*Original Research Article*

# Impact ofSowing dates and bio-fertilizers on yield attributes and yield parametersin okra [*Abelmoschus esculentus* (L.) Moench].


## ABSTRACT

The field experiment was conducted during the *kharif* seasonsof 2022-23 and 2023-24 at the Vegetable Research Farm, Department of Vegetable Science, Chandra Shekhar Azad University of Agriculture and Technology,Kalyanpur, Kanpur to study the impact of sowing dates and bio-fertilizers on yield attributes and yield parameters in okra [*Abelmoschus esculentus* (L.) Moench]. The experiment was laidout in a Factorial Randomized Block Design (FRBD) with 3 replications. Twelve treatment combinations comprising of three sowing dates *viz*., $D_1$ ($1^{st}$July), $D_2$ ($15^{th}$July) and $D_3$ ($30^{th}$July) and four levels of bio-fertilizers *viz*., $B_0$ Control (No bio-fertilizer), $B_1$ (*Azotobacter* @ 3 kg/ha), $B_2$ (PSB @ 3 kg/ha) and $B_3$ (*Azotobacter* @ 3 kg/ha + PSB @ 3 kg/ha). The results of the study revealed that the treatment combination $D_1$ ($1^{st}$July) with $B_3$(*Azotobacter* @ 3 kg/ha + PSB @ 3 kg/ha), performed better than other treatments such as yield attributes and yield parameters *viz*., days to first fruit initiation (45.15 days), days to first picking (46.77 days), number of fruits per plant (26.49), fruit length (13.67 cm), average fruit weight (13.76 g), fruit yield per plant (356.98 g), fruit yield per plot (12.49 kg), fruit yield (132.16 q/ha).


***Keywords*:** Sowing dates, *Azotobacter,* PSB, okra and yield.



## 1. INTRODUCTION

Okra [*Abelmoschus esculentus*(L.) Moench] is an important vegetable crop in tropical, sub-tropical and temperate regions around the world(Arapitsas, 2008)[1].Okra is a warm-season crop because it is grown season during *zaid*and *kharif*. It originated from Ethiopia(Lamont, 1999)[2].Okra belongs to the family Malvaceae and the genus *Abelmoschus*, with chromosome number 2n = 130 as described by(Gadwal *et* al., 1968)[3].It is also called Bhindi in India, Lady's finger in England (Ndunguru and Rajabu,(2004)[4]. The temperature ranges between 21 to 30ºC for growth, flowering, and yield, 35ºC for fast germination, fails to below 17ºC (Tindal, 1983)[5]. It can be grown on wide ranges of soils but well-fertile soil respectively (Akinyele and Temikotan, 2007)[6]. In India, it is most commonly grown in Gujarat, West Bengal, Odisha, Bihar, Madhya Pradesh and Uttar Pradesh. Among these states, Gujarat is a leading okra-producing state with an area and production of 85.15 thousand ha and 1019.42 thousand metric tonnes, with productivity of 11.97 MT/ha respectively. Uttar Pradesh covers an area of 24.19 thousand hectares with production of 325.59 thousand metric tonnes and productivity of 13.46 MT/ha (Annonymous 2007)[7]. The nutrient value of okra (per 100 g edible portion) contains 89.6 % moisture, 35 kcal energy, 0.2 g fat, 1.9 g protein, 0.07 mg thiamine, 6.4 g carbohydrates, 0.10 mg riboflavin, 0.6 mg niacin, 13 mg ascorbic acid, 0.7 g minerals like; 6.9 mg sodium, 103 mg potassium, 56 mg phosphorus, 66 mg calcium, 1.5 mg iron. Dry seeds of okra contain 13-22% edible oil and 20-24% protein (Thamburaj and Singh, 2018)[8].Carbohydrates are available in the form of mucilage (Liu *et al*., 2005)[9]**.**Okra is mainly grown to itstender green fruits cooked in curry and consumed as soups. The stems and roots of okra are used to clean sugarcane juice from which gur or jaggery is prepared (Chauhan, 1972)[10].Sowing date also has agreat impact on the yield and quality of okra (Moniruzzaman*et al*., 2007)[11].Its production and productivity are also affected due to inappropriate sowing dates, nutrients, and severe attack several insect-pests, weeds and diseases (Saha *et al.*, 1989)[12].For better yield and quality of different crops that depends on sowing time in the proper growth season.Okra also found that seeds sown in July have higher fruit yield compared to late August and October (Yogesh and Gopal, 2001)[13].The plant sown at proper time gets advantage of climatic factors, like; temperature, rainfall and during growth and development. Delayed sowing time causes decreased pod yield of okra (Ghannad*et al.,* 2014) [14].A good cultivar sown at an improper time given poor yield. Bio-fertilizers are the formulation of living microorganisms such as bacteria, fungi and algae an ability to mobilize nutrients from non-usable forms through biological processes (Tien *et al.,* 1979)[15]. Bio-fertilizers are potential sources of plant nutrition Bio-fertilizers. Used to bio-fertilizers that are efficient safe and organic crop production(Uddin *et al.,* 2019) [16].In Proper conditions *Azotobacter and Azospirillum*an enhance plant growth and development results promote the yield of crops in different types of soils (Jagnow,1987) [17], (Becking 1992) [18]. *Azotobacter* and*Azospirillum* are non-symbiotic, free-living, gram-negative, aerobic bacteria that nitrogen-fixing in non-leguminous crops (Kumar *et al.,* 2017)[19].

## 2. MATERIALS AND METHODS

The field experiment was conducted at the Vegetable Research Farm, Department of Vegetable Science, Chandra Shekhar Azad University of Agriculture and Technology, Kalyanpur, Kanpur during the *kharif* seasons of 2022-23 and 2023-24. The experiment was laid out in a factorial randomized block design with three replications.Twelve treatment combinations were used, comprising three sowing dates, *viz*., $D_1$ ($1^{st}$July), $D_2$ ($15^{th}$ July) and $D_3$ ($30^{th}$July), and four levels of bio-fertilizers, *viz*., $B_0$Control (No bio-fertilizer), $B_1$ (*Azotobacter* @ 3 kg/ha), $B_2$ (PSB @ 3 kg/ha) and $B_3$ (*Azotobacter* @ 3 kg/ha + PSB @ 3 kg/ha). A soil sample was randomly collected from the experimental field at a depth of 0-15 cm. The collected sample was thoroughly mixed, and a composite soil sample of 500 g was prepared. Subsequently, the sample was analyzed for physical and chemical properties at the soil testing laboratory of Chandra Shekhar Azad University of Agriculture & Technology, Kanpur, U.P. The pH was determined using a pH meter, and available nitrogen was measured by the alkaline permanganate method suggested by (Piper 1966) [20]. Available phosphorus and potash were analyzed using Olsen's method (Olsen 1954) [21]. and the Flame photometer method, respectively. The electrical conductivity (E.C.) was determined by the Conductivity Bridge as described by (Jackson 1967) [22]. Each plot was 3.15 × 3.0 m in size and 60× 45 cm spacing. The recommended fertilizer dose of 120 kg/ha N, 60 kg/ha $P_2O_5$ and 60 kg/ha $K_2O$ was applied to the experimental plots. Thinning was done 15 days after sowing, leaving one healthy plant per hill. All recommended cultural practices and plant protection measures were followed throughout the experiment (Chattopadhyay *et al.,* 2007) [23]. Observations of yield attributes and yield parameters were recorded on five randomly selected and tagged competitive plants from each plot in each replication. All parameters were statistically analyzed using the analysis of variance (ANOVA) suggested by (Panse and Sukhatme 1985) [24].

**Table 1. Details of treatments**

| Treatments | Notation | Treatment combinations |
|---|---|---|
| $T_1$ | $D_1$ $B_0$ | Date of sowing ($1^{st}$ July) + Control (No bio-fertilizer) |
| $T_2$ | $D_1$ $B_1$ | Date of sowing ($1^{st}$ July) + *Azotobacter* @ kg/ha |
| $T_3$ | $D_1$ $B_2$ | Date of sowing ($1^{st}$ July) + PSB @ 3 kg/ha |
| $T_4$ | $D_1$ $B_3$ | Date of sowing ($1^{st}$ July) + *Azotobacter* @ 3 kg/ha + PSB @ 3 kg/ha |
| $T_5$ | $D_2$ $B_0$ | Date of sowing ($15^{th}$ July) + Control (No bio-fertilizer) |
| $T_6$ | $D_2$ $B_1$ | Date of sowing ($15^{th}$ July) + *Azotobacter* @ 3 kg/ha |

| | | |
|---|---|---|
| $T_7$ | $D_2 B_2$ | Date of sowing (15th July) + PSB @ 3 kg/ha |
| $T_8$ | $D_2 B_3$ | Date of sowing (15th July) + *Azotobacter* @ 3 kg/ha + PSB @ 3 kg/ha |
| $T_9$ | $D_3 B_0$ | Date of sowing (30th July) + Control (No bio-fertilizer) |
| $T_{10}$ | $D_3 B_1$ | Date of sowing (30th July) + *Azotobacter* @ 3 kg/ha |
| $T_{11}$ | $D_3 B_2$ | Date of sowing (30th July) + PSB @ 3 kg/ha |
| $T_{12}$ | $D_3 B_3$ | Date of sowing (30th July) + *Azotobacter* @ 3 kg/ha+ PSB @ 3 kg/ha |

## 3. RESULTS AND DISCUSSION

The results of the present study clearly indicate that the data presented in Tables 2 and 3 demonstrate the effects of different sowing dates and bio-fertilizers, along with their combined effects during the 2022-23 and 2023-24 study. These findings revealed variations in the yield attributes and yield parameters of okra,*viz.,*days to first fruit initiation, days to first picking, number of fruits per plant, fruit length (cm), average fruit weight (g), fruit yield per plant (g), fruit yield per plot (kg), fruit yield (q/ha).

### 3.1 Yield attributes and yield parameters

#### 3.1.1 Days to first fruit initiation

The data (shown in Table 2) pertaining to the effect of sowing dates and bio-fertilizers on days to first fruit initiation revealed significant differences among sowing dates. In the years 2022-23 and 2023-24, sowing date $D_1$ (1st July) was recorded the minimum number of days to first fruit initiation (46.21 and 46.09 days), while sowing date $D_3$ (30thJuly) was reported the maximum number of days to first fruit initiation (47.75 and 47.63 days). In the case of bio-fertilizers during both years, $B_3$ (*Azotobacter* @ 3 kg/ha + PSB @ 3 kg/ha) reported the minimum number of days to first fruit initiation (46.15 and 46.01 days), while $B_0$ showed the maximum number of days (48.15 and 48.06 days). The combination effect of sowing dates and bio-fertilizers demonstrated that $D_1B_3$ registered the minimum number of days to first fruit initiation (45.21 and 45.09 days),while the maximum number of days was found in $D_3B_0$ (48.57 and 48.49 days) among the treatments. These results might be attributed to favourable weather conditions during plant vegetative growth and development, as bio-fertilizers enhance nutrient availability in the plant, resulting in reduced number of days for first fruit initiation. Similar findings were reported by (Bake *et al.,* 2017)[25], (Singh *et al*., 2018) [26] and (Chaodhary*et al*., 2015)[27].

#### 3.1.2 Days to first picking

In both years 2022-23 and 2023-24, the significant variations in dates of sowing $D_1$ (1stJuly) obtained the minimum days to first picking (47.26 and 47.13 days), while the maximum was observed in $D_3$ (30th July) with 48.95 and 47.84 days, respectively. In the case of bio-fertilizers, significant differences were also noted in both years, $B_3$ (*Azotobacter* @ 3 kg/ha + PSB @ 3 kg/ha) reported the earliest days to first picking (47.17 and 47.02 days), while the maximum was found in $B_0$ (49.18 and 48.84 days). The data pertaining to the interaction effect of sowing dates and bio-fertilizers did not significantly reveal that $D_1B_3$ reported the minimum number of days to first picking (46.84 and 46.71 days). In comparison, the highest number of days was registered in $D_3B_0$ (49.97 and 49.74 days), as demonstrated in Table 2. The sowing time has a significant impact on yield attributes, the earliest picking, when seeds were sown on 1st July, might be attributed to favorable weather conditions, such as optimal temperature and good rainfall, which resulted in quick and early flowering. This led to increased photosynthesis and, consequently, enhanced early picking compared to other sowing dates. In the case of bio-fertilizers, the differences might be due to faster and more vigorous vegetative growth, which results in early fruit picking. These findings agree with the results of (Padhiyar*et al.,* 2023) [28], (Sood and Kaur, 2019) [29], (Marak, 2023) [30] and (Kanzariya*et al*. 2010) [31].

### 3.1.3 Number of fruits per plant

The data as illustrated in Table 2, showed significant differences in sowing dates and bio-fertilizers on the number of fruits per plant during both the years 2022-23 and 2023-24, date of sowing, $D_1$ (1$^{st}$July) exhibited the highest number of fruits per plant (24.33 and 24.69), while lowest number of fruits per plant (22.04 and 22.39) was reported in $D_3$ (30$^{th}$July). In the case of bio-fertilizers, $B_3$ (*Azotobacter* @ 3 kg/ha + PSB @ 3 kg/ha) registered the maximum number of fruits per plant (24.55 and 25.13), whereas the minimum was reported in $B_0$ (21.20 and 21.24). The data pertaining to the combined effect of sowing dates and bio-fertilizers in both years showed that $D_1B_3$ obtained the maximum number of fruits per plant (26.23 and 26.75), while the lowest was reported in $D_3B_0$ (20.16 and 20.19). The study indicated that although number of fruits per plant is controlled by genetic material, but also influenced by environmental factors such as temperature, sowing date, soil conditions and agricultural practices. The study clearly indicates that sowing okra seeds during the first week of July is advantageous for obtaining maximum number of fruits and bio-fertilizers also known to produce amino acids, vitamins, growth promoting substances like; IAA and gibberellins that help in better growth and yield. These findings are consistent with previous research by(Ghannad*et al.,* 2014) [14]. (Undie and Litio, 2018) [32],(Pandey *et al.,* 2009) [33] and (Sundararao and Sinha, 1963) [34].

### 3.1.4 Fruit length (cm)

From the Table 2 it is clear that in both years 2022-23 and 2023-24, date of sowing $D_1$ (1$^{st}$July) reported maximum fruit length (12.33 and 12.68 cm), while minimum fruit length observed (10.71 and 11.02 cm) in $D_3$ (30$^{th}$July). In the case of bio-fertilizers, highest fruit length (12.52 and 12.97 cm) was found in $B_3$ (*Azotobacter* @ 3 kg/ha + PSB @ 3 kg/ha), while the lowest fruit length (9.78 and 9.92 cm) was recorded in $B_0$. The data pertaining to the interaction effect was also significant on sowing dates and bio-fertilizers of 2022-23 and 2023-24, maximum fruit length exhibited (13.39 and 13.96 cm) in $D_1B_3$, while minimum fruit length was reported in $D_3B_0$ (8.98 and 9.14 cm), first and second year, respectively. The first week of July was shown to have been associated with increased fruit length, likely due to favourable environmental conditions (temperatures, rainfall) during this period. Nitrogen is the major constituent of proteins, enzymes, hormones, vitamins, alkaloids, and chlorophyll and their synthesis could have been accelerated by the adequate supply of nitrogen in association with bio-fertilizers. This improvement in the plant's growth may be attributed to better root development, mineral uptake, and plant-water relationship. The ability of the microorganisms to fix the atmospheric nitrogen to the soil and make it available to the growing plants. In addition to nitrogen fixation, *Azotobacter* apart from nitrogen-fixation is also responsible for the production of plant hormones like IAA, GA3, and cytokinins like substances which ultimately results in better plant growth and fruit length. Similar findings were also reported by(Padhiyar*et al.,* 2023) [28], (Talukder *et al*., 2003) [35] and(Chaodhary*et al*., 2015) [27].

### 3.1.5 Average fruit weight (g)

During the both years 2022-23 and 2023-24, dates of sowing, $D_1$ (1$^{st}$July) recorded maximum average fruit weight (12.59 and 13.24 g), while $D_3$ (30$^{th}$July) registered minimum average fruit weight (11.56 and 11.74 g). In the case of bio-fertilizers, the maximum average fruit weight (12.72 and 13.21 g) was reported in $B_3$ (*Azotobacter* @ 3 kg/ha + PSB @ 3 kg/ha), while the lowest average fruit weight was recorded (11.10 and 11.20 g) in the treatment $B_0$. The interaction effect was also significant on sowing dates and bio-fertilizers of both years, maximum average fruit weight recorded in $D_1B_3$ (13.34 and 14.19 g), whereas minimum average fruit weight (10.78 and 10.86 g) was registered in the treatment combination $D_3B_0$ in the year of

2022-23 and 2023-24, as showed in Table 3 (Fig.1). Variation in the individual fruit weight might be due to the genetic potential of different okra cultivars, it is due to favourable environmental conditions. Plants get more nutrients from the soil and other natural resources from the environment which facilitates proper development of pods. Bio-fertilizer treatments showed a significant effect on yield attributing parameters and yield of okra. Bio-fertilizers containing living and latent cells of efficient strains of *Azoptobacter* (nitrogen-fixing), phosphate solubilizing bacteria which augment the availability and access of nutrients leading to higher growth of the plants.The increase in fruit yield with the combined application of *Azoptobacter* and PSB might be due to increased availability of both N and P nutrients resulting in higher nutrient uptake with consequent increase in average fruit weight and yield of okra. The results is in close conformity with that of (Zeb*et al*., 2015) [36], (Dash *et al.,* 2013) [37] and (Bamboriya*et al.,* 2018) [38].

### 3.1.6 Fruit yield per plant (g)

In both the years 2022-23 and 2023-24, $D_1$ sowing date ($1^{st}$July) exhibited the maximum fruit yield per plant (307.54 and 317.10 g), whereas minimum fruit yield per plant (255.24 and 263.27 g) was recorded in sowing date $D_3$ ($30^{th}$July). In the case of bio-fertilizers, $B_3$ (*Azotobacter* @ 3 kg/ha + PSB @ 3 kg/ha) registered the highest fruit yield/plant (313.10 and 327.78 g) while the lowest in $B_0$ (235.39 and 236.51 g). The data pertaining to the combination effect of sowing dates and bio-fertilizers in both the years, $D_1B_3$ exhibited the maximum fruit yield per plant (349.90 and 364.06 g), while minimum fruit yield per plant was reported in the $D_3B_0$ (217.32 and 218.25 g), as demonstrated in Table 3. This might have resulted from the maintenance of optimum plant population and favourable weather conditions during plant vegetative growth and development. The reason for the increase in fruit yield might be the solubilizing effect of bio-fertilizers as evidenceby the increase in the uptake of plant nutrients. Similar results were accordanece by (Morwal and Patel, 2017) [39], (Meena *et al*., 2019) [40] and (Kumar *et al.*, 2017) [19].

### 3.1.7 Fruit yield per plot (kg)

From the Table 3, it is clear that both the years 2022-23 and 2023-24, sowing date, $D_1$ ($1^{st}$ July) registered the maximum fruit yield per plot (10.76 and 11.10 kg), while the minimum fruit yield per plot (8.93 and 9.21 kg) was observed in $D_3$ ($30^{th}$ July). In the case of bio-fertilizers, recorded the maximum fruit yield per plot (10.95 and 11.47 kg) in $B_3$ (*Azotobacter* @ 3 kg/ha + PSB @ 3 kg/ha), while minimum fruit yield per plot (8.23 and 8.27 kg) was recorded in $B_0$. In respect of the interaction effect of sowing dates and bio-fertilizers, significant results were observed during 2022-23 and 2023-24. The combination $D_1B_3$recorded the highest fruit yield per plot (12.24 and 12.74 kg), whereas the lowest fruit yield per plot was registered in the treatment combination$D_3B_0$ (7.60 and 7.63 kg).This increase in fruit yield could be attributed to environmental conditions, particularly temperature and relative humidity, during the crop growth period. The higher fruit yield with the combined application of Azotobacter and PSB might be due to the increased availability of both nitrogen (N) and phosphorus (P) nutrients, leading to higher nutrient uptake and a consequent increase in fruit yield per plot.These results are in accordance with the findings of(Ghannad*et al.,* 2014) [14],(Padhiyar*et al.,* 2023) [41], (Prasad and Naik, 2013) [42] and (Bamboriya*et al.,* 2018) [38].

### 3.1.8 Fruit yield (q/ha)

The data shown in Table 3 (Fig.2) pertaining to the fruit yield (q/ha) reveal that in the years 2022-23 and 2023-24, $D_1$ Sowing date (1st July), highest fruit yield (113.83 and 117.41 q/ha), while lowest fruit yield (94.47 and 97.46 q/ha) found in the treatment $D_3$ (30th July). In the case bio-fertilizers, $B_3$*Azotobacter* @ 3 kg/ha + PSB @ 3 kg/ha) registered the maximum fruit yield (115.90 and 121.37 q/ha), while the minimum fruit yield (87.12 and 87.55 q/ha). The result of the combination effect of sowing dates and bio-fertilizers was also significant in the first and second years, $D_1B_3$ produced maximum fruit yield (129.52 and 134.81 q/ha), while minimum fruit yield (80.42 and 80.74 q/ha) recorded in $D_3B_0$. Delayed sowing in monsoon seasons results in a decreased yield of up to 20-30%. These results might be due to more favourable environmental conditions during all stages of crop growth. Plant growth and yield are largely dependent on biomass production (photosynthesis) and its distribution in various parts of the plant. Integrated use of recommended NPK and seed inoculation with bio-fertilizers, particularly, *Azotobacter*, P-solubilizers (PSB) effect on biomass partitioning. This may be because the biomass accumulated in vegetative parts of the plant at the active growth stage was efficiently distributed and accumulated later on in the reproductive part (fruits) resulting in an increase in fruit yield quintal per ha. This is in close agreement with the findings of (Bake *et al.,* 2017) [25], (Talukder *et al*., 2003) [35] and (Pandey *et al.,* 2009) [33] and (Sahu *et al.* 2014) [43].

## 4. CONCLUSION

On the basis of results, it may be concluded that the application of sowing date 1st July + *Azotobacter* @ 3 kg/ha + PSB @ 3 kg/ha was found to be best than other treatment combinations in the yield attributes and yield parameters *viz.,* days to first fruit initiation, days to first picking, number of fruits per plant, fruit length (cm), average fruit weight (g), fruit yield per plant (g), fruit yield per plot (kg), fruit yield (q/ha). It may be recommended for farmers of the central plain zone of Uttar Pradesh better yield in okra.

## DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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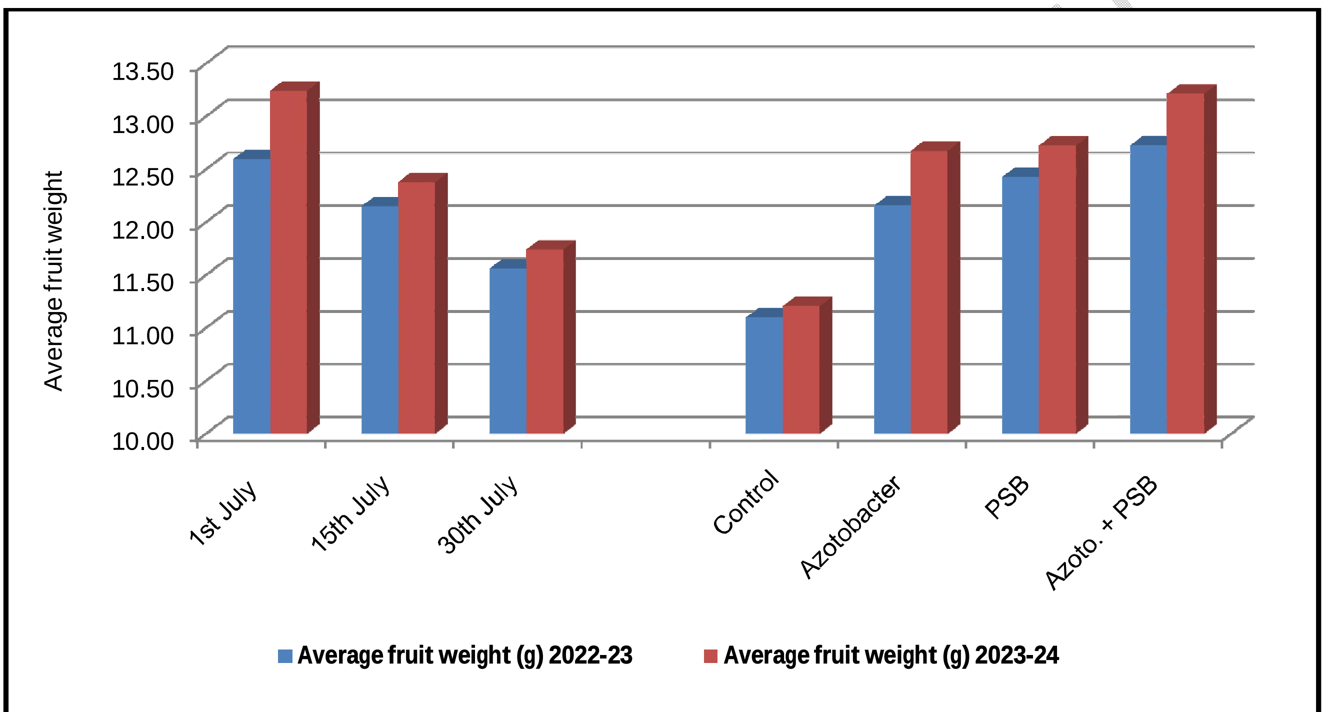


**Fig.1. Impact of Sowing dates and bio-fertilizers on average fruit weight (g) of okra**

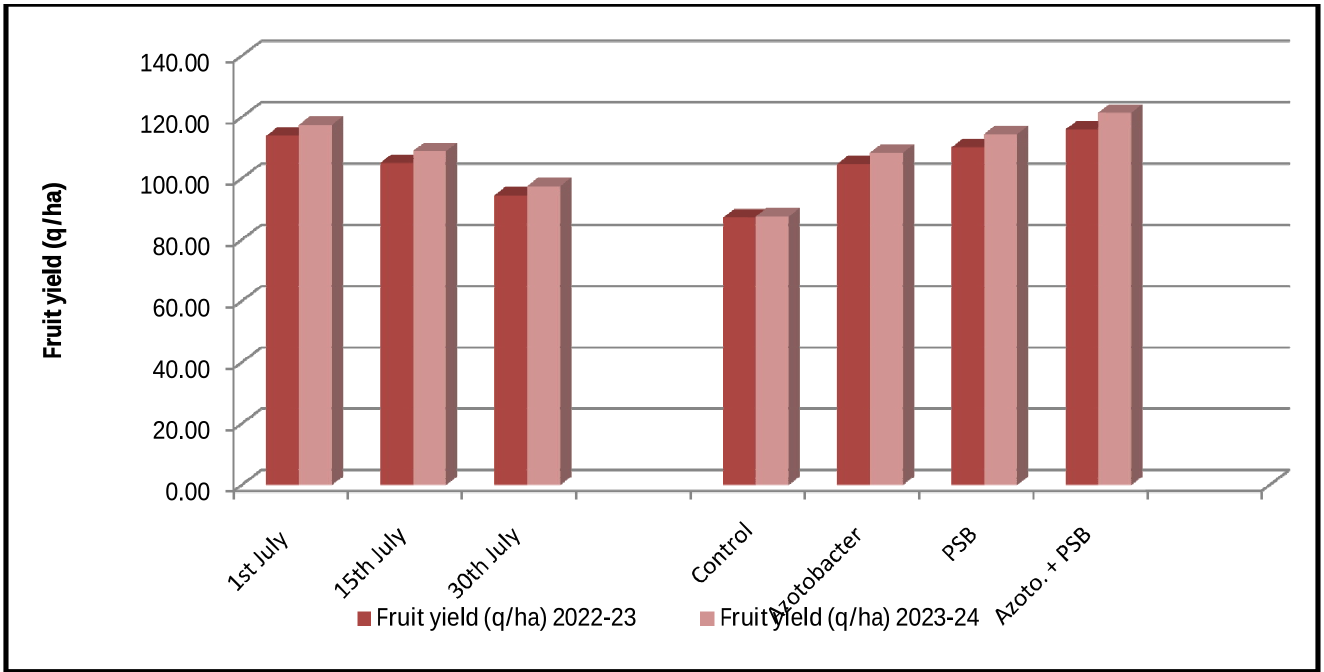


**Fig.2. Impact of Sowing dates and bio-fertilizers on fruit yield (q/ha) of okra**

**Table 2 Days to first fruit initiation, Days to first picking, Number of fruits per plant and Fruit length (cm)**

| Treatments | Days to first fruit initiation | | Days to first picking | | Number of fruits per plant | | Fruit length (cm) | |
|---|---|---|---|---|---|---|---|---|
| | 2022-23 | 2023-24 | 2022-23 | 2023-24 | 2022-23 | 2023-24 | 2022-23 | 2023-24 |
| **Effect of datesof sowing** | | | | | | | | |
| $D_1$ | 46.21 | 46.09 | 47.26 | 47.13 | 24.33 | 24.69 | 12.33 | 12.68 |
| $D_2$ | 46.90 | 46.78 | 47.53 | 47.42 | 23.29 | 23.71 | 11.63 | 11.90 |
| $D_3$ | 47.75 | 47.63 | 48.95 | 47.84 | 22.04 | 22.39 | 10.71 | 11.02 |
| **SE(m)±** | **0.182** | **0.179** | **0.173** | **0.190** | **0.092** | **0.092** | **0.045** | **0.046** |
| **CD (*P*=0.05)** | **0.538** | **0.530** | **0.510** | **0.559** | **0.270** | **0.270** | **0.133** | **0.135** |
| **Effect of bio-fertilizers** | | | | | | | | |
| $B_0$ | 48.15 | 48.06 | 49.18 | 48.84 | 21.20 | 21.24 | 9.78 | 9.92 |
| $B_1$ | 46.97 | 46.85 | 47.55 | 47.43 | 23.24 | 23.67 | 11.78 | 12.08 |
| $B_2$ | 46.55 | 46.41 | 47.36 | 47.18 | 23.88 | 24.34 | 12.15 | 12.50 |
| $B_3$ | 46.15 | 46.01 | 47.17 | 47.02 | 24.55 | 25.13 | 12.52 | 12.97 |
| **SE(m)±** | **0.211** | **0.207** | **0.200** | **0.219** | **0.106** | **0.106** | **0.052** | **0.053** |
| **CD (*P*=0.05)** | **0.622** | **0.612** | **0.589** | **0.646** | **0.312** | **0.312** | **0.153** | **0.156** |
| **Interaction(Datesofsowing×Bio-fertilizers)** | | | | | | | | |
| $D_1B_0$ | 47.81 | 47.72 | 49.69 | 49.42 | 21.92 | 21.97 | 10.45 | 10.59 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| $D_1B_1$ | 46.29 | 46.18 | 48.05 | 47.89 | 24.02 | 24.39 | 12.49 | 12.71 |
| $D_1B_2$ | 45.52 | 45.38 | 47.25 | 47.05 | 25.15 | 25.64 | 12.97 | 13.45 |
| $D_1B_3$ | 45.21 | 45.09 | 46.84 | 46.71 | 26.23 | 26.75 | 13.39 | 13.96 |
| $D_2B_0$ | 48.06 | 47.98 | 49.84 | 49.69 | 21.51 | 21.56 | 9.92 | 10.04 |
| $D_2B_1$ | 46.94 | 46.78 | 48.74 | 48.58 | 23.45 | 23.95 | 11.79 | 12.14 |
| $D_2B_2$ | 46.64 | 46.51 | 48.39 | 48.22 | 23.79 | 24.23 | 12.11 | 12.39 |
| $D_2B_3$ | 45.97 | 45.83 | 47.58 | 47.33 | 24.41 | 25.11 | 12.71 | 13.02 |
| $D_3B_0$ | 48.57 | 48.49 | 49.97 | 49.74 | 20.16 | 20.19 | 8.98 | 9.14 |
| $D_3B_1$ | 47.67 | 47.59 | 49.55 | 49.24 | 22.25 | 22.68 | 11.05 | 11.38 |
| $D_3B_2$ | 47.48 | 47.33 | 49.21 | 48.97 | 22.71 | 23.16 | 11.36 | 11.65 |
| $D_3B_3$ | 47.28 | 47.11 | 48.92 | 48.71 | 23.02 | 23.52 | 11.45 | 11.93 |
| **SE(m)±** | **0.365** | **0.359** | **0.346** | **0.379** | **0.183** | **0.183** | **0.090** | **0.092** |
| **CD (*P*=0.05)** | **NS** | **NS** | **NS** | **NS** | **0.541** | **0.540** | **0.265** | **0.271** |

Table 3. Average fruit weight (g), Fruit yield per plant (g), Fruit yield per plot (kg) and Fruit yield (q/ha)

| Treatments | Average fruit weight (g) | | Fruit yield per plant (g) | | Fruit yield per plot (kg) | | Fruit yield (q/ha) | |
|---|---|---|---|---|---|---|---|---|
| | 2022-23 | 2023-24 | 2022-23 | 2023-24 | 2022-23 | 2023-24 | 2022-23 | 2023-24 |
| **Effect of datesof sowing** | | | | | | | | |
| $D_1$ | 12.59 | 13.24 | 307.54 | 317.10 | 10.76 | 11.10 | 113.83 | 117.41 |
| $D_2$ | 12.15 | 12.38 | 283.59 | 293.94 | 9.92 | 10.29 | 105.00 | 108.83 |
| $D_3$ | 11.56 | 11.74 | 255.24 | 263.27 | 8.93 | 9.21 | 94.47 | 97.46 |
| **SE(m)±** | **0.047** | **0.044** | **2.418** | **2.741** | **0.091** | **0.085** | **0.745** | **0.838** |
| **CD (*P*=0.05)** | **0.139** | **0.131** | **7.139** | **8.091** | **0.270** | **0.249** | **2.198** | **2.473** |
| **Effect of bio-fertilizers** | | | | | | | | |
| $B_0$ | 11.10 | 11.20 | 235.39 | 236.51 | 8.23 | 8.27 | 87.12 | 87.55 |
| $B_1$ | 12.15 | 12.67 | 282.73 | 292.43 | 9.89 | 10.23 | 104.65 | 108.29 |
| $B_2$ | 12.43 | 12.72 | 297.29 | 309.04 | 10.40 | 10.81 | 110.05 | 114.39 |
| $B_3$ | 12.72 | 13.21 | 313.10 | 327.78 | 10.95 | 11.47 | 115.90 | 121.37 |
| **SE(m)±** | **0.054** | **0.051** | **2.793** | **3.165** | **0.106** | **0.098** | **0.860** | **0.967** |
| **CD (*P*=0.05)** | **0.160** | **0.151** | **8.243** | **9.343** | **0.312** | **0.288** | **2.538** | **2.855** |
| **Interaction(Datesofsowing×Bio-fertilizers)** | | | | | | | | |
| $D_1B_0$ | 11.39 | 11.52 | 249.66 | 251.11 | 8.73 | 8.78 | 92.38 | 92.91 |
| $D_1B_1$ | 12.59 | 13.77 | 302.41 | 311.46 | 10.58 | 10.90 | 111.95 | 115.34 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| $D_1B_2$ | 13.05 | 13.48 | 328.20 | 341.78 | 11.48 | 11.96 | 121.48 | 126.56 |
| $D_1B_3$ | 13.34 | 14.19 | 349.90 | 364.06 | 12.24 | 12.74 | 129.52 | 134.81 |
| $D_2B_0$ | 11.12 | 11.23 | 239.19 | 240.17 | 8.37 | 8.41 | 88.57 | 88.99 |
| $D_2B_1$ | 12.24 | 12.47 | 287.02 | 298.65 | 10.04 | 10.45 | 106.24 | 110.58 |
| $D_2B_2$ | 12.41 | 12.64 | 295.23 | 306.26 | 10.33 | 10.71 | 109.31 | 113.33 |
| $D_2B_3$ | 12.82 | 13.17 | 312.93 | 330.69 | 10.95 | 11.57 | 115.87 | 122.43 |
| $D_3B_0$ | 10.78 | 10.86 | 217.32 | 218.25 | 7.60 | 7.63 | 80.42 | 80.74 |
| $D_3B_1$ | 11.63 | 11.78 | 258.76 | 267.17 | 9.05 | 9.35 | 95.76 | 98.94 |
| $D_3B_2$ | 11.82 | 12.05 | 268.43 | 279.07 | 9.39 | 9.76 | 99.36 | 103.28 |
| $D_3B_3$ | 12.01 | 12.27 | 276.47 | 288.59 | 9.67 | 10.10 | 102.32 | 106.87 |
| **SE(m)±** | **0.094** | **0.089** | **4.837** | **5.482** | **0.183** | **0.169** | **1.489** | **1.675** |
| **CD (*P*=0.05)** | **0.277** | **0.262** | **14.278** | **16.182** | **0.540** | **0.499** | **4.396** | **4.945** |