**Effect of zinc nutrition on productivity, quality and biofortification in potato (*Solanum Tuberosum*)**

**ABSTRACT**

An experiment was conducted during winter (rabi) seasons of 2022–23 at Vegetable Research Farm, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, (UP), India to assess effect of zinc nutrition on growth and yield of potato (Solanum tuberosum L.) through soil and foliar zinc sulphate application. The experiment consisted of 7 treatment combination of soil and foliar applications ; T1 (Control i.e No Zinc, Only RDF), T2 (RDF + 2.5 Kg Zn/ha from zinc sulphate at the time of planting) , T3 (RDF+5.0 Kg Zn/ha from zinc sulphate at the time of planting) , T4 ( RDF + Foliar application of Zinc Sulphate @ 2g/lt (400 ppm Zn) at 25 days after planting) , T5 (RDF + Foliar application of Zinc Sulphate @ 2g/lt (400 ppm Zn) at 25 and 50 days after planting) , T6 (RDF + T2+ Foliar application of Zinc Sulphate @ 2g/lt (400 ppm Zn) at 25 days after planting) , T7 (RDF + T2+ Foliar application of Zinc Sulphate @ 2g/lt (400 ppm Zn) at 25 and 50 days after planting ) in a randomized block design with 3 replications. The results revealed that the application of ZnSO4 @2.5 kg/ha at the time of planting and foliar application of zinc sulphate @0.2% at 25 and 50 DAP (T7) gave significantly higher total tuber yield, and number of tubers. The benefit-cost analysis of tuber production under different basal soil application levels and foliar application revealed highest benefit-cost ratio of 1.671 with treatment T7 followed by T6 (1.629) and T3 (1.57). The experiment highlights the importance of soil and foliar zinc sulphate application for improved tuber yield and zinc fortification in a sustainable and cost-effective manner.

**Keywords**: Potato, Biofortication, Tuber yield, Zinc

**INTRODUCTION**

Potato (Solanum tuberosum L.) is one of the main food crops worldwide. Its production at global level reached at 366.2 million tonnes (Mt), covering 17.6 million ha (Mha) with a yield of 20.8 t/ha during triennium ending (TE) 2018. India is the second largest contributor after China, both in area and production of potato. It contributed over 12% share in both area and production of potato with a yield of 21.8 t/ha during TE 2018. The total area in world under potato cultivation is 19.303 m/ha and total production is 388.19 million tonnes with 20.11 tonnes productivity. Where as in India, the total area is 1.843million ha and production is 50.33 million tonnes with 27.31tonnes productivity. India produces potato crop annually in two harvest seasons, kharif and rabi. Kharif produces is available in to market from August to October which accounts for 15-20 per cent. The rabi crop is harvested from mid-December to mid-April, which account for 80% to 85%. Potato production in India reached at 53.03 Mt from harvested area of 2.2 Mha in 2019-20. The eastern region of India is the key potato producing tract and accounts for about 72% of total output in 2019.

The potato, also referred to as the "king of vegetables," can significantly augment the nation's food requirements since it yields more dry matter, balanced proteins, and calories per unit area of land and time than other important food crops. Without a doubt, if potatoes are recognized as a major food in our nation and are no longer only a vegetable, the problem of malnutrition and undernutrition can be substantially resolved. However, because potatoes are somewhat susceptible to zinc shortage, potato output is restricted in soils lacking in zinc. Because zinc increases the synthesis of growth hormones and chlorophyll, it is essential for the general growth and development of potatoes (**Ali *et al.,* 2008**). Around 49 % of Indian soils are deficient in zinc and the repeated practice of paddy-wheat crop rotation in the Tarai region of Uttarakhand has further led to diminution of zinc in the soil (**Sharma *et al*., 2013).** Worldwide, micronutrient insufficiency is the most prevalent nutritional issue. One of the micronutrients, zinc (Zn), directly affects the functioning of over 300 biological enzymes and is crucial for the function of the human immune system. The deliberate addition of essential micronutrients, like vitamins and minerals, to regular meals is known as fortification. The goal is to improve the nutritional value of the meal while posing little risk to public health. Biofortification is the process of improving the nutritional quality of food crops by conventional plant breeding, contemporary agronomic methods, and biotechnology. In contrast to traditional fortification, biofortification aims to increase the amounts of essential nutrients in staple food crops while the plants are still growing rather than after the crops have been manually processed.

Therefore, to reduce the micronutrient malnutrition globally, there is an urgent need to improve the world’s most consumed non-grain food crop ‘Potato’. It is already a rich source of micronutrients **(Navarre *et al*., 2019)**, especially when consumed along with skin. Its biofortification could be a boon for people suffering from hidden hunger. More than 50% potatoes are produced by developing countries, where the micronutrient malnutrition is highly prevalent **(Perez et al., 2018;).** Hence, from the standpoint of human health, the significance of micronutrient biofortification in potatoes increases since a greater proportion of the global population consumes them in big quantities. An adult male human's daily need of 5.5% can be met by 200 g fresh weight (FW) of unpeeled potato tubers (i.e., around 11 mg Zn). Moreover, potato tubers may have a high bioavailability of zinc due to their comparatively large amounts of organic molecules that promote zinc absorption and low concentrations of chemicals that inhibit zinc absorption. Increasing the concentration of Zn in tubers through fertilization may be an easy way to boost the amount of bioavailable zinc in diets high in potatoes.

**MATERIAL AND METHOD**

The experiment entitled was conducted at vegetable research farm of Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya (U.P.) to study **“the effect of zinc nutrition on productivity, quality and biofortification in potato (*Solanum tuberosum* L.)”** The university situated in Ayodhya-Raibareli Road, about 55 km away from Ayodhya at 260 47' N latitude, 820 12' E longitude and, an altitude of 113 m above the mean sea level. There is approximately 1001 mm of rainfall annually, with the majority falling between mid-June and the end of September. The minimum temperature reaches as low as 3℃ during mid- January. Land preparation was started after harvesting of Kharif crop. One ploughing was done by disc plough followed by two ploughing by tractor drawn cultivator and planking was done invariably after each ploughing to get the fine seed bed. The potato crop was planted with seeds of cultivar Kufri Garima having uniform tubers of 25-30 g size at a spacing of 60 cm × 20 cm on the ridges at the rate of 25 q/ha. Half does of nitrogen (urea) was applied as basal and remaining half was applied as top dressing through urea. Full dose of phosphorus and potassium was applied at the time of sowing potato tubers. Soil application of zinc was applied at the time of sowing and foliar spray was spraying in standing crop as per treatment.

**RESULT AND DISCUSSION**

In order to understand how the zinc nutrition affect the productivity, quality and biofortification of potato over time, the following parameters were monitored.

The maximum Plant emergence of 97.22 % at DAS was observed with control T1 Treatment followed by T4 treatment (Foliar application of Zinc Sulphate @ 2g/lt (400 ppm Zn) at 25 days after planting) Plant emergence at 30 DAS, 96.91 % which was at par with T5 treatment (Foliar application of Zinc Sulphate @ 2g/lt (400 ppm Zn) at 25 and 50 days after planting). While minimum was recorded in T7 treatment (T2+ Foliar application of Zinc Sulphate @ 2g/lt (400 ppm Zn) at 25 and 50 days after planting) with plant emergence at 30 DAS, 96.29 %.

Table No. 1: Effect of various treatments of zinc application on plant emergence (30 DAS).

|  |  |
| --- | --- |
| **Treatments** | **Plant emergence (%)** |
| **T1-** No Zinc (Control) | 97.22 |
| **T2-** 2.5 Kg Zn/ha from zinc sulphate at the time of planting | 95.68 |
| **T3-** 5.0 Kg Zn/ha from zinc sulphate at the time of planting | 95.68 |
| **T4-** Foliar application of Zinc Sulphate @ 2g/lt (400 ppm Zn) at  25 days after planting | 96.91 |
| **T5-** Foliar application of Zinc Sulphate @ 2g/lt (400 ppm Zn) at  25 and 50 days after planting | 96.91 |
| **T6-** T2 + Foliar application of Zinc Sulphate @ 2g/lt (400 ppm  Zn) at 25 days after planting | 96.60 |
| **T7-** T2 + Foliar application of Zinc Sulphate @ 2g/lt (400 ppm  Zn) at 25 and 50 days after planting | 96.29 |
| **SEm ±** | 1.20 |
| **CD at 5 %** | NA |

The plant height was found to be significantly affected by the application of zinc sulphate to crop, either soil application as well as foliar, or combined soil and foliar application in potato. The highest plant height was recorded in the treatment T7 (T2+ Foliar application of Zinc Sulphate @ 2g/lt (400 ppm Zn) at 25 and 50 days after planting) of 58.08 cm that was at par with the treatment T6 (T2+ Foliar application of Zinc Sulphate @ 2g/lt (400 ppm Zn) at 25 days after planting) of 57.77cm and T3 (56.98 cm) significantly superior to control (53.67 cm) as well as treatment T2 (54.87 cm) . **Al Jobory and Al-Hadithy (2014) and Rakshya and Arjun (2019)** also reported increase in plant height with adequate supply of zinc in potato (either through soil application or foliar application) resulted from increased internodal distance.

**Table No. 2: Effect of various treatments of zinc application on plant height(cm).**

|  |  |  |
| --- | --- | --- |
| **Treatments** | **Plant Height (cm)** | |
| **30 DAS** | **60 DAS** |
| **T1-** No Zinc (Control) | 24.12 | 53.67 |
| **T2-** 2.5 Kg Zn/ha from zinc sulphate at the time of planting | 24.34 | 54.87 |
| **T3-** 5.0 Kg Zn/ha from zinc sulphate at the time of planting | 25.08 | 56.98 |
| **T4-** Foliar application of Zinc Sulphate @ 2g/lt (400 ppm  Zn) at 25 days after planting | 24.53 | 55.21 |
| **T5-** Foliar application of Zinc Sulphate @ 2g/lt (400 ppm  Zn) at 25 and 50 days after planting | 24.81 | 56.54 |
| **T6-** T2 + Foliar application of Zinc Sulphate @ 2g/lt (400 ppm Zn) at 25 days after planting | 25.33 | 57.77 |
| **T7-** T2 + Foliar application of Zinc Sulphate @ 2g/lt (400 ppm Zn) at 25 and 50 days after planting | 25.65 | 58.08 |
| **SEm±** | **0.30** | **0.88** |
| **C.D. at 5%** | **NA** | **2.74** |

Total number of leaves was found to be significantly affected by the application of zinc sulphate with maximum number of leaves per plant in T7at 30 DAS (32.81) and 60 DAS (48.52) followed by T6 having number of leaves per plant at 30 DAS (31.50) and 60 DAS (48.25) and T3 with number of leaves per plant at 30DAS (30.51) and at 60DAS (47.74).

**Table No.3: Effect of various treatments of zinc application on number of leaves plant-1.**

|  |  |  |
| --- | --- | --- |
| **Treatments** | **Number of leaves** | |
| **30 DAS** | **60DAS** |
| **T1-** No Zinc (Control) | 24.51 | 43.63 |
| **T2-** 2.5 Kg Zn/ha from zinc sulphate at the time of planting | 28.24 | 46.82 |
| **T3-** 5.0 Kg Zn/ha from zinc sulphate at the time of planting | 30.51 | 47.74 |
| **T4-** Foliar application of Zinc Sulphate @ 2g/lt (400 ppm  Zn) at 25 days after planting | 27.32 | 46.54 |
| **T5-** Foliar application of Zinc Sulphate @ 2g/lt (400 ppm  Zn) at 25 and 50 days after planting | 28.80 | 47.12 |
| **T6-** T2 + Foliar application of Zinc Sulphate @ 2g/lt (400 ppm Zn) at 25 days after planting | 31.50 | 48.25 |
| **T7-** T2 + Foliar application of Zinc Sulphate @ 2g/lt (400 ppm Zn) at 25 and 50 days after planting | 32.81 | 48.52 |
| **SEm±** | **0.51** | **0.91** |
| **C.D. at 5%** | **1.60** | **2.82** |

The data pertaining to tuber number per plot (0-25, 25-50, 50-75 and >75) have been recorded, the treatment T7 give best result followed by T6 treatment. While minimum tuber number per plot in each grade was found under treatment T1.

During crop growth stages, the introduction of micronutrient fertilizers greatly boosts the nutrient content of foliage; in contrast, later growth phases see an increase in the translocation of nutrients, which improves number of tubers per plant and hence number of tubers per plot. Achieving improved tuber yield. These findings are similar to the findings of **Nagar *et al.,* (2023) and Tiwari *et al.,* (2023).**

**Table No. 4: Effect of various treatments of zinc application on number of tubers plot-1.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Treatments** | **Number of tuber plot-1** | | | |
| **0-25** | **25-50** | **50-75** | ➢ **75** |
| **T1-** No Zinc (Control) | 105.92 | 97.60 | 85.69 | 62.79 |
| **T2-** 2.5 Kg Zn/ha from zinc sulphate at the time of planting | 106.99 | 105.98 | 93.98 | 71.33 |
| **T3-** 5.0 Kg Zn/ha from zinc sulphate at the time of planting | 117.05 | 103.24 | 91.24 | 65.38 |
| **T4-** Foliar application of Zinc Sulphate @ 2g/lt (400 ppm Zn) at  25 days after planting | 115.07 | 99.50 | 87.50 | 76.81 |
| **T5-** Foliar application of Zinc Sulphate @ 2g/lt (400 ppm Zn) at  25 and 50 days after planting | 111.10 | 101.56 | 89.56 | 79.86 |
| **T6-** T2 + Foliar application of Zinc Sulphate @ 2g/lt (400 ppm  Zn) at 25 days after planting | 117.51 | 105.22 | 93.22 | 74.68 |
| **T7-** T2 + Foliar application of Zinc Sulphate @ 2g/lt (400 ppm  Zn) at 25 and 50 days after planting | 112.93 | 98.82 | 86.82 | 70.41 |
| **SEm±** | **4.81** | **3.82** | **3.25** | **1.89** |
| **C.D. at 5%** | **NA** | **NA** | **NA** | **5.68** |

The maximum tuber yield on fresh weight basis (26.86 t/ha) was recorded T7 treatment (T2 + Foliar application of Zinc Sulphate @ 2g/lt (400 ppm Zn) at 25 and 50 days after planting), which was significantly superior over rest of the treatments. However minimum tuber yield (21.48 t/ha) was recorded in control plot.

The application of micro-nutrients fertilizers significantly increases nutrient content of foliage during stages of crop growth, while the translocation of integrates increase during later growth phases, resulting in yield improvements. Zinc plays a very significant role in realizing better tuber yield as well as quality. When zinc sulphate is applied as both soil and foliar application, it enhances the availability of zinc to the plants. This increased zinc availability promotes healthier plant growth. These findings are similar to the findings of **Ram *et al.,* (2013), Mahmud *et al.,* (2021), Nagar *et al.,* (2023).**

The maximum haulm weight on fresh weight basis of 16.26 t/ha was recorded with T7 treatment (T2+ Foliar application of Zinc Sulphate @ 2g/lt (400 ppm Zn) at 25 and 50 days after planting), which was significantly superior over rest of the treatments. However minimum tuber yield (14.99 t/ha) was recorded in control plot.

Higher biological yield (t/ha) was recorded maximum, 43.12 t/ha with T7 treatment (T2 + Foliar application of Zinc Sulphate @ 2g/lt (400 ppm Zn) at 25 and 50 days after planting) followed by T6 treatment (T2 + Foliar application of Zinc Sulphate @ 2g/lt (400 ppm Zn) at 25 days after planting) with biological yield 42.55 t/ha. The control (T1) treatment registered minimum biological yield 36.47 t/ha during the study. Biological yield in the top four treatments followed the order T7> T6> T3> T5. These results corroborate with the findings of **Nagar *et al.,* (2023), Tiwari *et al*., (2023).**

**Table No. 5: Effect of various treatments of zinc application on yield and yield attributes on fresh weight basis.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Treatments** |  | **Fresh weight basis** | |  |
| **Tuber yield**  **(t ha-1)** | **Halum Yield**  **(t ha-1)** | **Biological Yield (t ha-1)** | **HI (%)** |
| **T1-** No Zinc (Control) | 21.48 | 14.99 | 36.47 | 58.89 |
| **T2-** 2.5 Kg Zn/ha from zinc sulphate at the time of planting | 24.36 | 15.82 | 40.18 | 60.62 |
| **T3-** 5.0 Kg Zn/ha from zinc sulphate at the time of planting | 25.88 | 16.03 | 41.91 | 61.75 |
| **T4-** Foliar application of Zinc Sulphate @ 2g/lt (400 ppm Zn) at  25 days after planting | 23.40 | 15.72 | 39.12 | 59.81 |
| **T5-** Foliar application of Zinc Sulphate @ 2g/lt (400 ppm Zn) at  25 and 50 days after planting | 25.21 | 15.91 | 41.12 | 61.30 |
| **T6-** T2 + Foliar application of Zinc Sulphate @ 2g/lt (400 ppm  Zn) at 25 days after planting | 26.40 | 16.15 | 42.55 | 62.04 |
| **T7-** T2 + Foliar application of Zinc Sulphate @ 2g/lt (400 ppm  Zn) at 25 and 50 days after planting | 26.86 | 16.26 | 43.12 | 62.29 |
| **SEm±** | **0.65** | **0.21** | **0.66** | **0.53** |
| **C.D. at 5%** | **1.43** | **0.64** | **2.07** | **1.61** |

Higher Harvest index (%) was recorded maximum, 62.29% with T7 treatment (T2 + Foliar application of Zinc Sulphate @ 2g/lt (400 ppm Zn) at 25 and 50 days after planting) followed by T6 treatment (T2 +Foliar application of Zinc Sulphate @ 2g/lt (400 ppm Zn) at 25 days after planting) with harvest index, 62.04 %. The control (T1) treatment registered minimum harvest index,58.89 % during the study.

The harvest index in potatoes can increase with soil application of zinc and foliar application of zinc because zinc is essential for various metabolic processes, including photosynthesis and carbohydrate metabolism. By ensuring adequate zinc availability in the soil and through foliar application, plants can efficiently convert sunlight into energy and allocate more resources towards tuber formation, ultimately increasing the harvest index. Additionally, zinc plays a role in hormone regulation, which can further enhance tuber development. These results corroborate with the findings of **Lenka *et al.,(*2020).**

The data pertaining to tuber yield grade wise (0-25, 25-50, 50-75 and >75) have been recorded, the treatment T7 give best result as compare to other treatments. The maximum tuber yield in each grade i.e. 0-25g (2.29 t/ha), 25-50g (6.54 t/ha), 50-75g (8.54 t/ha) and >75g (9.49 t/ha) respectively. While minimum tuber yield in each grade size 0-25g (2.03 t/ha), 25-50g (4.92 t/ha), 50-75g (6.92 t/ha) and >75g (7.62 t/ha) was found under treatment T1.

During crop growth stages, the introduction of micronutrient fertilizers greatly boosts the nutrient content of foliage; in contrast, later growth phases see an increase in the translocation of nutrients, which improves tuber yield. Achieving improved tuber yield. These findings are similar to the findings of **Nagar *et al.,* (2023) and Tiwari *et al.,* (2023).**

**Table No. 6: Effect of various treatments of zinc application on tuber yield of potato (t ha1) as grade wise.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Treatments** |  |  | **Tuber grades** |  |
| **0-25 g** | **25-50 g** | **50-75 g** | ➢ **75 g** |
| **T1-** No Zinc (Control) | 2.03 | 4.92 | 6.92 | 7.62 |
| **T2-** 2.5 Kg Zn/ha from zinc sulphate at the time of planting | 2.13 | 6.06 | 8.06 | 8.12 |
| **T3-** 5.0 Kg Zn/ha from zinc sulphate at the time of planting | 2.28 | 6.31 | 8.31 | 8.98 |
| **T4-** Foliar application of Zinc Sulphate @ 2g/lt (400 ppm Zn) at  25 days after planting | 2.09 | 5.83 | 7.83 | 7.66 |
| **T5-** Foliar application of Zinc Sulphate @ 2g/lt (400 ppm Zn) at  25 and 50 days after planting | 2.21 | 6.29 | 8.29 | 8.43 |
| **T6-** T2 + Foliar application of Zinc Sulphate @ 2g/lt (400 ppm  Zn) at 25 days after planting | 2.28 | 6.52 | 8.52 | 9.08 |
| **T7-** T2 + Foliar application of Zinc Sulphate @ 2g/lt (400 ppm  Zn) at 25 and 50 days after planting | 2.29 | 6.54 | 8.54 | 9.49 |
| **SEm±** | **0.05** | **0.08** | **0.09** | **0.11** |
| **C.D. at 5%** | **0.18** | **0.25** | **0.28** | **0.36** |

Higher cost of cultivation of Rs. 90500 ha-1 was recorded with the application of T7treatment (T2+ Foliar application of Zinc Sulphate @ 2g/lt (400 ppm Zn) at 25 and 50 days after planting) followed by the application of T6 treatment (T2+ Foliar application of Zinc Sulphate @ 2g/lt (400 ppm Zn) at 25 days after planting) with cost of cultivation of Rs. 90366 ha-1. Lowest cost of cultivation was recorded with control treatment (T1, depicted in Table No.7 & Fig No.1. The highest cost of cultivation in zinc-applied soil may be due to the additional expense of purchasing and applying zinc supplements, along with potential increases in other related agricultural inputs and management practices to maximize the benefits of zinc application. These findings are similar to the findings of Nagar *et al*., (2023)

Higher gross returns of Rs. 130541 ha-1 were recorded with the application of with the application of T7treatment (T2+ Foliar application of Zinc Sulphate @ 2g/lt (400 ppm Zn) at 25 and 50 days after planting) followed by the application of T6 treatment (T2+ Foliar application of Zinc Sulphate @ 2g/lt (400 ppm Zn) at 25 days after planting )with gross return of Rs 127155 ha 1 . Lower gross return of Rs. 95387 ha-1 was obtained with control treatment plot (T1), depicted in Table No.7 & Fig No.1. Gross return is higher with zinc-applied soil because zinc enhances plant growth, yield, and quality by improving nutrient uptake (nitrogen, phosphorus, and potassium), boosting photosynthesis, and increasing resistance to stress. This results in higher crop productivity and better market value, leading to greater financial returns. These findings are similar to the findings of Nagar et al., (2023)

Higher net return of Rs. 151214.6776 ha-1 was recorded with the application of T7 treatment (T2+ Foliar application of Zinc Sulphate @ 2g/lt (400 ppm Zn) at 25 and 50 days after planting) followed by the application of T6 treatment (T2+ Foliar application of Zinc Sulphate @ 2g/lt (400 ppm Zn) at 25 days after planting ) with net return of Rs.147206.0165 ha-1. Lowest net return of Rs.103235.8985 ha-1 was recorded with control treatment (T1), depicted in Table No.7 & Fig No.1. Net return is higher in zinc-applied soil because the increased yield and quality of crops due to improved nutrient uptake and plant health outweigh the additional costs of zinc application, resulting in greater profits for farmers. These findings are similar to the findings of Yadav et al., (2021), Nagar et al., (2023)

Higher B:C ratio of 1.671 was recorded with the application of T7treatment (T2+ Foliar application of Zinc Sulphate @ 2g/lt (400 ppm Zn) at 25 and 50 days after planting) followed by the application of T6 treatment (T2+ Foliar application of Zinc Sulphate @ 2g/lt (400 ppm Zn) at 25 days after planting ) with B:C ratio of 1.629. Lowest B:C ratio of 1.146 was recorded with control treatment (T1), depicted in Table No7 & Fig No.1. These findings are similar to the findings of Yadav et al., (2021), Nagar et al., (2023) The benefit-cost (B:C) ratio is higher in zinc-applied potato-cultivated soil because the increased yield and quality of potatoes due to zinc application outweigh the additional costs of zinc supplements, leading to greater profitability.

**Table No. 8: Economics of various treatments influenced by zinc level.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Treatments** | **Cost of cultivation (Rs/ha)** | **Gross return (Rs/ha)** | **Net return (Rs/ha)** | **B:C ratio** |
| **T1-** No Zinc (Control) | 90070 | 193305 | 103235 | 1.14 |
| **T2-** 2.5 Kg Zn/ha from zinc sulphate at the time of planting | 90165 | 219245 | 129080 | 1.43 |
| **T3-** 5.0 Kg Zn/ha from zinc sulphate at the time of planting | 90422 | 232962 | 142540 | 1.57 |
| **T4-** Foliar application of Zinc Sulphate @ 2g/lt (400 ppm Zn) at  25 days after planting | 90105 | 210617 | 120512 | 1.33 |
| **T5-** Foliar application of Zinc Sulphate @ 2g/lt (400 ppm Zn) at  25 and 50 days after planting | 90198 | 226899 | 136701 | 1.51 |
| **T6-** T2 + Foliar application of Zinc Sulphate @ 2g/lt (400 ppm  Zn) at 25 days after planting | 90366 | 237572 | 147206 | 1.62 |
| **T7-** T2 + Foliar application of Zinc Sulphate @ 2g/lt (400 ppm  Zn) at 25 and 50 days after planting | 90500 | 241714 | 151214 | 1.67 |

**CONCLUSION:**

The current study concludes that applying zinc sulphate enhances tuber production and related quality measures. It was discovered that the best way to increase yield and biofortify zinc in potato cultivation for sustainable tuber production was to apply zinc sulphate topically in addition to soil.

**REFERENCE**

**Al-Fadhly, J. T., Ahmed, F. W., & Abd, W. M. (2019).** Effect of spraying with zinc and manganese at different stage of potato growth on quality of potato tuber (Solanum tuberosum L.) desiree class: As a role of friendly biochemical health. *Biochemical and Cellular Archives*, *19*(2), 3955-3959.

**Dogra, P., Qureshi, F. M., Jat, G., Meena, R. H., & Yadav, B. L. (2015).** Effect of Zinc Application with Different Saline Waters on Soil Properties and Wheat Yield. *Indian Journal of Fertilisers*, 32.

**Lenka, B., Divya, R. K., & Das, S. K. (2020).** Nutrient use efficiency, yield attributes and comparative economics of potato crop (Solanum tuberosum L.) in response to zinc and boron nutrition in entisols of India. *International Journal of Chemical Studies*, *8*(3), 10-17.

**Mahmud, N. U., Ferdous, Z., Ullah, H., Ahmed, N. U., Molla, S. H., & Anwar, M. (2021).** Effect of zinc on grading, quality and yield of potato *(Solanum tuberosum)* in Bangladesh. International Journal of Agriculture technology, 17(5), 1821-1832

**Nagar, B. L., Singh, J., Yadav, D. L., VERMA, H. P., & Meena, R. R. (2024).** Agronomic zinc biofortification of potato *(Solanum tuberosum)* through soil and foliar zinc sulphate application in Rajasthan. *The Indian Journal of Agricultural Sciences*, 94(1), 016-020.

**Navarre, D. A., Brown, C. R., & Sathuvalli, V.R. (2019).** Potato vitamins, minerals and phytonutrients from a plant biology perspective. *American Journal of Potato Research*

**Ram, U. S., Srivastava, V. K., Hemantaranjan, A., Sen, A., Singh, R. K., Bohra, J. S., & Shukla, U. (2013).** Effect of Zn, Fe and FYM application on growth, yield and nutrient content of rice. *ORYZA-An International Journal on Rice,* 50(4), 351-357.

**Sharma, J., Kumar, P., Dua, V. K., Kumar, M., Sharma, V., & Kumar, D. (2022).** Strategies for agronomic biofortification of potato tubers with zinc. *Potato Journal*, 49(1).

**Thingujam, U., Kundu, D., Khanam, R., Mondal, S., & Hazra, G. C. (2019).** Soil Available Zinc and Its Relationship with Soil Properties in Rice Soils of West Bengal, India. *Int. J. Curr. Microbiol. App. Sci*, *8*(8), 486-491

**Tiwari, T., Tiwari, U. S., Sharma, S., Pandey, H. P., Sachan, R., Kumar, D., ... & Singh, K. K. (2023).** Effect of biofortification with zinc and iron on growth parameters, yield attributes and yield of barley (Hordeum vulgare L.). *International Journal of Plant & Soil Science*, *35*(18), 1148-1157.