Original Research Article

Phosphorous Application Improved Growth and Fruit Yield of Okra (*Abelmoschus esculentus* L.) During *Kharif* Season in Bangladesh

.ABSTRACT

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| --- |
| The experiment was conducted at the field experimental station of Sher-e-Bangla Agricultural University (SAU), Dhaka, during the *Kharif* season (April to August) of 2023 to investigate the influence of different phosphorus levels on the growth, yield attributes, and yield of okra (*Abelmoschus esculentus* L.). This experiment was conducted using a randomized complete block design (RCBD) with four replications. The experimental treatments consisted of two okra varieties, namely 'BARI Dherosh-2' and 'Chamak' and four levels of phosphorous, viz., 0.0, 70.0, 90.0, and 110 kg P₂O₅ ha⁻¹. Data on plant height, leaves per plant, petiole length, stem diameter, internode length, and branches per plant were recorded at 20, 40, 60, 80, and 100 days after sowing (DAS). Days required to first flowering, number of floral buds per plant, number of pods per plant, individual pod weight, pod length and diameter, pod yield, and dry matter accumulation in different plant parts were also recorded. The result found that the vegetative growth parameters and yield-contributing characters were significantly improved with phosphorus fertilization. The ‘BARI Dherosh-2’ when treated with 90 P₂O₅ ha⁻¹ resulted in maximum plant height (99.27 cm at 100 DAS), branches per plant (4.68 at 100 DAS), fruits per plant (36.65), and fruit yield (14.94 t ha⁻¹). The results were statistically similar to those obtained with the treatment combination using the same variety at 110 P₂O₅ ha⁻¹. It has been concluded that 'BARI Dherosh-2' along with a dosage of 90 kg P₂O₅ per hectare could be a suitable dose for cultivating okra during the kharif season in Bangladesh. |

***Keywords****: Okra; BARI Dherosh-2; Phosphorus; kharif* season; *Growth, Yield,*

1. INTRODUCTION

Okra (*Abelmoschus esculentus* L.) is a vegetable crop typically cultivated for its tender, green fruits, which are prized for their culinary versatility and nutritional value (Wang *et al.,* 2017). It plays a prominent role in the culinary traditions of various tropical and subtropical regions, such as the Southern United States, India, West Africa, and the Middle East. A key ingredient in dishes like gumbo, a popular Creole creation, and featured in soups, stews, and curries, okra's mild, slightly nutty flavor and distinctive texture make it a favorite across diverse culinary landscapes (Reed, 2006).

The nutritional contribution of okra extends to being a rich source of dietary fiber, vitamins and minerals like potassium and magnesium. With dietitians recommending a daily vegetable intake of 285g for adults (Rampal and Gill, 1990), okra proves to be a healthy addition. Its antioxidant content, low-calorie nature, and potential health benefits, including blood sugar regulation and digestive health support, make it a favorable choice (Elhassaneen *et al.,* 2020).

Traditionally, okra has found use in various cultures for its perceived health benefits. It is thought to regulate blood sugar, aid in digestive health, and offer relief from conditions like constipation (Abdul Razis *et al.,* 2013). Being heat-tolerant and drought-resistant, okra is well-suited for cultivation in hot and dry climates. Its short growing cycle and high yield potential make it a crucial cash crop for small-scale farmers in many developing nations (Patil *et al.,* 2017).

Phosphorus, an essential macronutrient, plays a vital role in various plant physiological processes such as photosynthesis, energy transfer, and nucleic acid synthesis (Raghothama, 1999). It is crucial for root development, flowering, and fruiting (Schachtman *et al*.,1998). Phosphorus deficiency in okra can lead to reduced root growth, delayed flowering, and poor fruit formation, impacting fruit yield and quality (Zhang *et al.,* 2016). Ahmad and Tallock (1964) observed a 75 percent yield increase with phosphorus application at 56 kg ha-1, highlighting its importance in fruiting development.

Referred to as "the life key," phosphorus plays a critical role in numerous physiological processes. Achieving high-quality okra green fruit yields necessitates the right fertilizer amounts, with phosphorus fertilizer holding significance in this context. Despite varying outcomes in research reports, understanding the specific impact of phosphorus levels on okra's growth is crucial for tailoring nutrient management practices. This becomes especially important amid increasing global demand for nutritious and sustainable food sources.

In recent years, sustainability and resource conservation have raised concerns about the environmental impact of chemical fertilizer (nutrient) management (Syers et al., 2008). Phosphorus has gained attention due to its limited availability in soils and tendency to pollute water (Cordell et al., 2009). Understanding the relation between okra growth and phosphorus levels can help increase agricultural yield while reducing the adverse environmental impacts. In order to support sustainable agricultural practices, this study intends to investigate the effects of varying phosphorus levels on growth attributes and productivity of okra. Besides, the study aims to find out a suitable combination phosphorus and okra variety for ensuring higher yield of the crop, which could ultimately help the growers.

2. material and methods

2.1 Experimental Site

The experiment was conducted at the research farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, Bangladesh, during the *Kharif* season (April 2023 to August 2023). Geographically, the experiment site was located at 23°74’N latitude and 90°35’E longitude, with an elevation of 8.1 m above sea level. The experimental site had a subtropical climate and was a part of the Modhupur Tract (AEZ-28). The soil was shallow red-brown terrace soil with a silty clay texture. Before transplanting, four 0-20 cm topsoil cores were collected from the experimental field using a standard auger for analysis of physiochemical properties. The properties of topsoil are shown in Table 1.

2.2 Planting Material

Two okra varieties were used as planting materials viz. (i) BARI Dherosh-2 and (ii) ACI Okra “Chamak”. The seeds were obtained from the Bangladesh Agricultural Research Institute in Joydebpur, Gazipur and Siddiq Bazar respectively.

**Table 1. Physical, chemical and biological properties of experimental soil (0-20 cm)**

|  |  |  |
| --- | --- | --- |
| Particulars | Value | Methods |
| Sand (%)  Silt (%)  Clay (%) | 16  56  28 | Hydrometer meter method (Gee and Bauder, 1986) |
| Bulk density, g c m-3 | 1.23-1.45 | Core Sampler methos (Blake and Hartge, 1986) |
| pH (1: 2.5: Soil: Water) | 5.56 | Glass Electrode method |
| Organic carbon (g kg-1) | 0.45 | K2Cr2O7oxidation-titration method (Blake, 1965) |
| Total N, % | 0.064 | Modified Kjeldahl Method (Bremner and Mulvaney,1982) |

**2.3 Experimental design and Treatments**

The experiment was conducted under field condition using a 2×4 factorial randomized complete block design (RCBD) with four replications. Four levels of phosphorous (P) fertilizer were applied viz, T0: 0 kg P2O5 ha-1 (control), T1: 70 kg P2O5 ha-1, T2: 90 kg P2O5 ha-1, and T3: 110 kg P2O5 ha-1. The total experimental area was 300 m2 (30 m length × 10 m width dividing into 4 blocks. Each block had 8 treatments place randomly, making 32 treatment plots in total. Each unit plot was 3.0 m long and 2.0 m wide, maintaining a 1.0-meter spacing between blocks and a 0.5- meter spacing between two plots.

**2.4 Growth Condition and Management**

The okra seeds were sown on 6th April, 2026 in the main field. To manage soil-borne diseases, Bavistin was applied as a treatment for the seeds were treated with Bavistin to prevent soil borne disease. Seeds were placed in rows at a depth of 2-3 cm, with 30 cm spacing between plants and 60 cm between rows. After seedling germination Intercultural operations such as gap filling, weeding, earthing up, irrigation, and pests and diseases control were conducted to promote healthy growth and enhance yield whenever necessary. Cinocarb 3G was applied during the final land preparation, and mechanical methods and the application of Darsban 29 EC at a 3% concentration to manage cutworms. Diseased discolored and yellowish leaves were also removed to ensure healthy plant growth and development. The okra fruits were harvested at intervals of every 4 days based on eating quality. Harvesting commenced on May 22, 2023, and continuing till 15 July 2023 to ensure optimal ripeness and quality for consumption or processing.

**2.5 Data Collection**

To assess the impact of various treatments in the experiment on plant growth, yield attributes, and overall yield, data was collected systematically. Five plants were randomly chosen from the middle rows of each unit plot to avoid any border effects. Data were collected on following parameters: plant height, number of leaves, length of petiole, diameter of stem, length of leaf, number of branches per plant, length of internode, diameter of fruit, fresh weight of plant, dry weight of plant, yield/plot, yield/hectare.

These parameters were recorded at four different time points: 20, 40, 60, 80 and 100 days after sowing (DAS). Additionally, the fresh weight of leaves per plant and the dry weight per plant were measured at 100 DAS. Other crucial yield-related characteristics and parameters were also documented, such as: The number of days required for flowering to occur, Number of flowers per plant, Number of fruits per plant, Weight of individual fruits, Length of fruits, Diameter of fruits, Yield per plot.

**2.5 Data Analysis**

Collected data were statistically analyzed using Statistix 10 software. Mean for treatments were calculated, and analysis of variance and difference between treatment means was assessed by Least Significant Difference (LSD) test at 5% level of significance (Gomez and Gomez, 1984).

3. results and discussion

**3.1 Plant height**

Plant height of okra exhibited significant variations at 20, 40, 60, 80, and 100 days after sowing (DAS) in response to different phosphorus levels (Table1). Phosphorous application increased plant height by 11.1 to 35.9% over control. At each time point, T2 treatment yielded the tallest plants which were statistically similar to T3 treatment. T1 treatment showed intermediate heights while the shortest plants were observed under T0 (control). Interaction effect of P doses and varieties on plant height also indicted the similar tends. The combination V1T3 exhibited the highest plant heights (18.0, 40.52, 74.97, 86.65, and 99.27 cm at 20, 40, 60, 80, and 100 DAS). Conversely, the V2T0 treatment produced the lowest plant height. Increases in plant height attributed to phosphorous application were also documented by Uddin *et al.,* (2014). This trend also aligns with the findings of Bhai and Singh (1998).

**Fig. 1.** Bar graph showing interaction effects of phosphorous doses and varieties on plant height of okra at different days after sowing (DAS). In a bar, groups with similar letter(s) are statistically alike, while those with different letter(s) show significant differences at a 0.05 probability level. V1, BARI Dherosh-2; V2, Chamak. T0, 0 kg P2O5 ha-1, T1, 70 kg P2O5 ha-1; T2, 90 kg P2O5 ha-1; T3, 110 kg P2O5 ha-1. DAS, days after sowing.

**3.2 Internode length**

Phosphorus application significantly improved the average internode length of okra recorded at final harvest (100 DAS) (Table 2). BARI Dherosh-2; and Chamak varieties showed 8.13 to 40.08% and 13.5 to 29.41% improvements with selected phosphorus treatments, respectively. The longest average internode (14.73 cm) was produced by BARI Dherosh-2 with T2 (90 kg P2O5 ha-1) treatment which was statistically similar to the internode length of the same variety under T3 (110 kg P2O5 ha-1). The Chamak variety also produced longest internode with T2 treatment, however compared to BARI Dherosh-2 its average internode length was 14.9% shorter at similar phosphorous levels. Both varieties produced shortest internode length under T0 (0 kg P2O5 ha, i.e., control condition). These findings underscore that both the variety and the application of phosphorus can influence internode length. Previous studies suggested that the application of phosphorus significantly increases internode length okra (Uddin et al., 2014; Bhai and Singh,1998).

**Fig. 1.** Bar graph showing interaction effects of phosphorous doses and varieties on average internode length of okra at final harvest (100 DAS). In a bar, groups with similar letter(s) are statistically alike, while those with different letter(s) show significant differences at a 0.05 probability level. V1, BARI Dherosh-2; V2, Chamak. T0, 0 kg P2O5 ha-1, T1, 70 kg P2O5 ha-1; T2, 90 kg P2O5 ha-1; T3, 110 kg P2O5 ha-1. DAS, days after sowing.

**3.3 Leaves number**

Phosphorus application significantly improved the leaf number of okra recorded at 20, 40, 60, 80, and 100 days after sowing (DAS) in response to different phosphorus levels (Table 3). The highest leaf number (49.47plant-1) of okra was observed from T2 (90 kg P2O5 ha-1) treatment, which was statistically similar T3 (110 kg P2O5 ha-1) treatment. Interaction effects of variety and phosphorous level also showed significant variation in okra leaf production. The V1T2 produced the maximum leaf number at different days after sowing which were 17.8 to 22.6% and 16.3 to 28.2% greater over the V1T0 and V2T0 treatments, respectively. Okra leaf production per plant at different DAS under V2T2 treatment were significantly higher than V2T0 treatment and statistically identical with V2T3 treatment, but **11.6 to 13 % lesser** compared to V1T2 treatment. Overall data indicated that phosphorous improves leaves production in okra. The result aligns with those reported by Firoz (2009) and Uddin et al. (2014), who observed that better phosphorus-nourished okra plants show higher growth, as reported for number of leaves, leaf size and branch numbers. However, V1 (BARI Dherosh-2) produced more leaves than V2 (Chamak), highlighting its superior photosynthetic potential.

**Table 2. Effect of phosphorus on leaves number of okra at different days after sowing**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Treatments** | **Leaves number** | | | | |
| **20 DAS** | **40 DAS** | **60 DAS** | **80 DAS** | **100 DAS** |
| **T0** | 6.21b | 16.83b | 31.07a | 39.30c | 42.00b |
| **T1** | 6.01b | 17.47b | 33.63bc | 40.78bc | 44.56b |
| **T2** | 6.88a | 21.36a | 37.06a | 45.58a | 49.47a |
| **T3** | 7.02a | 20.78a | 36.63ab | 43.80ab | 49.18a |
| LSD (0.05) | 0.50 | 1.89 | 3.29 | 3.22 | 3.31 |
| CV (%) | 7.37 | 9.54 | 6.71 | 6.46 | 6.20 |

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability. T0, 0 kg P2O5/ha, T1, 70 kg P2O5/ha; T2, 90 kg P2O5/ha; T3, 110 kg P2O5/ha. DAS, days after sowing.

**Table 3. Interaction effect of fertilizer doses and varieties on leaves number of okra at different days after sowing**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Treatments** | **Leaves number** | | | | |
| **20 DAS** | **40 DAS** | **60 DAS** | **80 DAS** | **100 DAS** |
| **V1T0** | 6.17cd | 16.77c | 35.70bc | 40.75cde | 42.82bc |
| **V1T1** | 5.80d | 17.75bc | 37.62ab | 42.67bcd | 46.00b |
| **V1T2** | 7.27a | 22.62a | 39.90a | 46.72a | 52.50a |
| **V1T3** | 7.17ab | 22.42a | 39.72a | 45.15ab | 52.00a |
| **V2T0** | 6.25cd | 16.90c | 27.67d | 38.10e | 40.92c |
| **V2T1** | 6.22cd | 17.20c | 29.65d | 38.90de | 43.37bc |
| **V2T2** | 6.50bcd | 20.10ab | 35.22bc | 44.45abc | 46.45b |
| **V2T3** | 6.87abc | 19.15bc | 34.12c | 42.45bcd | 46.37b |
| **LSD (0.05)** | 0.70 | 2.68 | 3.43 | 4.03 | 4.22 |
| **CV (%)** | 7.37 | 9.54 | 6.71 | 6.46 | 6.20 |

In a column, groups with similar letter(s) are statistically alike, while those with different letter(s) show significant differences at a 0.05 probability level. V1, BARI Dherosh-2; V2, Chamak. T0, 0 kg P2O5/ha, T1, 70 kg P2O5/ha; T2, 90 kg P2O5/ha; T3, 110 kg P2O5/ha. DAS, days after sowing.

**3.4 Leaf dry matter content**

Biomass content reflects carbohydrate partitioning in plant. Application of different levels of phosphorus in selected Okra varieties showed significant variation in the total biomass content of leaves (Table 4). The biomass content of leaves of BARI Dherosh-2 was maximum (26.35 g plant-1) with T2 (90 kg P2O5 ha-1) treatment, which was 26.1% and 28.5% greater than V1T0 and V2T0 treatments, respectively. The variation in leaf biomass content of V1T2, V1T3, V2T2, and V2T3 treatments was statistically identical. Lowest leaf biomass content (20.51 g plant-1) observed in V2T0 treatment which was statistically similar with V1T0 but 21.15% and 22% lower than V2T2, and V2T3 treatments, respectively.

Singh et al. (2022) reported that plants receiving 90–100 kg P₂O₅/ha recorded a 20–30% increase in leaf dry matter compared to unfertilized controls. Our result found up to 28.5% increase in leaf biomass content with 90 kg P₂O₅ ha-1. Kumar et al. (2021) reported that phosphorus fertilization improved dry matter production in multiple plant parts of okra, with leaf dry matter being most responsive due to higher source-sink activity. Phosphorus fertilization significantly increased dry matter content in okra by promoting chloroplast development and photosynthetic efficiency (Singh et al. 2022). Phosphorus deficiency reduced leaf dry matter by up to 35%, primarily due to impaired root function and reduced leaf expansion (Khan et al. 2020).

**3.5. Branches per plant**

The combination V1T2 treatment exhibited the height number of branches per plant (4.68) at final harvest which was 44% greater than V1T0 treatment but statistically similar to V1T3 treatment. The V2T2 treatment had 37.4% height number of branches per plant compared to V2T0 but statistically similar with V2T1 and V2T3 treatments. Conversely, the combination V2T0 showed the lowest number of branches (2.43). These results indicate that the application of phosphorus can influence branching of okra, however, responses could vary with variety selection.

**Table 4. Interaction effect of phosphorus levels and varieties on Dry leaf biomass, branches number of okra at final harvest**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Treatments** | **Dry leaf biomass**  **(g plant-1)** | **Branches number (plant-1)** | **Stem base diameter (cm)** | **Days of first flowering** |
| **V1T0** | 20.89d | 3.25c | 1.75c | 44.25a |
| **V1T1** | 23.29c | 4.26b | 1.81c | 43.65a |
| **V1T2** | 26.03ab | 4.68a | 2.62a | 38.25b |
| **V1T3** | 26.35a | 4.60a | 2.63a | 38.62b |
| **V2T0** | 20.51d | 2.43d | 1.80c | 43.82a |
| **V2T1** | 22.85c | 3.16c | 1.97c | 43.90a |
| **V2T2** | 24.84bc | 3.34c | 2.31b | 37.85b |
| **V2T3** | 25.02b | 3.16c | 2.27b | 38.50b |
| **LSD (0.05)** | 2.31 | 0.330 | 0.26 | 3.839 |
| **CV (%)** | 7.82 | 6.22 | 8.23 | 6.35 |

In a column, groups with similar letter(s) are statistically alike, while those with different letter(s) show significant differences at a 0.05 probability level. V1, BARI Dherosh-2; V2, Chamak. T0, 0 kg P2O5/ha, T1, 70 kg P2O5/ha; T2, 90 kg P2O5/ha; T3, 110 kg P2O5/ha. DAS, days after sowing.

**3.6 Stem Base Diameter**

The effect of different varieties and phosphorus doses showed significant variation in the stem diameter of okra at 100 days after sowing, as summarized in Table 4. The V1T3 treatment exhibited the widest stem base diameter (2.63 cm) which was statistically similar to V1T2 but 50.3% wider over the stem base diameter observed with V1T0 treatment. Conversely, the V1T0 showed the lowest stem diameter (1.75 cm) at final harvest which was statistically similar to V1T0 and V2T0 but varied statistically with other treatment.

**4.7 Days to first flowering**

The application of phosphorus significantly reduced the day to flowering in okra (Table 6). The minimum days required to first flowering (38.25 days) of okra under the V1T2 treatment, which was statistically similar to V1T3, V2T2, and V2T3. The maximum day to first flowering (44.25 days) was under V1T0 treatment, which was statistically similar to the V2T0, and V2T1. These results demonstrate that both variety and the application of phosphorus can influence the day of flowering.

**4.8 Number of flowers per plant**

The effect of different varieties and phosphorus doses showed significant variation in the number of flowers of okra, as outlined in Table 5. The combination V1T2 exhibited the highest number of flowers (39.05), which was statistically similar to V1T3 and V2T2. The number of flowers observed under V1T2 treatment was 74.7% greater than V1T0. The V2T2 treatment had 63.9% higher number of flowers per plant compared to V2T0, but statistically similar with V2T3 treatment. Conversely the V1T0 exhibited the lowest number of flowers (22.35). These findings highlight that the application of phosphorus can affect the flower production of okra, though the response may differ depending on the variety selection.

**4.9 Number of fruits per plant**

Application of different levels of phosphorus in selected Okra varieties exhibited significant variation in the number of fruits per plant (Table 5). The fruit number of BARI Dherosh-2 was maximum (36.65 plant) with T2 (90 kg P2O5 ha-1) treatment, which was statistically similar to the same variety under T3 (110 kg P2O5 ha-1) treatment. The plants under V2T0 treatment produced 86.9% and 97.6% greater fruits per plant than V1T0 and V2T0 treatments, respectively. The Chamak variety also produced highest number of fruits per plant withT2 treatment, however compared to BARI Dherosh-2 its average fruits number was 9.76% smaller at similar phosphorous levels. Both varieties produced smallest number of fruits per plant under T0 (0 kg P2O5 ha-1, i.e., control condition). These findings underscore that both the variety and the application of phosphorus can influence internode length. In previous study, Laxman et al. (2004) found that increasing phosphorus levels up to 90 kg/ha resulted in a higher number of fruits per plant. On the other hand, Sultana (2002) identified 80 kg/ha as the optimal phosphorus rate for okra.

**4.10 Fruit length**

Phosphorus application significantly influenced the average fruit length of okra recorded in (Table 5). BARI Dherosh-2, and Chamak varieties showed 17.7 to 68.3% and 33.1 to 83.9% improvements with selected phosphorus treatments, respectively. The longest average fruit length (17.57cm) was produced by Chamak with T2(90 kg P2O5 ha-1) treatment which was statistically similar to the fruit length of the same variety under T3 (110 kg P2O5 ha-1) treatment. The BARI dherosh-2 variety also produced longest fruit length with T2 treatment, however compared to Chamk its average fruit length was 6.8% shorter at similar phosphorous levels. Both varieties produced shortest fruit length under T0 (0 kg P2O5 ha-1, i.e., control condition). These results highlight that both the variety and the application of phosphorus can influence fruit length. Previous studies suggested that the application of phosphorus significantly increases internode length okra (Uddin et al., 2014; Laxman et al, 2004). The findings are similar to those of Arora et al. (1991) and Naik and Srinivas (1992), who observed a significant increase in pod length in okra with the application of phosphorus.

**4.11 Fruit diameter**

The fruit diameter of okra varied significantly due to the different varieties and phosphorus levels, as shown in Table5. The V1T2 treatment exhibited the widest fruit diameter (1.91 cm) which was statistically similar to V1T3 but 31.7% wider over the fruit diameter observed with V1T0 treatment. The combination of V2T2 treatment exhibited widest fruit diameter (1.87cm) which was 48.4% greater than V2T0 but statistically similar with V2T3 treatment. Conversely, the V2T0 showed the lowest fruit diameter (1.26 cm) in average which was statistically similar to V1T0, V1T1 and V2T2 but varied statistically with other treatment.

**Table 5. Interaction effect of fertilizer doses and varieties on yield contributing characteristics of okra**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Treatments** | **No. of Flower plant-1** | **No. of Fruit plant-1** | **Average Fruit length (cm)** | **Average Fruit diameter (cm)** | **Fruit weight**  **(g fruit-1 )** | **Fruit yield**  **(t ha-1)** |
| **V1T0** | 22.35c | 19.60e | 9.77c | 1.45bc | 8.75b | 5.67d |
| **V1T1** | 31.25b | 28.67d | 11.50bc | 1.47b | 9.40b | 8.97c |
| **V1T2** | 39.05a | 36.65a | 16.45a | 1.91a | 12.22a | 14.94a |
| **V1T3** | 38.82a | 35.97ab | 16.37a | 1.81a | 12.50a | 14.45a |
| **V2T0** | 23.07c | 18.52e | 9.55c | 1.26c | 8.72b | 5.38d |
| **V2T1** | 28.85b | 29.77cd | 12.72b | 1.45bc | 9.47b | 9.38c |
| **V2T2** | 37.82a | 32.77bc | 17.57a | 1.87a | 11.50a | 12.80b |
| **V2T3** | 37.65a | 32.60c | 17.42a | 1.85a | 11.47a | 12.42b |
| **LSD (0.05)** | 4.468 | 3.33 | 1.987 | **0.205** | **1.04** | **1.54** |
| **CV (%)** | 9.39 | 7.73 | 9.71 | **8.53** | **6.81** | **9.99** |

In a column, groups with similar letter(s) are statistically alike, while those with different letter(s) show significant differences at a 0.05 probability level. V1, BARI Dherosh-2; V2, Chamak. T0, 0 kg P2O5 /ha, T1, 70 kg P2O5 /ha; T2, 90 kg P2O5 /ha; T3, 110 kg P2O5 /ha. DAS, days after sowing.

**4.12 Fruit weight**

The interaction effect of varieties and different phosphorus levels demonstrated significant variation in the weight of fruits (Table 5). The combination of V1T2 treatment displayed the maximum fruit weight (12.50g) which was 42.8% and 43.3% greater than V1T0 and V2T0 treatments respectively. The variation in fruit weight of V1T2, V1T3, V2T2 and V2T3 treatments was statistically similar. Lowest fruit weight (8.72g) was observed in V2T0 which was statistically similar with V1T0, but 31.8% and 31.5% lower than V2T2 and V2T3 treatments, respectively. These results emphasize that both the choice of variety and the application of phosphorus can influence the weight of individual fruits.

**4.13 Fruit yield**

Application of different levels of phosphorus in selected Okra varieties exhibited significant variation in the fruit yield (Table 5). The maximum yield was obtained from the V1T2 treatment (14.94 t/ha), which was 163.4% to 177.7% higher than the V1T0 and V2T0 treatments. It was statistically similar to the V1T3 treatment but significantly higher than all other treatments. The V2 also produced highest fruit yield (12.80tha-1) with T2 treatment, however compared to V1 its fruit yield was 16.7% smaller at similar phosphorous levels. Minimum fruit yield (5.38) observed in V2T0 treatment which was statistically similar with V1T0.These results emphasize the synergistic effect of variety selection and phosphorus application on okra yield per hectare. Increasing levels of phosphorus up to 90 kg/ha increased yield/ha (Laxman et al., 2004). Okra plants were more efficient in their use of P in terms of yield/ha (Akinrinde and Adigun, 2005)

4. Conclusion

The field experiment was conducted to investigate the influence of different phosphorus levels on the growth, yield attributes, and yield of okra (*Abelmoschus esculentus* L.) during *Kharif* season in Bangladesh.

The results revealed that the vegetative growth parameters and reproductive parameters of okra were improved with phosphorus fertilization. However, the application of 90 kg P ha⁻¹ (T2) and 110 kg P₂O₅ ha⁻¹ (T3) treatments significantly highest influence on of growth and yield enhancement of okra compared to the other treatments. The BARI dherosh-2 and chamak, both varieties responded positively to this phosphorus inputs. However, plant development, flowering, and fruiting response of BARI dherosh-2 to phosphorus treatments was much higher than the variety ‘Chamak’. Among the two selected varieties, BARI dherosh-2 yielded higher quantities and best quality fruits across all phosphorus treatments. Our result suggest that the 90 kg P₂O₅ ha-1 phosphorus application could be the most effective dose for promoting robust plant growth and maximizing yield and quality of BARI dherosh-2.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.

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