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RESEARCH ARTICLE

Response of potato varieties to the effect of mixed synthetic fertilisers in the northwestern region of Bangladesh

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Abstract

The experiment was conducted at the Horticulture research field in the Department of Crop Science and Technology in the University of Rajshahi, Bangladesh, during the rabi season from October 2021 to February 2022. In this study, the effect of varieties, different doses of potassium and boron fertilisers and their combinations were evaluated to determine the optimum combination for enhancing the growth and yield of potato. The experiment was conducted as a factorial randomised block design with three replications. Two varieties; Lal Sheal (V_1) and BARI Potato-7 (V_2) and five different combination of fertiliser application; T_1 = control (0 kg MP and 0 kg boric acid)/ha, T_2 = (120 kg MP + 14 kg boric acid)/ha, T_3 = (140 kg MP + 16 kg boron) /ha, T_4 = (160 kg MP + 18 kg boric acid)/ha and T_5 = (180 kg MP + 20 kg boric acid)/ha and the interaction of varieties and different fertiliser dozes were evaluated. The results showed that varietal differences were significant for all measured traits. The V_2 variety consistently exhibited higher plant height, more leaves, larger tuber length and width, maximum number of fresh and defected tuber and higher yield compared to V_1. Among fertiliser treatments, T_5 (the highest mixed fertiliser dose) significantly improved plant height (59.95 cm), leaf number (57.83 per plant) and tuber size (11.56 cm length, 12.67 cm diameter), resulting in the maximum yield (19.75 kg/plot, 24.47 t/ha). The combined effect of variety and fertiliser treatments revealed that the V_2T_5 interaction produced the highest yield (20.23 kg/plot, 28.65 t/ha), while V_1T_1 produced the lowest yield. These results indicate that both genetic potential and balanced nutrient management significantly influence potato growth and productivity. Therefore, the use of BARI Potato-7 with optimised mixed synthetic fertiliser combinations can enhance tuber yield and quality in the northwestern region of Bangladesh. Further studies are recommended to refine fertiliser optimization for sustainable and region-specific potato production.

Keywords: mixed fertiliser; nutrient use efficiency, nutrient management strategies; potato variety; yielding

Introduction

Potato (*Solanum tuberosum* L.) is one of the most important global food and commercial crops, cultivated across different agro-climatic zones due to its diverse adaptability and high productivity. Globally, potatoes rank as the fourth most significant food crop after wheat, rice and maize, with an annual production that exceeds 300 mt grown in more than 100 countries (1). In Bangladesh, potato is the second most harvested crop after rice, producing 10.2 Mmt in 2022–23 (2). Potato tubers are rich in essential nutrients, including vitamin C and B_6, iron and zinc, contributing to their high nutritional value (3). They also contain bioactive compounds such as phenolic compounds, anthocyanins and carotenoids, which exhibit antioxidant, anti-diabetic, anti-inflammatory and cardio-protective properties (4). Consequently, potatoes represent a critical component of human nutrition and public health.

In Bangladesh, the productivity of potato varieties is strongly influenced by integrated nutrient management strategies combining inorganic and organic fertilisers (5). Potatoes are a high-value crop requiring balanced fertilisation to achieve optimal growth and yield (6). In many potato-growing regions, nitrogen (N) and phosphorus (P) fertilisers are widely applied, whereas potassium (K) is often neglected, leading to declining soil K levels (7). Potatoes, compared to other vegetable crops, demand a relatively high K supply and are considered an indicator crop for soil potassium availability (8). Adequate potassium fertilisation enhances yield, tuber quality, photosynthesis, water use efficiency, nutrient utilisation, root development, stress tolerance and disease resistance (9). It also promotes carbohydrate synthesis, supporting tuber development, with studies reporting that application of 125–150 kg K ha^{-1} as muriate of potash (MP) results in high-quality, profitable yields (10).

Boron (B) is an essential micronutrient that influences multiple physiological and metabolic processes, including protein synthesis, sugar transport, respiration, RNA synthesis, hormone regulation, flowering and fruiting (11). Boron enhances structural integrity, root and shoot growth, nutrient translocation, tuber size and yield, while deficiency can lead to hollow heart, reduced tuber number, lower quality and increased stress susceptibility (12). Integrated application of boron with N and K significantly improves both yield and tuber quality (13). Foliar or soil application of boron, such as borax, has been shown to increase haulm weight, tuber number, dry matter content and overall yield relative to untreated controls (14).

The synergistic interaction between potassium and boron is particularly important, as K regulates essential physiological functions, while B ensures structural stability and efficient nutrient uptake. Together, they optimise plant growth, tuber development and yield quality (15). Despite the importance of these nutrients, research in Bangladesh has largely focused on individual effects of N, P, or K fertilisers, with limited studies exploring combined or synergistic effects on different potato varieties. Consequently, the potential of integrated varietal selection and fertiliser management to enhance productivity and tuber quality remains underexplored. This study aims to evaluate the synergistic effects of potassium and boron fertilisation on the growth and yield performance of two widely cultivated potato varieties; Lal Sheal and BARI Potato-7. Specific objectives include assessing vegetative parameters such as plant height, leaf number and leaf dimensions, as well as yield-related traits, including the number of tubers per plant, tuber size and total tuber yield per hectare. The study also seeks to identify optimal fertiliser combinations that maximise productivity while maintaining soil health and environmental sustainability.

Materials and Methods

Details of the experimental site

The experiment was conducted at the Horticulture research field in the Department of Crop Science and Technology in University of Rajshahi, Bangladesh, during the period from October 2021 to February 2022 to find out the effect of K and B on the growth and yield of potato (Table 1). The experimental site was located at 24° 22'42.5"N latitude and 88°37'57.4"E longitude and 200 cm above sea level (16). During the growth period, the average maximum and minimum temperature was recorded as 27.64 °C and 16.16 °C respectively, while the average precipitation was 32 mm and the humidity was 80.2 % (2). The soil of the experimental area was loamy, belonging to the High Barind Tract under the Agro Ecological Zone 11. The selected site was a well-drained medium-highland with soil pH 5.9.

Table 1. The climatic factors in the experimental area during the period of experimentation are based on the monthly average

Growing season	Rainfall (mm)	Temperature (°C)		Humidity (%)
		Max	Min	
Oct-2021	116	33.1	24.5	84
Nov-2021	1	29.4	17.3	79
Dec-2021	1	26.3	14.2	79
Jan-2022	3	23.4	12.2	82
Feb-2022	39	26	12.6	77

Source: BBS (Bangladesh Bureau of Statistics). 2023. Statistical Yearbook Bangladesh 2023.

Soil sampling and analysis

Soil samples were collected from ten randomly selected places across the field at depths ranging from 10 to 15 cm before the start of the experiment. After removing any undesired contaminants, these samples were merged to form a composite sample, which was air-dried, ground and sieved through a 2 mm mesh. The composite sample was then stored in a plastic bag container for further mechanical and chemical analysis. The initial analysis included determining the texture, pH, organic matter concentration and total N. The analysis also assessed the amounts of exchangeable K, as well as available phosphorus, zinc and boron. The nutrient profile was determined at the Soil Resource Development Institute (SRDI), Rajshahi Regional Research Laboratory in Bangladesh. Soil pH was measured by a glass electrode pH meter and the Organic carbon of soil samples was determined by the wet oxidation method (17). The organic matter was calculated by multiplying percent organic carbon by the conventional van Bemmelen factor of 1.73 (18).

Organic matter (%)

= Organic carbon (%) × Van Bemmelen factor (18) (Eqn. 1)

Total nitrogen content of soil was determined by the semi-micro method, where soil was digested with 30 % H conc, H_2SO_4 and catalyst mixture, while available phosphorus was extracted from soil by shaking with 0.5 M $NaHCO_3$ solution at pH 8.5 (17, 19). To estimate available Zinc and boron, atomic absorption spectrophotometry was used at 213.9 nm and 420 nm, where Exchangeable K was examined using a flame photometer (20). The soil chemical analysis revealed that the soil was loamy s with a pH of 5.9, N of 0.11 %, P of 16.60 ppm, K of 0.14 C mol/ kg, sulfur of 17.05 mg/L and organic carbon of 1.59 % per 100 g of soil. Zinc and boron concentrations in the soil were found to be lower at 0.039 and 0.23 mg/L, respectively.

Experimental factors

There were two sets of factors in the experiment. The factors were varieties and the fertiliser application rate. They are shown below:

Factor A: Variety

Two potato varieties were used in this experiment- V_1 = Lal Sheal, V_2 = BARI potato-7.

These varieties were collected from the Bangladesh Agricultural Research Institute (BARI), Rajshahi region.

Factor B: Fertiliser application rate

A total of 5 different fertiliser application doses were applied in this experiment. T_1 = control (0 kg MP and 0 kg boric acid)/ha, T_2 = (120 kg MP + 14 kg boric acid)/ha, T_3= (140 kg MP + 16 kg boron)/ha, T_4 = (160 kg MP + 18 kg boric acid)/ha and T_5 = (180 kg MP + 20 kg boric acid)/ha.

Experimental layout and design

The experiment was carried out in a factorial randomised block design with three replications. The total number of treatments in this experiment was 30 (2 varieties, 5 doses, 3 replications). The net plot area was 2 m × 1.5 m. The spacing between each plot was 30 cm, whereas block to block distance was 50 cm.

Cultural operation

The experimental plot was prepared in the first week of October 2021 through two rounds of ploughing, cross-ploughing and

levelling using a power tiller. Weeds and plant debris were removed from the field and soil clods were broken down for fine tillage. The land was levelled and irrigation and drainage channels were installed around the perimeter. The land was finally prepared on 12 November 2021, three days before planting the seed. The soil was treated with Furadan 5G at 10 kg/ha. to protect the young plant from the attack of cut worm. The whole plot was fertilised with a basal dose according to the Fertiliser Recommended Guide. Cow dung and compost were applied before final land preparation. Full amounts of gypsum, $MgSO_4$ and $ZnSO_4$ were applied during final land preparation. Total TSP, 50 % Urea and 50 % Muriate of Potash (MP) were applied in furrows made on both sides of the seed rows and properly mixed with the soil. The remaining 50 % urea was applied after 35 days of planting. During the growing season, the sprouted tubers were planted in the experimental plots from 15 October to 20 November 2021 at a depth of 7 cm. After 21 days, tubers started to germinate. After germination, all other intercultural operations, such as weeding and mulching, irrigation, earthing up, gap filling, disease and pest control, haulm cutting and harvesting, were done according to the regional recommendation.

Data collection

Growth and yield parameters recorded were plant height, number of leaves per plant, number of fresh and defective tubers per plant, diameter and length of tubers (cm), tuber weight per plant (kg), tuber weight per plot (kg) and tuber yield (t/ha). Plant height was recorded at 15 days interval starting from 15 days of planting to 70 days of planting. The number of leaves was counted from 5 plants of each plot periodically after every 15 days, starting from 25, 40, 55 and 70 day finally the mean value was calculated. The length of the tuber was measured with a slide calliper from the neck of the tuber to the bottom of 20 selected marketable tubers from each plot and their average was taken in cm as the length of the tuber. The breadth of the potato was also measured at the middle portion of 20 selected marketable potatoes from each plot, which were used for length. The total number of tubers per plant was calculated by the following formula (21):

Number of tubers per plant = Total number of tubers from 3 replications after final harvest (Eqn. 2)

Tuber yield was measured from the figures of tubers per plant. The weight of the tuber for each plants were added to all plants of each plot.

Statistical analysis

The statistical analysis was conducted using the MSTAT- C statistical program. The analysis of variance (ANOVA) was conducted to assess the differences between treatments. When significant differences were identified, the treatment means were compared by applying Tukey's Honest Significant Difference (HSD) test at the 5 % probability level (p <0.05).

Results

Effects of variety, fertiliser treatment and their interaction on the growth morphology of potato

The differences between varieties, fertiliser treatments and their interaction were found statistically significant at p<0.05 according to Tukey's HSD test. The result showed that the plant height increased gradually with the passage of time. At 25 days after planting (DAP), the highest plant height (17.76 cm) was obtained from the BARI potato -7 (V_2) and the lowest (15.44 cm) was found from Lal sheal variety (V_1). Throughout the growth phases, the pattern remained consistent, with V_2 measuring 22.97 cm and V_1 measuring 20.62 cm at 40 DAP. At 70 DAP, the highest plant height (53.81 cm) was recorded from V_2 and the lowest was recorded from V_1 variety (Fig. 1). Plant height increased gradually with the advancement of growth stages under all treatments (Fig. 2). In case of fertiliser treatments, at 25 DAP, the longest plant (23.51 cm) obtained from T_5 and the shortest plant (11.15 cm) was recorded from T_1. Treatments T_2 and T_3 had intermediate plant heights, whereas T_4 had somewhat higher values. At 70 DAP, the highest plant height (59.2 cm) was observed from T_5 and the shortest plant (41.35 cm) was found from T_1 (Fig. 2).

At 25 DAP, the combination of variety and fertiliser treatments was observed to be significant. The obtained results revealed that the longest plant (24.23 cm) was observed in V_2T_5 treatment, while the shortest plant (11.90 cm) was displayed in V_1T_1 treatment combination. At 70 DAP, among the treatment combinations, V_2T_5 recorded the highest plant height (60.63 cm), which was statistically similar to V_1T_5 (57.76 cm). Whereas V_2T_1 showed the shortest plant statistically similar to V_1T_1 (Fig. 3). The differences between varieties, fertiliser treatments and their combined effects were statistically significant at p < 0.05 as determined by Tukey's HSD test. The results observed that the

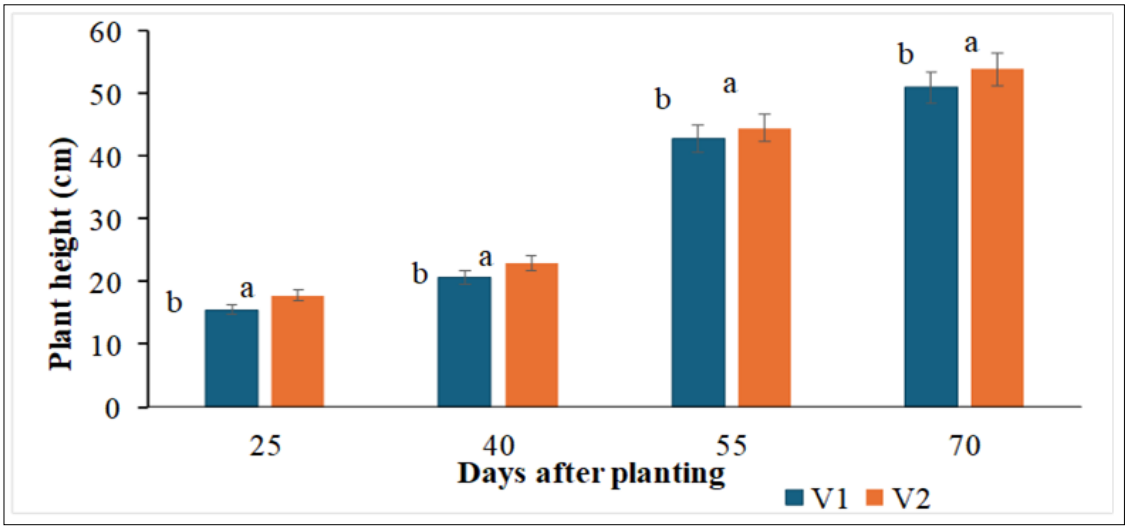

Fig. 1. Effect of varieties on plant height of potato at different days after planting (DAP). Different letters indicate significant differences (p<0.05; Tukey's HSD test). Values are the mean ± SD, n = 10. V_1 = Lal Sheal, V_2 = BARI potato-7.

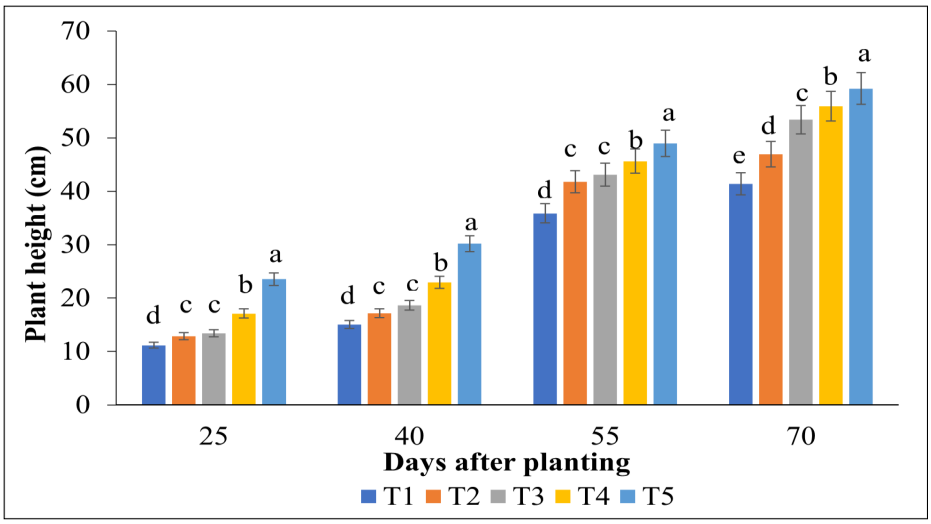

Fig. 2. Effect of fertiliser treatments on plant height of potato at different days after planting (DAP). Different letters indicate significant differences (p<0.05; Tukey's HSD test). Values are the mean ± SD, n = 10, T_1 = control, T_2 = (120 kg MP + 14 kg boric acid)/ha, T_3= (140 kg MP + 16 kg boron) /ha, T_4 = (160 kg MP + 18 kg boric acid)/ha and T_5 = (180 kg MP + 20 kg boric acid)/ha.

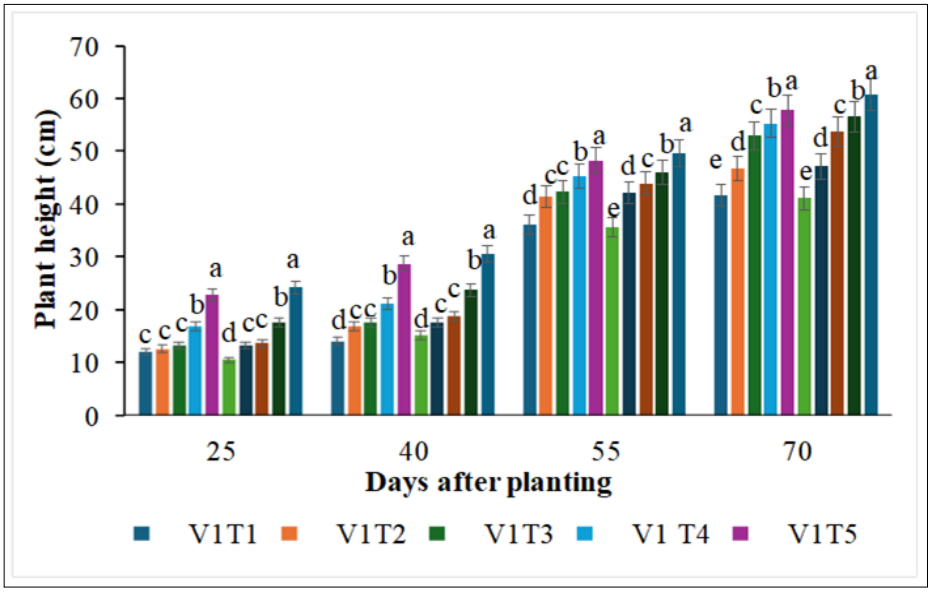

Fig. 3. Combined effect of varieties and fertiliser treatments on plant height of potato at different days after planting (DAP). Different letters indicate significant differences (p<0.05; Tukey's HSD test). Values are the mean ± SD, n = 10. T_1 = control, T_2 = (120 kg MP + 14 kg boric acid)/ha, T_3 = (140 kg MP + 16 kg boron) /ha, T_4 = (160 kg MP + 18 kg boric acid)/ha and T_5 = (180 kg MP + 20 kg boric acid)/ha. V_1 = Lal Sheal, V_2 = BARI potato-7.

number of leaves increased gradually with the advance of time. At 25 DAP, the results revealed that the maximum number of leaves per potato plant (30.933) was found in BARI potato-7 (V_2) and the minimum number of leaves per potato plant was found in Lal sheal (V_1) variety. At 40 and 55 DAP, the numbers rose even more with V_2 than V_1. The V_2 had the most leaves per plant at 70 DAP (51), while V_1 had the fewest leaves per plant (49.93) (Fig. 4). Regarding the treatment effects, T_1had the lowest number of leaves per plant. The leaf count gradually increased in T_2, T_3 and T_4 while the highest number was recorded in T_5, reaching 38.677 and 57.83 at 25 DAP and 70 DAP respectively (Fig. 5). The V_2T_5combination showed the maximum number of leaves (40.33 and 58.33), whereas the V_1T_1 combination recorded the minimum number of leaves (18.33 and 37) at 25 and 70 DAP, respectively (Fig. 6).

The quality of potato tuber affected by variety, fertiliser and their interaction

The differences in length and width, diameter of potato tuber between varieties, fertiliser treatments and its combinations were statistically significant at p < 0.05 according to Turkey's HSD test. At harvest, V_2 had the largest potato tuber length (7.53 cm) and diam eter (8.80 cm), while V_1 had a somewhat smaller tuber length (5.7 cm) and diameter (6.67 cm) than V_2 (Fig. 7). Tuber size also increased with treatment level at harvest where T_1 had the lowest length and width diameter; followed by T_2, T_3 and T_4 had intermediate sizes. Again, T_5 achieved the greatest tuber size during harvest (Fig. 8). The results indicated that the maximum length and width of 11.56 and 12.67 cm for potato tubers were recorded in the V_2T_5 combination, which was statistically comparable to the V_1T_5 at harvest. The minimum length and width diameter of 3.33 and 5.53 cmwere recorded in the V_1T_1 combination at harvest, which was similar to the V_2T_1 combination with measurements of 4.33 cm and 6.50 cm at harvest (Fig. 9). The differences between varieties, fertiliser treatments and the combined effect of varieties and fertiliser treatments were statistically significant at p<0.05 according to Tukey's HSD test. The highest number of fresh tubers (8.40) and the lowest number of defected tuber (2.80) were observed in V_2 at harvest and the comparatively lower number of fresh tubers (7.80) and higher number of defective tubers (3.33) were observed in V_1 (Fig. 10).

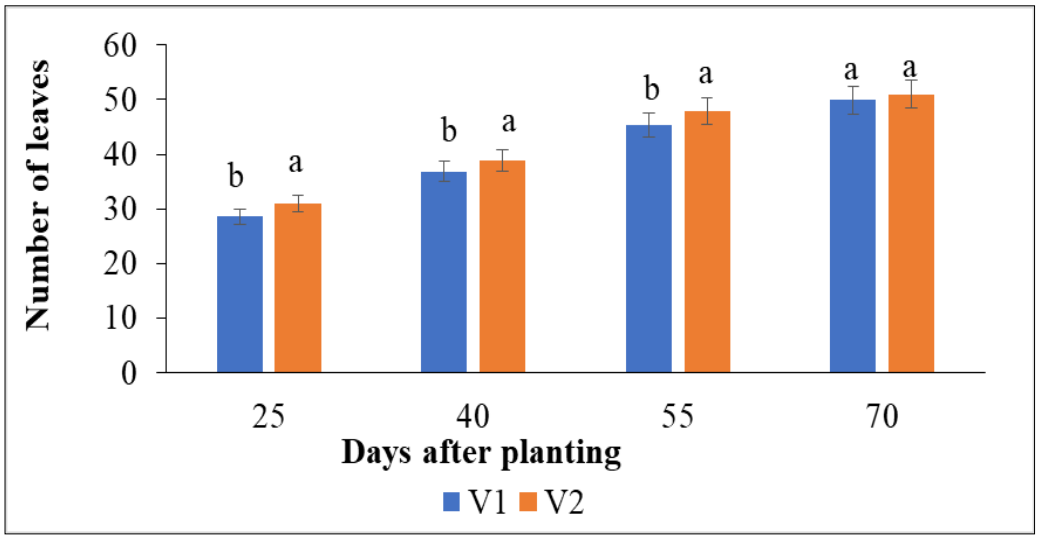

Fig. 4. Effect of varieties on the number of leaves of potato at different days after planting (DAP). Different letters indicate significant differences (p<0.05; Tukey's HSD test). Values are the mean ± SD, n = 10. V_1 = Lal Sheal, V_2 = BARI potato-7.

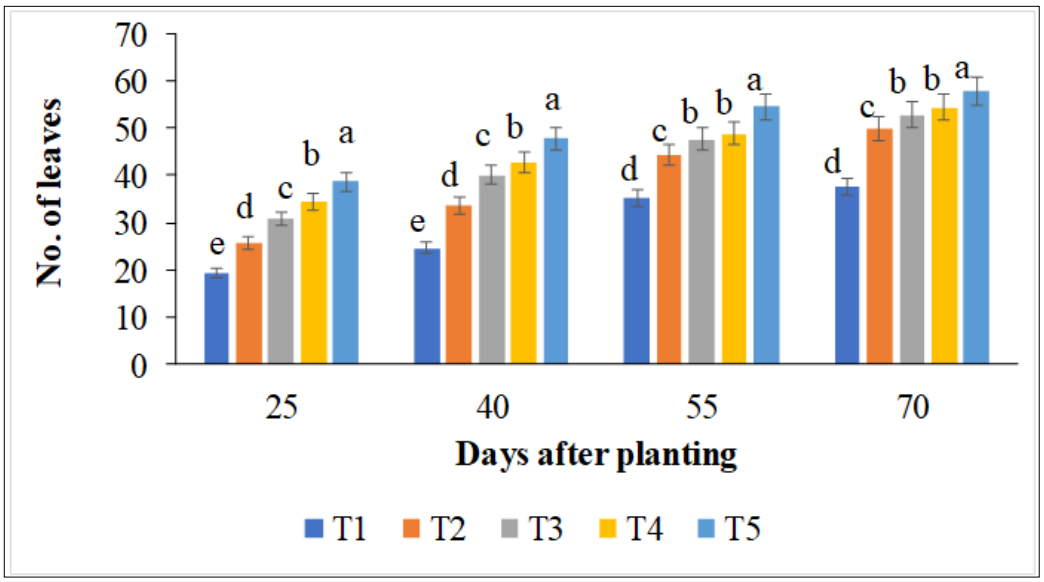

Fig. 5. Effect of fertiliser treatments on the number of leaves of potato at different days after planting (DAP). Different letters indicate significant differences (p<0.05; Tukey's HSD test). Values are the mean ± SD, n = 10. T_1 = control, T_2 = (120 kg MP + 14 kg boric acid)/ha, T_3 = (140 kg MP + 16 kg boron) /ha, T_4 = (160 kg MP + 18 kg boric acid)/ha and T_5 = (180 kg MP + 20 kg boric acid)/ha.

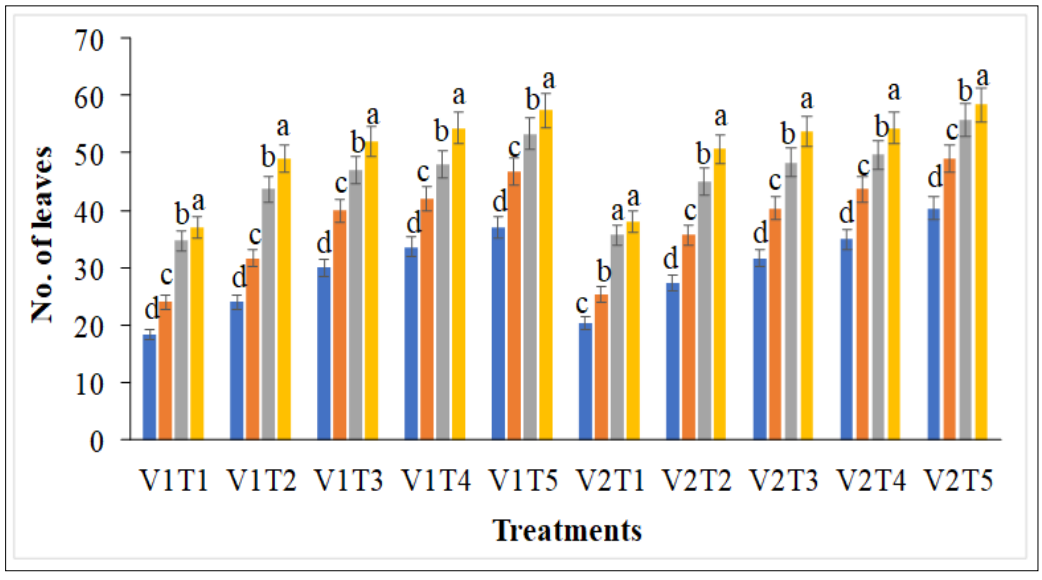

Fig. 6. Combined effect of varieties and fertiliser treatments on the number of leaves of potato at different days after planting (DAP). Different letters indicate significant differences (p<0.05; Tukey's HSD test). Values are the mean ± SD, n = 10 T_1 = control, T_2 = (120 kg MP + 14 kg boric acid)/ha, T_3 = (140 kg MP + 16 kg boron) /ha, T_4 = (160 kg MP + 18 kg boric acid)/ha and T_5 = (180 kg MP + 20 kg boric acid)/ha. V_1 = Lal Sheal, V_2 = BARI potato-7.

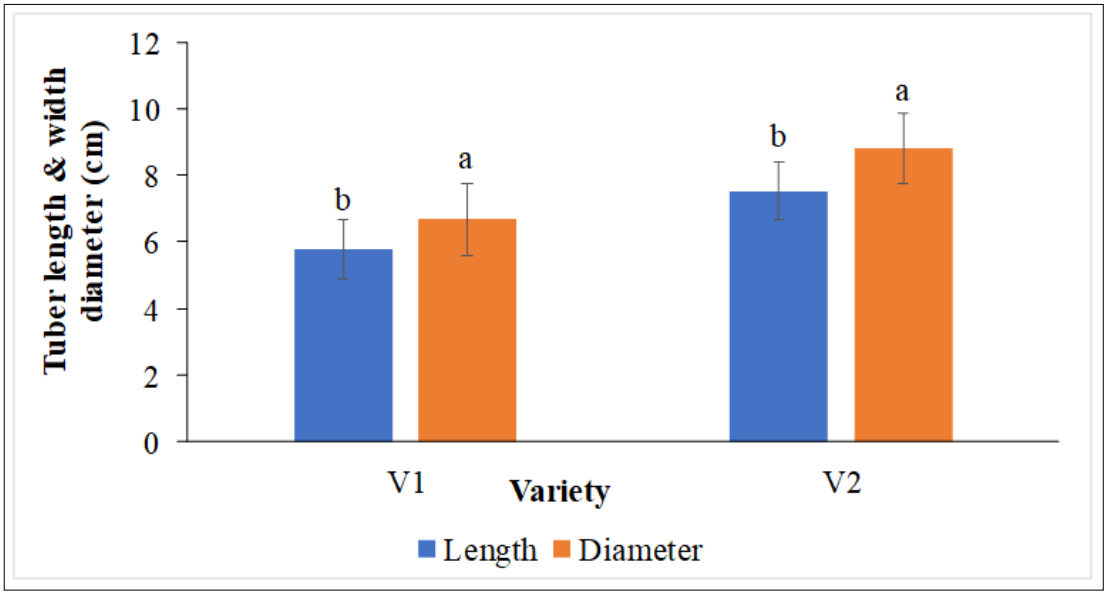

Fig. 7. Effect of varieties on length and diameter of potato. Different letters indicate significant differences ($p<0.05$; Tukey's HSD test). Values are the mean ± SD, n = 10. V_1 = Lal Sheal, V_2 = BARI potato-7.

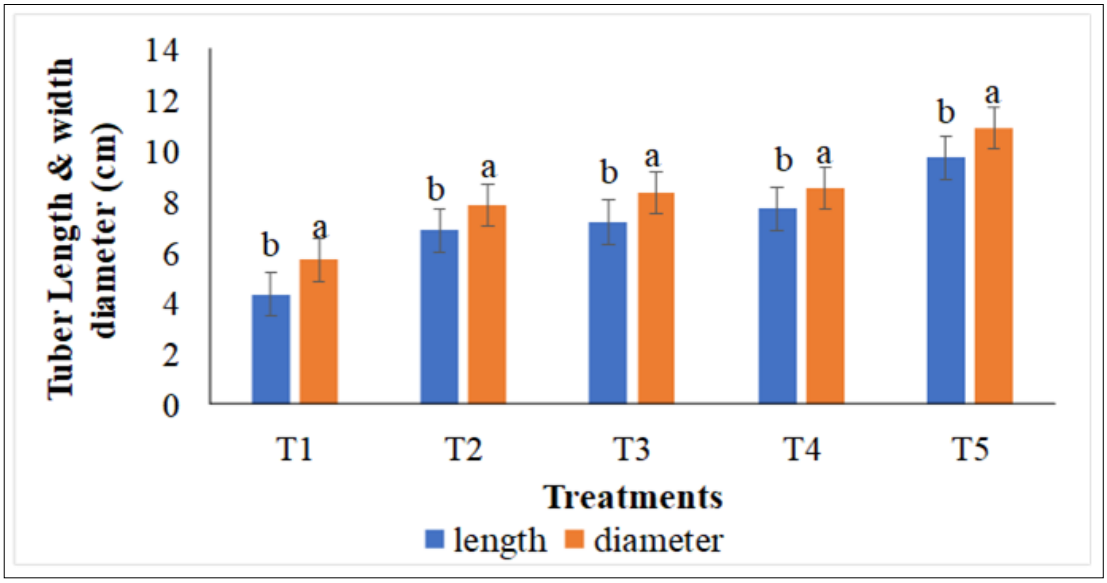

Fig. 8. Effect of fertiliser treatments on the length and diameter of potato. Different letters indicate significant differences ($p < 0.05$; Tukey's HSD test). Values are the mean ± SD, n = 10. T_1 = control, T_2 = (120 kg MP + 14 kg boric acid)/ha, T_3 = (140 kg MP + 16 kg boron) /ha, T_4 = (160 kg MP + 18 kg boric acid)/ha and T_5 = (180 kg MP + 20 kg boric acid)/ha.

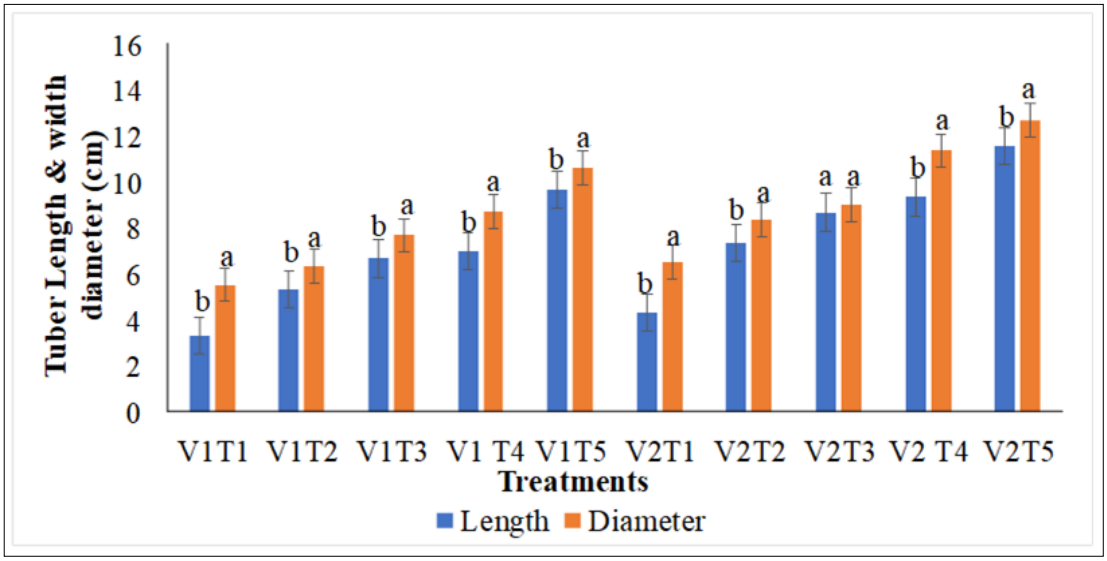

Fig. 9. Combined effect of varieties and fertiliser treatments on length and width diameter of potato. Different letters indicate significant differences ($p<0.05$; Tukey's HSD test). Values are the mean ± SD, n = 10. T_1 = control, T_2 = (120 kg MP + 14 kg boric acid)/ha, T_3 = (140 kg MP + 16 kg boron) /ha, T_4 = (160 kg MP + 18 kg boric acid)/ha and T_5 = (180 kg MP + 20 kg boric acid)/ha. V_1 = Lal Sheal, V_2 = BARI potato-7.

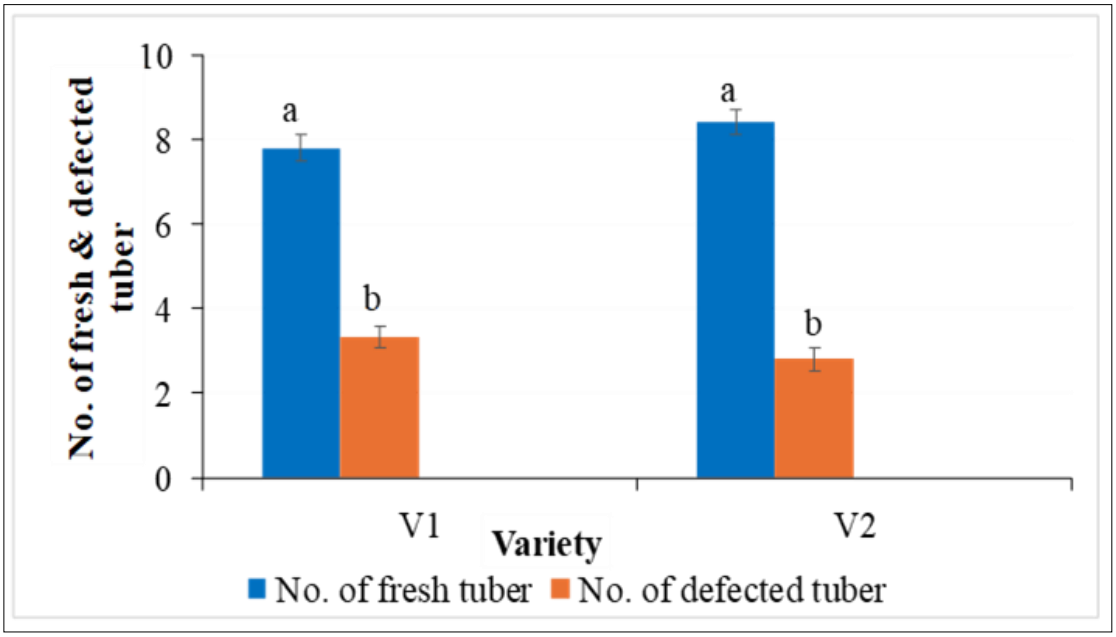

Fig. 10. Effect of varieties on no. of fresh and defected tuber. Different letters indicate significant differences ($p<0.05$; Tukey's HSD test). Values are the mean ± SD, n = 10. V_1 = Lal Sheal, V_2 = BARI potato-7.

The quantity of fresh tubers increased from T_1(5.67) to T_5 (10.00), whereas the quantity of defective tubers decreased from T_1 (3.67) to T_5 (1.80), signifying enhanced tuber quality at elevated treat ment levels (Fig. 11). The results revealed that the highest number of fresh potato tuber (12.37) and the lowest number of defected potato tuber per plant (2.23) were observed in V_2T_5 combination, while the lowest number of fresh tuber per plant (5.66) and the highest number of defected tuber per plant (4.24) were observed in V_1T_1combination at harvesting (Fig. 12).

Impact of potato cultivar, fertilisers and their interaction on the overall yield of potato

The differences between varieties, fertiliser treatments and the combinations of variety and fertiliser treatments were statistically significant at $p < 0.05$ according to Tukey's HSD test. V_2provided the highest yield of all, while V_1 cultivars produced the lowest yield (Fig.13). At harvest, the T_5 treatment produced the highest potato tubers (19.75 kg/plot and 24.47 t/ha). In the meantime, T_2, T_3 and T_4 showed intermediate yields. Conversely, T_1 had the lowest yield, weighing only 4.97 kg/plot and 15.57 t/ha (Fig.14). The highest yield of potato tubers was produced by the V_2T_5treatment, which generated 20.23 kg/plot and 28.65 t/ha. This yield, however, was statistically equivalent to the V_1T_5treatment. On the other hand, there was no discernible difference in the yields of the V_1T_1 treatment (5.26 kg/plot and 10.65 t/ha) and V_2T_1 (4.67 kg/plot and 14.87 t/ha), which had the lowest yield (Fig. 15).

Correlation between length, diameter (cm) and number of fresh tuber/potato with yield (t/ha) on the combined effect of varieties and fertiliser treatments

The results revealed that there was a positive and significant correlation found between length diameter (cm) with yield (t/ha) on the combined effect of varieties and fertiliser treatments (Fig. 16). Furthermore, number of fresh tuber/plant was also positively correlated with the yield (t/ha) on the combined effect of varieties and fertiliser treatments (Fig. 17).

Discussion

The growth and morphology of plants is influenced by genotypic variations and proper nutrient management strategies, leading to the proper physiology of plants. Proper physiology assured proper growth and development (22–30). The results showed that the plant height increased gradually with the advance of time at different DAP. The reason for this could be genetic dissimilarities between varieties (31). Research has demonstrated that plant height in potato varieties increased with genetic variation and identified high-yielding potato plants. The highest plant height was achieved from T_5 treatments and it might be due to the response to a greater number of mixed fertilisers (32). In some cultivars, potassium fertilisation significantly increased the yield of medium and large-sized tubers. Plant height in potato increases by the combined effect of varieties and mixed fertiliser treatments. It a genetic character and is different among the varieties with respect to genetic variation. Besides, the application of a balanced fertiliser supply provides more nutrients to the soil and promotes cell division and stem elongation (33).

V_2 produced more leaves than V_1 because of the genetic dissimilarities, nutrient uptake capability and strong root system (34). The findings in our study showed that applying a greater amount of mixed fertiliser caused the maximum number of leaves in T_5 (180 kg MP + 20 kg boric acid)/ha as compared to T_1 (Control). Research has demonstrated similar observations (35). Research indicates that the maximum number of leaves was observed in the V_2T_5 combination, while the minimum number of leaves was recorded in the V_1T_1 combination. These outcomes are relevant to the previous study (36). Research shows that a well-developed root system promotes nutrient and water uptake, which directly benefits canopy development, such as leaf emergence and elongation. The genotypic variation of different crops is responsible for overall yield and quality (37, 38). The highest tuber length and diameter were found in the V_2 as compared to the V_1 variety. Similarly, research indicates that physical dimensions and characteristics influence the length and width diameter of tubers

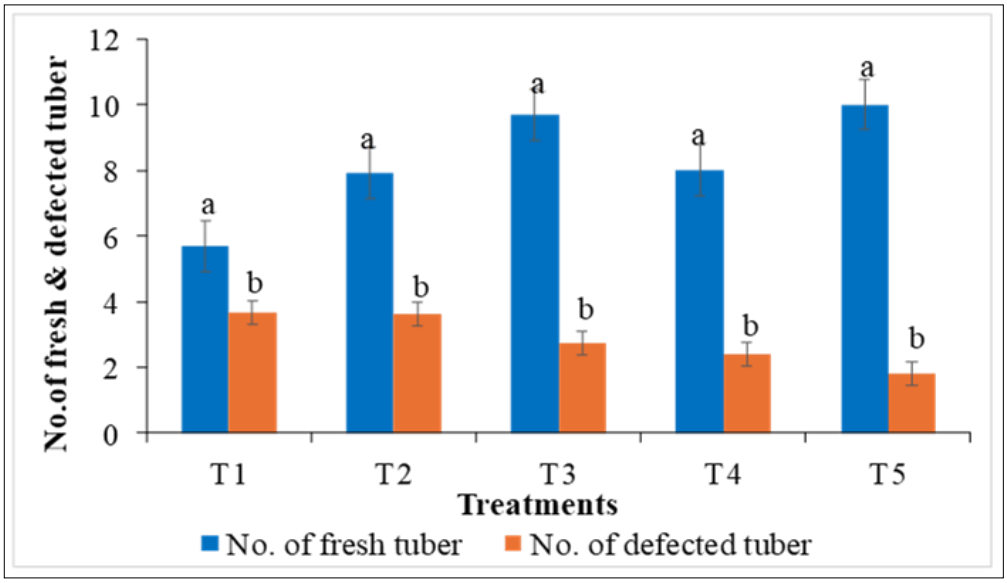

Fig. 11. Effect of fertiliser treatments on no. of fresh and defected tuber. Different letters indicate significant differences ($p < 0.05$; Tukey's HSD test). Values are the mean ± SD, n = 10. T_1 = control, T_2 = (120 kg MP + 14 kg boric acid)/ha, T_3 = (140 kg MP + 16 kg boron) /ha, T_4 = (160 kg MP + 18 kg boric acid)/ha and T_5 = (180 kg MP + 20 kg boric acid)/ha.

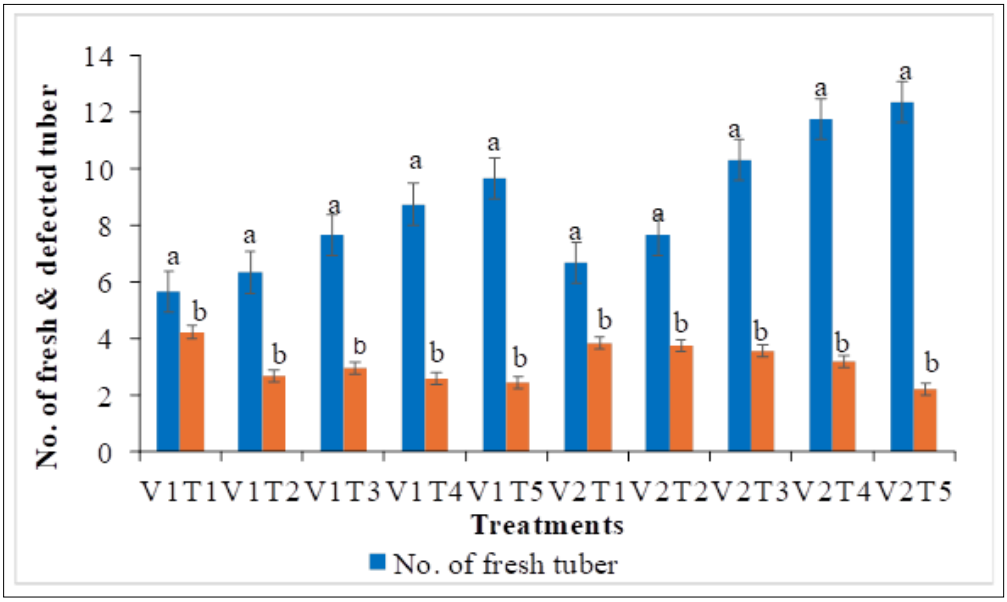

Fig. 12. Combined effect of varieties and fertiliser treatments on the length and width diameter of the potato. Different letters indicate significant differences (p<0.05; Tukey's HSD test). Values are the mean ± SD, n = 10. T_1 = control, T_2 = (120 kg MP + 14 kg boric acid)/ha, T_3 = (140 kg MP + 16 kg boron)/ha, T_4 = (160 kg MP + 18 kg boric acid)/ha and T_5 = (180 kg MP + 20 kg boric acid)/ha. V_1 = Lal Sheal, V_2 = BARI potato-7.

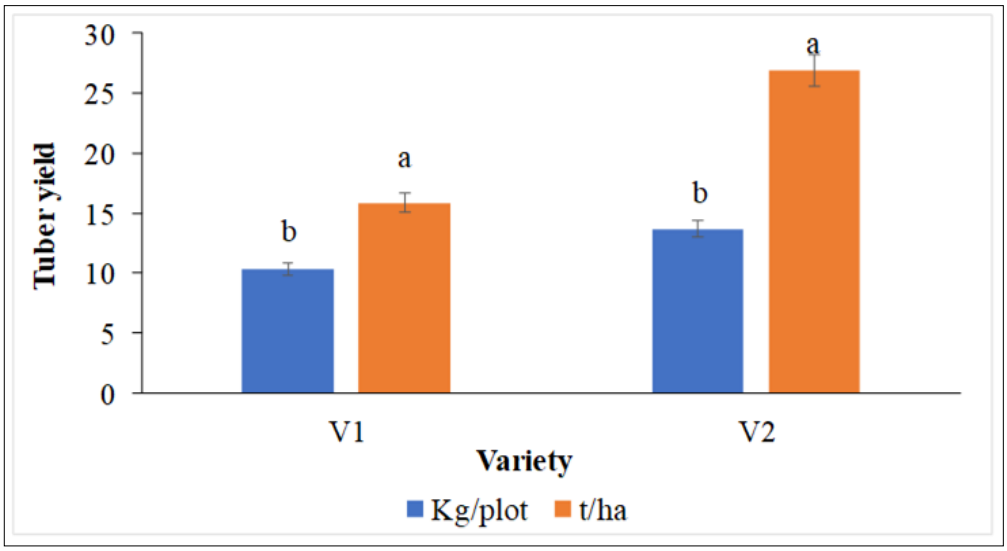

Fig. 13. Effect of varieties on growth and yield components of potato. Different letters indicate significant differences ($p < 0.05$; Tukey's HSD test). Values are the mean ± SD, n = 10. V_1 = Lal Sheal, V_2 = BARI potato-7.

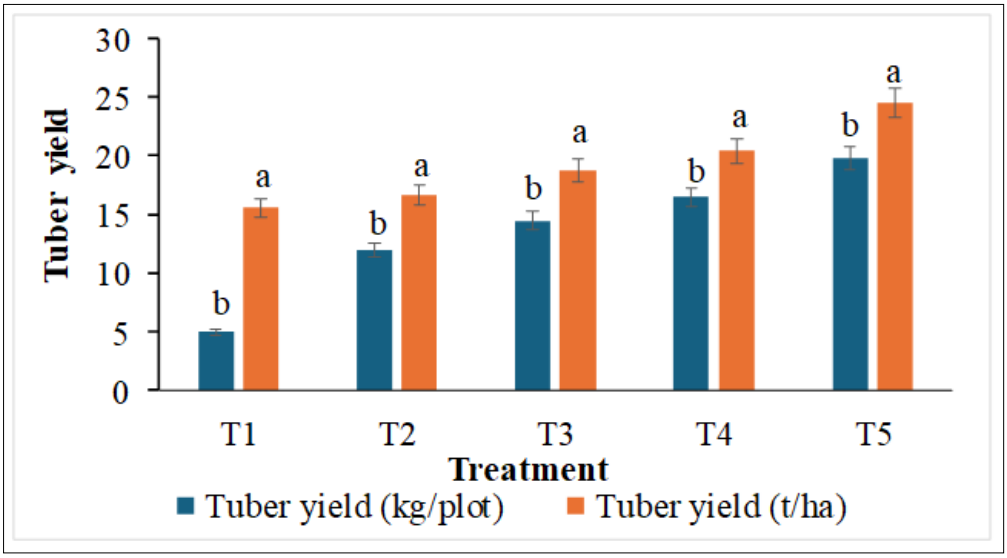

Fig. 14. Effect of the yield component of the potato at different levels of mixed fertiliser. Different letters indicate significant differences ($p < 0.05$; Tukey's HSD test). Values are the mean ± SD, n = 10 T_1 = control, T_2 = (120 kg MP + 14 kg boric acid)/ha, T_3 = (140 kg MP + 16 kg boron) / ha, T_4 = (160 kg MP + 18 kg boric acid)/ha and T_5 = (180 kg MP + 20 kg boric acid)/ha.

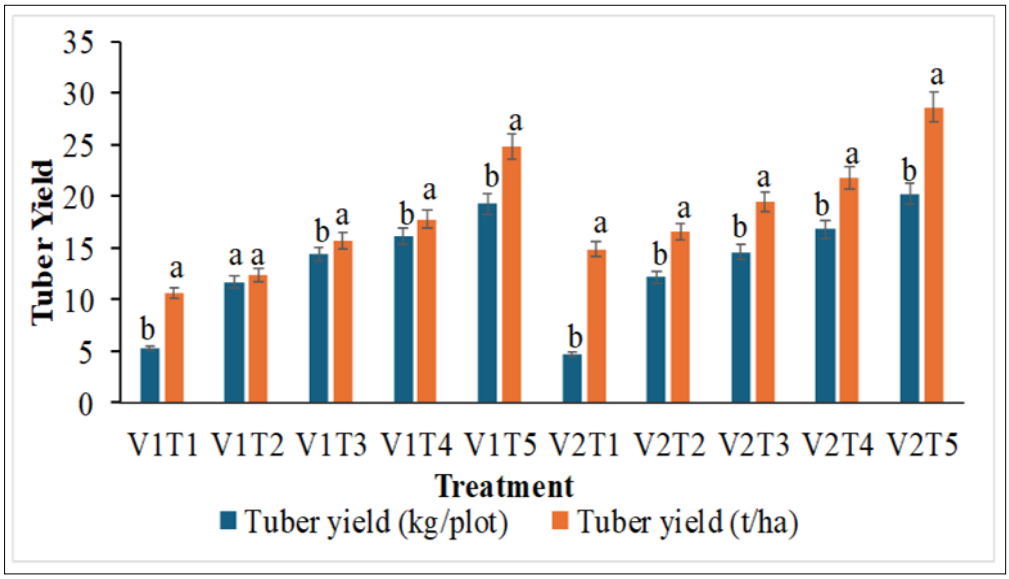

Fig. 15. Combined effect of varieties and fertiliser treatments on the yield of potato. Different letters indicate significant differences ($p<0.05$; Tukey's HSD test). Values are the mean ± SD, n = 10. T_1 = control, T_2 = (120 kg MP + 14 kg boric acid)/ha, T_3 = (140 kg MP + 16 kg boron)/ha, T_4 = (160 kg MP + 18 kg boric acid)/ha and T_5 = (180 kg MP + 20 kg boric acid)/ha. V_1 = Lal Sheal, V_2 = BARI potato-7.

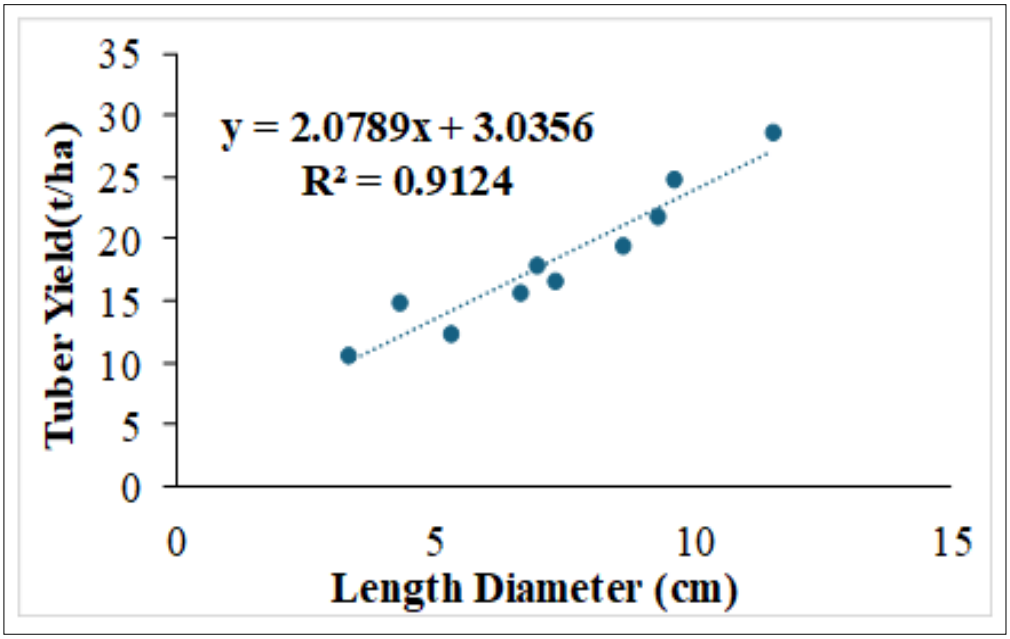

Fig. 16. Correlation between length diameter (cm) and tuber yield (t/ha) of potato on the combined effect of varieties and fertiliser treatments.

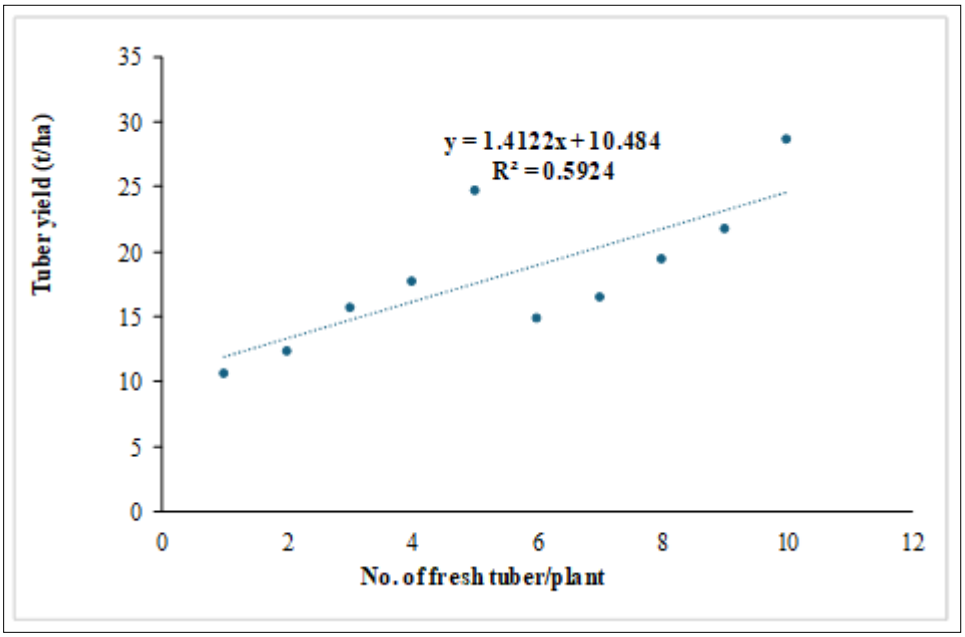

Fig. 17. Correlation between the number of fresh tubers/plant and tuber yield (t/ha) of potato on the combined effect of varieties and fertiliser treatments.

(39). At harvest, the highest length and diameter of tuber were recorded from T_5, followed by T_4, while the lowest length and diameter were found from T_1. Research has demonstrated that the F_2 formula (60 g/L fulvic acid, N-P-K = 130-120-150 g/L) significantly increased plant height and stem diameter relative to the control and conventional fertiliser (40). The present results revealed that the V_2T_5 combination had the highest average length and width diameter compared to other treatments due to the decreased spacing (higher density).

The results found that fresh tuber yield was obtained from high-yield varieties, as well as the environmental influence (41). Similarly, research described that potato varieties significantly affect the rates of external and internal defects in tubers, but the climatic conditions during the growing season have the greatest impact (42). The maximum number of fresh tubers and the lowest number of defective tubers were obtained from the T_5 treatment. Research found that application of blended fertilisers significantly improves tuber number, weight and overall yield compared to single-nutrient treatments (32). The results found that decreased spacing (higher density) increases total yield and tuber numbers per hectare (43). On the other hand, our results showed a non-significant effect on the integration of variety and fertiliser treatment. These outcomes are in corroboration with the findings of previous research (44). Our results exhibited a significant variation in terms of tuber yield. These results are in corroboration with the findings of previous studies (41). They found that the variety Belete produced the maximum total tuber yield of 32.8 t/ha and marketable tuber yield of 29.1 t/ha. Conversely, the farmers' variety Nech Abeba produced the minimum total tuber yield of 13.8 t/ha and marketable tuber yield of 8.4 t/ha. The varietal and environmental variations, as well as their interaction, have a considerable influence on potato tubers.

The maximum yield of potato tubers (1.31 kg/plant, 19.75 kg/plot and 24.47 ton/ha) was observed in the T_5, followed by the T_4 treatment. The presence of greater amounts of nutrients up to a certain level may enhance the photosynthetic rate of potato tubers. Research reported that the application of different levels of mixed fertiliser (N, P and K) treatments had a substantial effect on the higher yield of potato tubers (45). Likewise, research confirmed that the combined application of recommended doses of N, P, K, Zn and B fertiliser enhanced the yield of potato (46). The highest production of the BARI potato-7 variety with a suitable amount of fertiliser is due to the proper physiological maturity of the seed tuber and better adaptability with climatic conditions, proper planting time and appropriate intercultural operation.

These findings are aligned with the previous research evidence (47, 48). They found that these factors are responsible for the highest yield of potato tubers. A significant positive correlation between length, diameter and tuber yield of potato on the combined effect of varieties and fertiliser was observed in this study, indicating that larger length and diameter are associated with higher yields. This finding is consistent with previous research (49). Additionally, the correlation between the number of fresh tuber/plant and yield on the combined effect of varieties and fertiliser treatments exhibited highly significant positive results, suggesting that the maximum number of fresh tubers/plants enhanced the yield of potato. This result is aligned withprevious research (50).

Conclusion

The findings of this experiment revealed that different varieties, fertiliser doses and their combination significantly influenced the growth, yield contributing characteristics and yield of potato cultivation. Growth parameters like, plant height, number of leaves, average length and width diameter of tuber and yield contributing parameters, such as number of fresh and defected tuber, tuber yield kg/plot and tuber yield ton/ha were obtained highest at V_2 (BARI Potato-7) variety, T_5(K: B = 180 kg:20 kg) treatment and V_2T_5 combination. It may be concluded from the present study that potato production increased with the increasing level of K and B fertilisers combinations, Excessive uses of K and B fertiliser showed retarding effect and did not bring further improvement. Further research across multiple seasons and different agro-ecological zones is advised to validate these findings and evaluate the economic feasibility with more precision of the experiment.

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Authors' contributions

MIA and BS contributed to writing the original draft, visualisation, funding acquisition, data curation, methodology, investigation, reviewing and editing. MSH analysed the data, interpreted and prepared the manuscript, validation funding. SK contributed to writing, review, editing and funding acquisition. KSK contributed to software, data analysis, writing-review & editing. MKI contributed to writing, review & editing, resources and funding acquisition. NJ contributed to writing-review, editing, Resources and funding acquisition. SMS contributed to writing, review & editing, resources and funding acquisition. MSK contributed to Software, data analysis, writing-reviewing & editing. MMH contributed to conceptualisation, validation, writing-reviewing & editing, resources and funding acquisition. All the authors read and approved the final manuscript.

Compliance with ethical standards

Conflict of interest: Authors do not have any conflict of interests to declare.

Ethical issues: None

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