24 | 25.07 |
| T9 | 24.14 | 25.87 | 25.00 | 2.06 | 2.23 | 2.14 | 27.53 | 28.10 | 27.81 |
| T10 | 29.25 | 29.37 | 29.31 | 2.44 | 2.60 | 2.52 | 31.69 | 31.98 | 31.83 |
| T11 | 13.44 | 13.55 | 13.50 | 1.74 | 1.76 | 1.75 | 15.18 | 15.31 | 15.25 |
| T12 | 21.36 | 21.10 | 21.23 | 1.96 | 2.04 | 2.00 | 23.31 | 23.14 | 23.22 |
| F-test | ** | ** | ** | ** | ** | ** | ** | ** | ** |
| S.Em ± | 0.67 | 0.88 | 0.56 | 0.07 | 0.08 | 0.06 | 0.73 | 0.83 | 0.55 |
| C.D. @ 5% | 1.97 | 2.58 | 1.58 | 0.21 | 0.26 | 0.16 | 2.15 | 2.43 | 1.58 |

**Table 9: Potassium absorption (in kilogrammes per hectare) by potato tubers and haulm in a sequential cropping system based on potatoes as a crop**

| Treatments | Tubers | | | Haulm | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| | **2020** | **2021** | **Pooled** | **2020** | **2021** | **Pooled** | **2020** | **2021** | **Pooled** |
| T1 | 91.96 | 97.27 | 94.62 | 14.15 | 14.85 | 14.50 | 106.11 | 112.12 | 109.12 |
| T2 | 91.84 | 97.92 | 94.88 | 14.85 | 15.90 | 15.38 | 106.69 | 113.82 | 110.26 |
| T3 | 95.74 | 100.90 | 98.32 | 15.64 | 16.23 | 15.93 | 111.38 | 117.12 | 114.25 |
| T4 | 96.66 | 101.75 | 99.20 | 15.26 | 16.28 | 15.77 | 111.92 | 118.03 | 114.97 |
| T5 | 106.74 | 105.26 | 106.00 | 16.83 | 16.76 | 16.79 | 123.57 | 122.02 | 122.79 |
| T6 | 111.65 | 115.19 | 113.42 | 17.12 | 17.66 | 17.39 | 128.77 | 132.85 | 130.81 |
| T7 | 125.25 | 131.20 | 128.22 | 21.36 | 22.31 | 21.84 | 146.61 | 153.51 | 150.06 |
| T8 | 128.30 | 133.23 | 130.77 | 22.00 | 22.65 | 22.32 | 150.30 | 155.88 | 153.09 |
| T9 | 122.12 | 128.59 | 125.35 | 21.23 | 22.31 | 21.77 | 143.35 | 150.89 | 147.12 |
| T10 | 131.25 | 136.05 | 133.65 | 23.32 | 23.95 | 23.63 | 154.57 | 160.00 | 157.28 |
| T11 | 87.37 | 91.06 | 89.21 | 15.60 | 16.29 | 15.95 | 102.97 | 107.35 | 105.16 |
| T12 | 100.04 | 104.31 | 102.17 | 17.28 | 18.09 | 17.68 | 117.31 | 122.40 | 119.86 |
| F-test | ** | ** | ** | ** | ** | ** | ** | ** | ** |
| S.Em ± | 4.60 | 4.40 | 3.19 | 0.71 | 0.75 | 0.52 | 5.19 | 5.51 | 3.79 |
| C.D. @ 5% | 13.50 | 12.91 | 9.08 | 2.08 | 2.21 | 1.48 | 15.22 | 16.17 | 10.79 |

**Properties of the soil after a potato harvest**

The ph, EC, OC, aN, pO2, pO3, k2O, sB, eCa, eMg, and DTPA extractable values of soil were measured. Zn, Cu, Fe, and Mn levels in soil after potato harvest

The pH level of the soil was not significantly different following the potato harvest. All of the study's treatments had pH levels between 6.69 and 6.99. Nonetheless, the pH of the T12 package of practise recommendations was measured at 6.99. The electrical conductivity of the soil was not significantly different before and after the potato harvest. In all of the study's treatments, the EC fluctuated between 0.206 and 0.230 dSm-1. However, a package of practise advice (T12) was found to have an EC of 0.230 dSm-1.

Soil organic carbon content changed greatly as a result of site-specific fertiliser management in a potato-based sequential cropping system, with potassium supplied in varying amounts through KCl, K2SO4, and Bio-K, and their combinations. All of the plots that were given Bio-K as their potassium supply ended up with a far greater percentage of organic carbon than the plots that were given KCl.

**Table 9:Site-specific nutrient management in a potato-based sequential cropping system and its effects on post-harvest soil pH, electrical conductivity (EC), and organic carbon (OC)**

| Treatments | Soil pH | | | EC(dSm-1) | | | OC (%) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2020 | 2021 | Pooled | 2020 | 2021 | Pooled | 2020 | 2021 | Pooled |
| T1 | 6.65 | 7.12 | 6.89 | 0.174 | 0.251 | 0.213 | 0.48 | 0.47 | 0.47 |
| T2 | 6.71 | 7.05 | 6.88 | 0.180 | 0.231 | 0.206 | 0.47 | 0.48 | 0.48 |
| T3 | 6.76 | 7.08 | 6.92 | 0.186 | 0.244 | 0.215 | 0.51 | 0.52 | 0.52 |
| T4 | 6.80 | 7.06 | 6.93 | 0.185 | 0.232 | 0.209 | 0.49 | 0.50 | 0.50 |
| T5 | 6.75 | 7.03 | 6.89 | 0.193 | 0.261 | 0.227 | 0.52 | 0.50 | 0.51 |
| T6 | 6.73 | 6.92 | 6.83 | 0.195 | 0.238 | 0.217 | 0.53 | 0.45 | 0.49 |
| T7 | 6.78 | 6.91 | 6.85 | 0.213 | 0.245 | 0.229 | 0.50 | 0.44 | 0.47 |
| T8 | 6.75 | 7.06 | 6.91 | 0.184 | 0.253 | 0.219 | 0.54 | 0.53 | 0.54 |
| T9 | 6.70 | 6.96 | 6.83 | 0.184 | 0.230 | 0.207 | 0.48 | 0.48 | 0.48 |
| T10 | 6.69 | 7.01 | 6.85 | 0.192 | 0.245 | 0.219 | 0.51 | 0.49 | 0.50 |
| T11 | 6.58 | 6.80 | 6.69 | 0.213 | 0.213 | 0.213 | 0.39 | 0.36 | 0.38 |
| T12 | 6.87 | 7.10 | 6.99 | 0.185 | 0.274 | 0.230 | 0.40 | 0.48 | 0.44 |
| F-test | NS | NS | NS | NS | NS | NS | ** | ** | ** |
| S.Em ± | 0.27 | 0.29 | 0.20 | 0.008 | 0.010 | 0.007 | 0.03 | 0.02 | 0.02 |
| C.D. @ 5% | NS | NS | NS | NS | NS | NS | 0.08 | 0.06 | 0.05 |
| Initial | 6.82 | 7..05 | - | 0.260 | 0.182 | - | 0.45 | 0.38 | - |

## 4. Conclusion

In order to achieve a yield of 25 t ha-1, it was found that applying 50% K through Bio-K + 50% K via K2SO4 + balancing NP via fertilisers considerably increased the plant height, number of leaves, and leaf area index of the harvested potatoes (to 72.94 cm, 4.24, 16.64, and 0.75, respectively). Significantly greater total dry matter production (91.47, 97.37, and 98.08 g plant-1) was reported at 45 DAP, 60 DAP, and harvest while applying 50% K via Bio-K + 50% K through K2SO4 + balance NP through fertilisers for intended yield of 25 t ha-1.

The application of 50% K through Bio-K + 50% K via K2SO4 + balance NP via fertilisers fo desired yield of 25 t ha-1 (24.21 t ha-1) considerably increased total tuber yield (t ha-1) of potato compared to other treatments in the research. The prescribed dosage of fertilisers resulted in a lower tuber yield (16.84 t ha-1). For a yield of 25 t ha-1 (115.73 and 157.28 kg ha-1), the most effective treatment for increasing potato total nutrient intake (N and K) was the application of 50% K via Bio-K + 50% K through K2SO4 + balance NP through fertilisers. However, with a yield of 25 t ha-1 (31.83 kg ha-1), the application of 50% K through Bio-K + 50% K via K2SO4 + balance NP via fertilisers resulted in much higher total phosphorous absorption by the potato crop than did the other treatments. In order to achieve the desired yield of 25 t ha-1 (0.54%), the organic carbon status of the soil was found to be much greater with 100% K via Bio-K + balancing NP through fertilisers. Fertiliser plots following package of practise recommendations had significantly greater accessible nitrogen, phosphorus, and potassium (266.66, 96.76, and 460.08 kg ha-1, respectively). With only RDF, the levels of accessible nitrogen (241.90 kg ha-1), phosphorus (82.21 kg ha-1), and potassium (430.31 kg ha-1) were all much lower.

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