JOURNAL OF AGRICULTURE AND APPLIED BIOLOGY
2023, Vol. 4, No. 1, 28 - 38
http://dx.doi.org/10.11594/jaab.04.01.04
E-ISSN: 2723-5106

Research Article

Varietal trials and yield components determining variation among okra varieties (*Abelmoschus esculentus* L.)

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Article history:
Submitted 10 December 2022
Accepted 27 January 2023
Published 16 February 2023

Keywords:
Arka anamika
Growth
Performance
Phenotypic correlation

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Abstract

Yield analysis is necessary to test the overall performance of different okra varieties. For this, field experiments were performed during the summer season to assess the yield or production of different okra varieties under open field conditions. The experiment comprised four treatments with seven replicas in an RCBD. The treatments included four different varieties of okra: Arka Anamika, Chiranjeevi F1, Gunjan, and JK 1666. The experimental results showed that the average mean yield of four okra varieties was 98.30 gm per plant. Overall, it was further revealed that Arka Anamika gave the highest yield (101.01gm), followed by Gunjan (98.89gm), Chiranjeevi F1 (96.95gm), and JK1666 (96.37gm). Similarly, other parameters were also analyzed simultaneously to check yield attributing factors which unveiled that plant height was maximum (162.55 cm) in Chiranjeevi F1, followed by Gunjan, JK 1666, and Arka Anamika. Moreover, the number of primary branches was highest for Chiranjeevi F1 (4.47). Contrary to this, the number of pods per plant was also the most significant (3.80) in Arka Anamika. Further, Gunjan topped all the other three varieties in terms of pod diameter (5.53 cm) and weight of pod (25.12 gm). The pod length was highest in JK 1666 (14.83 cm). The data from the experiment also demonstrated that Arka Anamika matured faster (50 DAS) than the other three varieties, which showed Arka Anamika to be more economical for farmers; hence, from our field research, it can be inferred that Arka Anamika is a good variety for farmers growing okra in the Morang area.

Introduction

Okra (*Abelmoschus esculentus*) is a warm-seasonal crop known as lady finger or ochro in many foreign countries, and bhindi in Nepal (Singh et al., 2018). It is a member of the genus Abelmoschus and the family Malvaceae. Originating in Tropical Asia or Africa, it is currently grown widely in the Tropics (Poudel et al., 2018). Around the world, okra mainly grows in areas experiencing hot temperatures with

How to cite:
Yadav, S. P. S., Bhandari, S., Ghimire, N. P., Nepal, S., Paudel, P., Bhandari, T., Paudel, P., Shrestha, S., & Yadav, B. (2023). Varietal trials and yield components determining variation among okra varieties (*Abelmoschus esculentus* L.). *Journal of Agriculture and Applied Biology, 4*(1): 28 - 38. doi: 10.11594/jaab.04.01.04

warm and humid nights where temperatures are more than 20◦ C (Anwar et al., 2011). Furthermore, Okra is a high-yielding annual plant that has a range of characteristics, including, pod shape, pigment, branching degree, maturation duration, and plant height (Aminu et al., 2017). According to Ministry of Agriculture and Livestock Development (2020), okra was produced nationwide at a productivity of 11.3 tons per hectare, totalling 122,101.6 metric tons on an area of 10,781.4 hectares (Jha et al., 2018). Okra cultivation is influenced by several abiotic and biotic elements. Conversely, biotic factors like insects, pests, weeds, and diseases (bacteria, fungus, viruses, mycoplasma, and nematodes) (Poudel et al., 2018).

Only the young pods of okra are consumed; the older ones are either discarded or given to the animals (Aminu et al., 2017). The fertilizer requirement for okra is mainly the soil enriched with vermicompost, manures, and biofertilizer, which provides additional substances not found in chemical fertilizer (Mal et al., 2013). The use of organic manure is mainly preferred for okra because it helps maintain the crop's sustainable fertility in the long run (Gudugi, 2013). The usage of low yielder types, poor plant densities, erroneous planting dates, soil fertility, availability of necessary plant nutrients, and suitable spacing all have a significant impact on the production and yield of okra (Khanal et al., 2020). The various growth parameters like plant height, pod diameter, number of branches, stem diameter, weight, and fruit yield significantly increase with the application of different plant-originated manures like mustard oil cakes, including poultry manure, goat manures, and earthworm manures, which also improves soil properties and facilitates plant growth (Kurunç & Ünlükara, 2009). The quality and quantity of okra are significantly affected by the diseases caused due to different viruses, bacteria, fungi, nematodes, insects, pests, etc. Cotton jassid is regarded as one of the most destructive sucking pests of okra. Besides jassid, the other pests are shoot and fruit borers, whitefly, aphid, and mite, which affect the okra plant (Das et al., 2011). Secondly, the most common fungal diseases are damping off, vascular wilt, powdery mildew, etc. (Kumar et al., 2013). By cultivating genotypes or varieties that produce much more than cultivars produced in the same soil and climate, it is possible to boost crop production (Singh et al., 2018). It is found that different types and hybrids require foreign soil and climatic condition for their optimum production, whereas a single variable may not be suitable for all the agroecology and climatic requirements; possibly, there is the varied response of different varieties (Margai et al., 2021). Thus, in response to that, we conducted this study to identify the well-suited and high-performing okra varieties for the Eastern-Terai region of Nepal. The four okra varieties, i.e., Arka Anamika, Chiranjeevi F1, Gunjan, and JK 1666, were selected from the recommendations of the National Agriculture Research Council (NARC) based on their adaptability and popularity. The information on the morphological and physiological variances amongst okra varieties might be advantageous for future initiatives in the production of high-yielding okras in the Eastern Terai region of Nepal.

Research methodology

Experimental site

The field experiment was carried out from June 9, 2022, to August 13, 2022, in the research field of G.P Koirala College of Agriculture and Research Centre located at Sundarharaicha, Morang, Nepal, to evaluate the yield of different varieties of okra. The climate of this area is tropical type. The average annual temperature of this area ranges between 22.81 to 32.46 °C, and the average yearly precipitation is 131.88mm. Geographically it is located at 26^0 40' 49.3" North latitude and 87^0 21' 16.1" East longitudes with an elevation of 150 m. The soil characteristics of the experimental site were analyzed in qualitative measures with the help of a soil test kit box (Table 1). The average highest temperature and lowest temperature throughout the study period were 31.74 °C and 24.44 °C, respectively, with an average amount of precipitation of 209.03 mm. The summary of the weather records collected during the research period is presented in (Figures 1, Figure 2, and Figure 3).

Table 1: Soil characteristics of the experimental site

S.N.	Soil characteristics	Properties
1	Nitrogen	Medium
2	Potassium	Medium
3	Phosphorus	Low
4	Soil pH	6.5
5	Soil texture	Silty loam

Research design

The research was designated in RCBD with four treatments replicated seven times. There were altogether 28 plots. Each plot was designated 9 m^2 (3m*3m) with a total area of 252 m^2. The gap between the two replications was maintained at 1m, and between the two treatments was 0.5m. 40 plants per plot were kept with spacing between rows to row 0.6m and plant to plant 0.35m. The fertilizer rate applied in the field was @120:60:60kg N: P: K and 25 tons of farm yard manure (FYM) per hectare. The complete dose of potassium and phosphorus followed by half dose of nitrogen were uniformly applied during the sowing time and the other half dose of nitrogen fertilizer was administrated in two split doses, one at flowering stage and the other was applied after weeding at 22 DAS. After 21 DAS, weeding was carried out, and irrigation was undertaken every seven days.

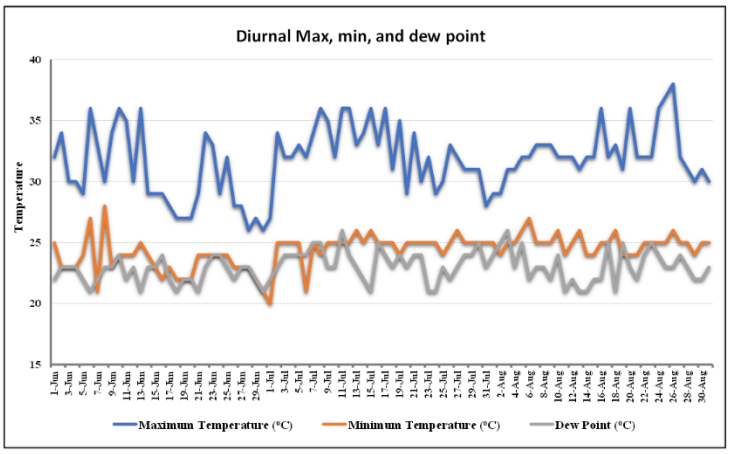

Figure 1. Diurnal maximum, minimum, and dew point (˚C) throughout the growing period of okra in Gothgaun, Morang

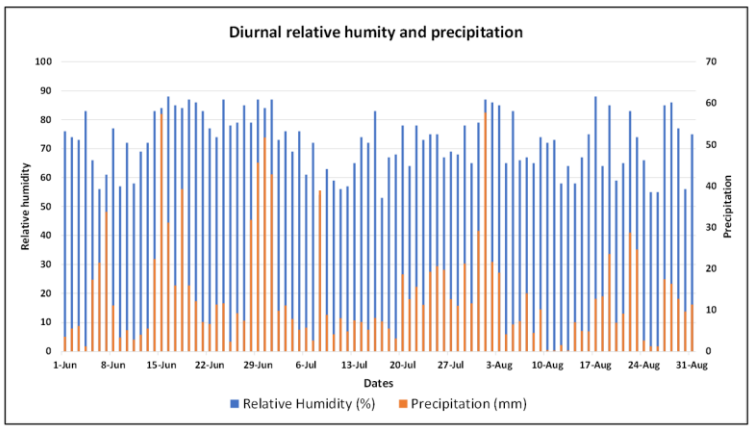

Figure 2. Diurnal relative humidity (%), and precipitation (mm) throughout the growing period of okra in Gothgaun, Morang

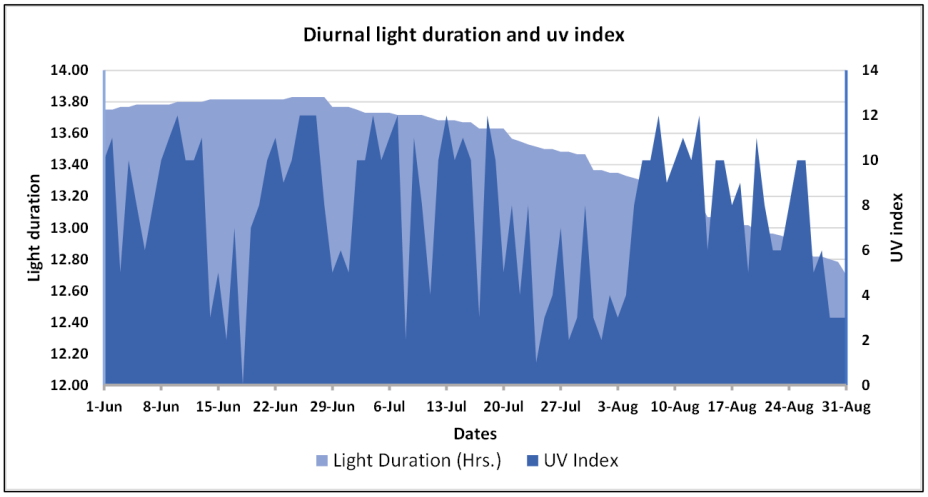

Figure 3. Diurnal light duration (hrs.) and UV index throughout the growing period of okra in Gothgaun, Morang

Treatment details

The treatment consists of four varieties of okra allocated as follows in the table below (Table 2).

Table 2. List of varieties utilized in the research

S. N.	Treatments	Symbol
1	Arka Anamika	T1
2	Chiranjeevi F1	T2
3	Gunjan	T3
4	JK 1666	T4

Data collection

From each experimental plot, twelve plants were selected in a random manner to collect the necessary data. The data were collected every seven days. The yield parameters of the okra that we examined were PB, PH, P/P, PL, PD, and W/P (Ashraf et al., 2020; Singh et al., 2018).

Plant height Using the measuring tape, the plant's height was calculated from its base to its tip (Adhikari & Piya, 2020) at weekly intervals until the plant was giving economic yield.

Primary branches Every week, the total number, of primary branches was tallied.

Number of pods per plant The overall P/P was evaluated through counting per treatment and per replica for each variety from the day of 50% flowering per plot (Aminu et al., 2019). After that, it was taken at weekly intervals.

Pod length Pod length and diameter were taken when the okra bears 50%. The pod length was taken manually with the help of measuring scale and diameter using a vernier caliper (Adhikari & Piya, 2020). The average length and diameter of the harvested pods were taken by dividing the total length of pods/diameter by the total number of pods per plant in each treatment for all replication.

Pod weight The digital weighing machine was used to measure the weight of obtained pods (Adhikari & Piya, 2020). The obtained data were expressed in tons per ha based on yield per plot (Ali et al., 2012).

Statistical analysis

The acquired data was entered using MS Excel (2019). The collected data were analyzed by using Gen-stat (18th edition). The collected figures were analyzed using DMRT for comparing the output means of each parametric data (Gomez & Gomez, 1984). The traits' phenotypic correlations were evaluated using RStudio software (4.2.2 Version). The graphs and bar charts for the different parameters were also created using MS Excel (2019).

Results and discussion

The results in Table 3-7 and Figure 5 show that the differences in pod diameter, pods per plant, and yield among the varieties were insignificant. Still, the plant height, primary branches, pod length, weight per pod, and DF were highly significant ($P \geq 0.1$). The study shows a significant growth in the height of

plants of all varieties up to 70 DAS. The maximum height (205.05) was attained by the variety Chiranjeevi F1 at all the growth stages (Table 3). Similarly, the minimum height of the plant (183.74) was acquired by the variety Arka Anamika. The average data observed in the plant height shows that the highest plant height was achieved by Chiranjeevi F1(162.55) followed by Gunjan (160.57), JK 1666 (156.55) and Arka Anamika (132.82) with the significant level at (P<0.001). According to Ghawade et al. (2018) and Dahal et al. (2021), the height of the plant in 60 DAS was 76.95. Likewise, Nagar et al. (2017) observed that the height of variety Ankur-40 was 130.9, and Chiranjeevi F1 obtained in our study was 205.05. In comparison to those studies, the plant height was higher. This might be because of the genotypic differences between the varieties. Similarly, the study shows that the highest number of primary branches was observed in the Chiranjeevi F1, and the lowest number of primary branches was observed in Gunjan (Table 3). The number of primary branches in 3 varieties (Chiranjeevi F1, Gunjan, JK166) gradually decreased to 56 DAS and then increased to 70 DAS. The number of primary branches in Arka Anamika was first increasing up to 28 DAS and then began to decrease to 56 DAS and again showed an increment to 70 DAS. The average data observed in the primary branches shows that the maximum PB was developed by Chiranjeevi F1(4.47) followed by JK 1666 (4.07), Arka Anamika (3.36), and Gunjan (2.85) with the significant level at (P<0.01). The outcome of the present study for main branches are consistent with the analysis made by Ibeh et al. (2019) and Singh and Singh (2013). Further, the study shows that JK 1666 has the largest pod length among other varieties (19.89) at 28 DAS (Table 4). The lowest pod length was observed in Arka Anamika and Chiranjeevi F1, which is 3.11 and 3.07, respectively, at 14 DAS. The highest mean was 17.37, which was observed on 28 DAS. The average data observed in the pod length shows that the longest pods was developed by JK 1666 (14.83) followed by Gunjan (14.75), Arka Anamika (13.25), and Chiranjeevi F1(12.47) with the significant level at (P<0.001). Accordingly, the results show alignment with the observation by Sibsankar et al. (2012) and Mal et al. (2013).

Table 3. Plant height and primary branches of different okra varieties at 14,28,42,56 and 70 DAS

Variety	Plant height (PH)						Primary branches (PB)					
	14 DAS	28 DAS	42 DAS	56 DAS	70 DAS	Average	14 DAS	28 DAS	42 DAS	56 DAS	70 DAS	Average
Arka Anamika	59.90^{c}	106.63^{c}	147.08^{b}	166.77^{b}	183.74^{c}	132.82^{b}	3.35^{b}	3.44^{bc}	3.32^{b}	3.23^{bc}	3.44^{bc}	3.36^{bc}
Chiranjeevi F1	97.31^{ab}	145.15^{ab}	173.28^{a}	191.95^{a}	205.05^{a}	162.55^{a}	4.80^{a}	4.47^{a}	4.27^{a}	4.19^{a}	4.62^{a}	4.47^{a}
Gunjan	106.65^{a}	154.10^{a}	170.33^{a}	181.21^{a}	190.56^{bc}	160.57^{a}	2.91^{b}	2.85^{c}	2.81^{b}	2.83^{c}	2.85^{c}	2.85^{c}
JK 1666	92.81^{b}	139.32^{b}	167.13^{a}	183.72^{a}	199.74^{ab}	156.55^{a}	4.28^{a}	4.25^{ab}	4.11^{a}	3.92^{ab}	3.78^{ab}	4.07^{ab}
Mean	89.17	136.30	164.46	180.91	194.77	153.12	3.83	3.75	3.63	3.54	3.68	3.69
SEM	3.593	4.315	3.714	3.768	4.005	3.622	0.293	0.281	0.264	0.267	0.285	0.253
CV (%)	10.7	8.4	6.0	5.5	5.4	6.3	20.2	19.8	19.3	19.9	20.5	18.2
LSD	10.676	12.820	11.035	11.195	11.901	10.762	0.870	0.834	0.785	0.792	0.846	0.752
F-Test	***	***	***	**	**	***	***	**	**	**	**	**

*Significant at 5% level of significance, **Significant at 1% level of significance, ***Significant at 0.1% level of significance, ^{NS}Non-significant, LSD: Least significant difference, SED: Standard error of difference, CV: Coefficient of difference

Table 4. Pod length and pod diameter of different okra varieties at 14,28,42,56 and 70 DAS

Variety	Pod length (PL)						Pod diameter (PD)					
	14 DAS	28 DAS	42 DAS	56 DAS	70 DAS	Aver-age	14 DAS	28 DAS	42 DAS	56 DAS	70 DAS	Aver-age
Arka Anamika	3.11^{c}	15.53^{c}	16.73^{bc}	15.73^{a}	15.18^{a}	13.25^{b}	1.54^{c}	5.81^{a}	6.29^{a}	6.12^{b}	6.25^{a}	5.20^{a}
Chiranjeevi F1	3.07^{c}	16.11^{c}	15.86^{c}	15.02^{ab}	12.27^{b}	12.47^{b}	1.26^{c}	5.91^{a}	6.26^{a}	6.61^{a}	6.00^{a}	5.21^{a}
Gunjan	12.53^{a}	17.97^{b}	17.90^{ab}	13.96^{b}	11.42^{b}	14.75^{a}	4.42^{a}	6.09^{a}	6.35^{a}	5.79^{b}	4.98^{b}	5.53^{a}
JK 1666	7.65^{b}	19.89^{a}	18.96^{a}	15.58^{a}	12.07^{b}	14.83^{a}	2.51^{b}	6.05^{a}	6.32^{a}	6.08^{b}	5.03^{b}	5.20^{a}
Mean	6.59	17.37	17.36	15.07	12.73	13.83	2.43	5.97	6.31	6.15	5.56	5.28
SEM	0.565	0.388	0.418	0.461	0.666	0.305	0.285	0.113	0.081	0.119	0.328	0.116
CV (%)	22.7	5.9	6.4	8.1	13.8	5.8	31.0	5.0	3.4	5.1	15.6	5.8
LSD	1.679	1.152	1.242	1.370	1.978	0.907	0.847	0.336	0.240	0.355	0.974	0.344
F-Test	***	***	***	*	**	***	***	NS	NS	**	*	NS

*Significant at 5% level of significance, **Significant at 1% level of significance, ***Significant at 0.1% level of significance, ^{NS}Non-significant, LSD: Least significant difference, SED: Standard error of difference, CV: Coefficient of difference

Table 5. Pods per plant and weight per pod of different okra varieties at 14,28,42,56 and 70 DAS

Variety	Pods per plant (P/P)						Weight per pod (W/P)					
	14 DAS	28 DAS	42 DAS	56 DAS	70 DAS	Aver-age	14 DAS	28 DAS	42 DAS	56 DAS	70 DAS	Aver-age
Arka Anamika	0.34^{c}	2.92^{b}	5.83^{a}	5.36^{a}	4.56^{a}	3.80^{a}	4.50^{c}	24.52^{c}	28.47^{b}	25.12^{a}	22.20^{a}	20.96^{c}
Chiranjeevi F1	0.43^{c}	3.14^{b}	6.06^{a}	4.73^{ab}	4.48^{a}	3.77^{a}	4.28^{c}	29.47^{b}	28.68^{b}	27.83^{a}	22.54^{a}	22.56^{bc}
Gunjan	1.71^{a}	4.08^{a}	6.34^{a}	2.87^{c}	1.93^{b}	3.38^{a}	18.29^{a}	32.56^{ab}	31.79^{a}	25.00^{a}	17.96^{a}	25.12^{a}
JK 1666	0.80^{b}	3.51^{ab}	5.90^{a}	3.96^{b}	2.20^{b}	3.27^{a}	10.50^{b}	34.06^{a}	32.40^{a}	25.56^{a}	18.39^{a}	24.18^{ab}
Mean	0.82	3.41	6.03	4.23	3.29	3.56	9.39	30.15	30.33	25.88	20.27	23.20
SEM	0.065	0.202	0.399	0.334	0.755	0.181	0.902	1.057	0.877	1.002	1.492	0.591
CV (%)	21.0	15.7	17.5	20.9	60.7	13.4	25.4	9.3	7.7	10.2	19.5	6.7
LSD	0.193	0.601	1.184	0.991	2.244	0.537	2.681	3.140	2.607	2.978	4.434	1.757
F-Test	***	**	NS	***	*	NS	***	***	**	NS	NS	***

*Significant at 5% level of significance, **Significant at 1% level of significance, ***Significant at 0.1% level of significance, ^{NS}Non-significant, LSD: Least significant difference, SED: Standard error of difference, CV: Coefficient of difference

Table 6. Days to 50% flowering and yield per plant of different okra varieties at 14,28,42,56 and 70 DAS

Variety	Days to 50% flowering (DF)	Yield per plant (Y/P)					
		14 DAS	28 DAS	42 DAS	56 DAS	70 DAS	Average
Arka Anamika	50^{b}	8.53^{c}	76.60^{c}	175.57^{a}	137.92^{a}	106.42^{a}	101.01^{a}
Chiranjeevi F1	56^{a}	8.09^{c}	98.29^{bc}	178.79^{a}	132.69^{ab}	66.89^{b}	96.95^{a}
Gunjan	55^{a}	44.49^{a}	130.54^{a}	197.41^{a}	80.39^{c}	41.62^{c}	98.89^{a}
JK 1666	54^{a}	17.21^{b}	122.23^{ab}	189.20^{a}	105.17^{bc}	48.02^{bc}	96.37^{a}
Mean	54	19.58	106.92	185.24	114.04	65.74	98.30
SEM	0.8	2.316	8.410	10.677	9.925	7.233	5.487
CV (%)	4.1	31.3	20.8	15.2	23.0	29.1	14.8
LSD	2.5	6.880	24.988	31.723	29.490	21.489	16.303
F-Test	***	***	**	NS	**	***	NS

*Significant at 5% level of significance, **Significant at 1% level of significance, ***Significant at 0.1% level of significance, NSNon-significant, LSD: Least significant difference, SED: Standard error of difference, CV: Coefficient of difference

In the case of pod diameter, the study shows a rapid increase in width up to 42 DAS, decreasing gradually up to 70 DAS. The pod diameter of Chiranjeevi F1 was low among other varieties (1.26) up to 14 DAS and increased to the highest value of (6.61) at 56DAS and decreased at 70DAS. The highest pod diameter (6.61) was observed in 56 DAS in the Chiranjeevi F1 (Table 4). The overall mean was highest in 42 DAS (6.31), followed by 6.15 in 56 DAS. The average data observed in the pod diameter shows that the widest pods was developed by Gunjan (5.53) followed by Chiranjeevi F1(5.21), Arka Anamika (5.20), and JK 1666 (5.20) with the significant level at (P>0.05). Mal et al. (2013), Sibsankar et al. (2012) and Dahal et al. (2021) proclaimed that mean diameter of the pod ranges from 2.94-2.97 and 1.53-1.67, respectively. Likewise, the pods per plant were increased significantly up to 42 DAS and decreased to (4.56) on 70 DAS. The lowest pods were observed on 14 DAS and the highest on 56 DAS in Arka Anamika. Like Arka Anamika, Chiranjeevi F1 had the same trend of lowest pods (0.43) on 14 DAS and gradually increased up to 42 DAS, which was the highest among its lifecycle (6.06). Gunjan had the lowest pods (1.71) and (1.93) on 14 DAS and 70 DAS, respectively (Table 5). The pods significantly increased to 28 DAS and reached the highest at 42 DAS. JK1666 also has the lowest pods on 14 DAS and increased up to (3.51), and on 42 DAS, pods were highest and slightly decreased to (3.96) on 56 DAS. The average data observed in the pods per plant shows that the highest P/P was developed by Arka Anamika (3.80) which was tailed by Chiranjeevi F1 (3.77), Gunjan (3.38) and JK 1666 (3.27) with the significant level at (P>0.05). The overall mean was highest on 42 DAS with (6.03). The results affirm the observations obtained by Sibsankar et al. (2012), whereas disagree with the findings of Choudhary et al. (2015). Table 5 illustrates the weight gained per pod at different growth stages. It shows a gradual increase in pod weight between (28 DAS to 56 DAS) and a slight decline at the end. The average data observed in the weight per pod shows that the highest weight per pod was developed by Gunjan (25.12) followed by JK 1666 (24.18), Chiranjeevi F1(22.56), and Arka Anamika (20.96) with the significant level at (P<0.001). The maximum pod weight was obtained from Jk1666 (34.06a g), and the minimum was recorded from Arka Anamika. Similar reports about the weights per pod were presented by Cohen et al. (2001). Arka Anamika reached the earliest among other varieties in days to 50% flowering (50 days). The flower started to bloom after a month of planting. Within 50 to 55 days, every variety attended 50 percent flowering (Table 6). This reveals that flower-bearing habits differ among distinct okra varieties but require similar durations to attain 50% flowering. The observed outcome coincides with the conclusion of Aminu et al. (2016) for days to 50% flowering but differ with the findings of Shannag et al. (2007). Furthermore, the results show that the yields per plant have increased significantly up to 42 DAS and gradually decreased to 70 DAS in Arka Anamika. Chiranjeevi F1 was low among other varieties up to 14 DAS and increased to the highest value of (178.79) and gradually decreased to 56 DAS and was recorded (as 66.89) the second highest value in 70 DAS (Table 6). The average data observed in the Y/P shows that the highest Y/P was achieved by Arka Anamika (101.01) followed by Gunjan (98.89), Chiranjeevi F1(96.95), and JK 1666 (96.37) with the significant level at (P>0.05). The uppermost yield (197.41) was observed in 42 DAS in the Gunjan variety. In the case of JK 1666, the yield was significantly increased up to 42 DAS (189.20) and decreased to (48.02) in 70DAS. The overall mean was highest in 42 DAS (185.24), followed by 114.04 in 56 DAS. The findings show conformity with the findings observed by Choudhary et al. (2015) and Shannag et al. (2007). But the mean yield per plant observed by Sibsankar et al. (2012) was (256.26), which shows that the mean yield per plant was higher

than the present result. This variation in the results among both studies might be because of the genotypic variation among the varieties utilized in the corresponding research.

Out of the eight growth and yield attributes studied between the different varieties of okra, primary branches (P ≥ 0.05) and pods per plant (P ≥ 0.01) exhibited a significantly positive correlation with the yield attributive trait, i.e., yields per plant. In addition, yields per plant have a positive but insignificant relationship with variables like PH, PL and PD was observed (Table 7). However, P/P and Y/P exhibited a negative association with days to 50% blooming. This suggests that early in the first flowering helped improve okra's fruit yield. Twenty correlation coefficients among the characters' interactions revealed that they were considerably positive and eight correlation co-efficient were significantly negative. In contrast, a higher correlation coefficient was observed between PL and W/P (r = 0.7851), followed by PH and DF (r = 0.6116). The lowest correlation coefficient was observed between primary branches and pod diameter (r = -0.3245) (Figure 4). The fundamental characteristics that might be used in selecting for maximum pod output in okra seemed to include PB, PH, PL, PD, P/P, and W/P because of their favorable phenotypic correlations with Y/P in this research. Aminu et al. (2017), Aminu et al. (2016), Kurunç & Ünlükara (2009), and Sibsankar et al. (2012) made the observation that a considerable increase in each of the measured factors might raise the overall yield of okra pods. The majority of the other characters were most significantly affected directly and indirectly by the assessed factors. These important agronomic factors may be crucial selection criteria for developing high pod yielding okra cultivars.

Table 7. Phenotypic correlations for growth and yield attributes of different varieties of okra

	PH	PB	P/P	PL	PD	W/P	Y/P	DF
PH	1**							
PB	0.3743*	1**						
P/P	-0.1312^{NS}	0.2343^{NS}	1**					
PL	0.1644^{NS}	-0.2492^{NS}	-0.152^{NS}	1**				
PD	0.046^{NS}	-0.3245^{NS}	0.3955*	0.5939**	1**			
W/P	0.5194**	-0.0708^{NS}	-0.1442^{NS}	0.7851**	0.605**	1**		
Y/P	0.1637^{NS}	0.3872*	0.5306**	0.1923^{NS}	0.1253^{NS}	0.2617^{NS}	1**	
DF	0.6116**	0.2818^{NS}	-0.1716^{NS}	0.0057^{NS}	0.0514^{NS}	0.3814*	-0.0849^{NS}	1**

*Significant at 0.05 level of significance, **Significant at 0.01 level of significance, ^{NS}Non-Significant, PH: Plant height, PB: Primary branches, P/P: Pods per plants, PL: Pod length, PD: Pod diameter, W/P: Weight per pod, Y/P: Yields per pod, DF: Days to 50% flowering

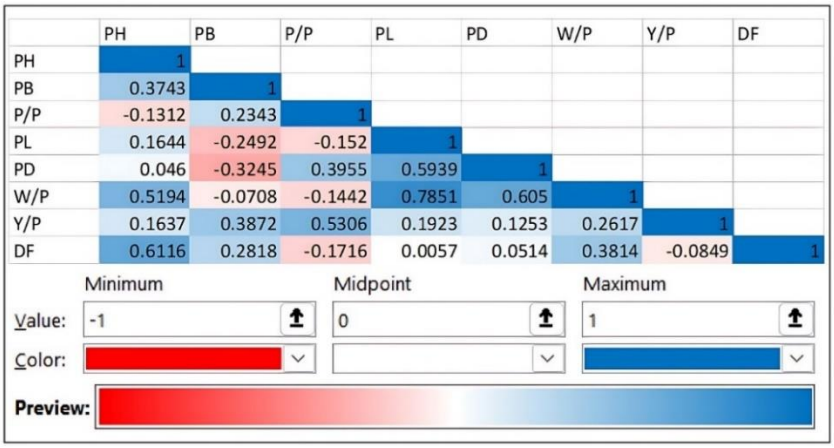

Figure 4. Exploration of phenotypic correlations of growth and yield attributes to represent the higher and lower correlations between the traits under conditional formatting rules

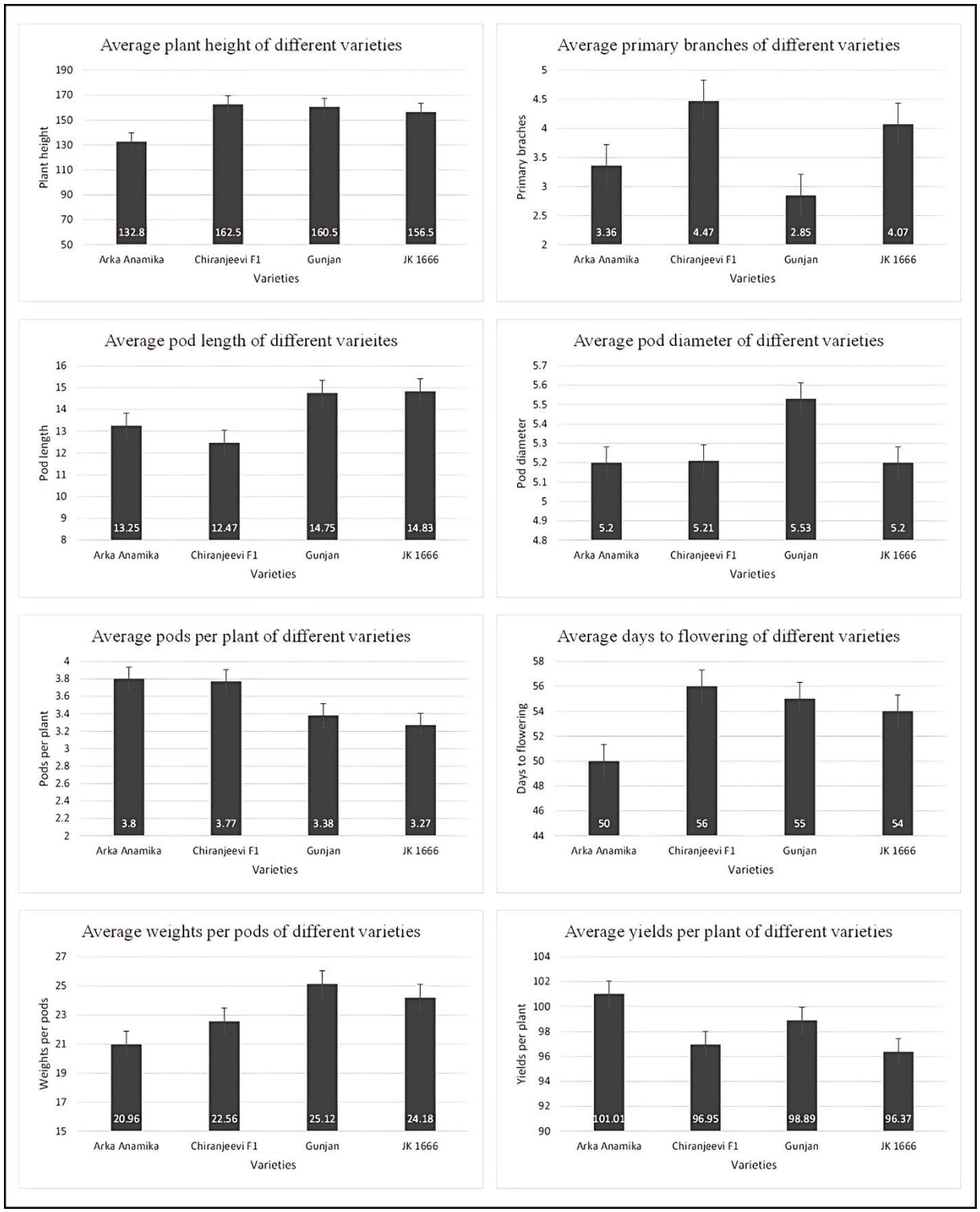

Figure 5. Comparative illustration of average growth and yield attributes (plant height, primary branches, pod length, pod diameter, pods per plant, weights per pod, yields per plant, days to 50% flowering) of different varieties through bar graphs

Conclusion

The experimental results show that the different plant parameters help to predict the overall yield and performance of the specific plant. On average, the overall yield is expected to reach 98.30 g for a plant in our field experiment. Flowering commences 50 to 54 days after sowing, with early flowering at 50 days for Arka Anamika. Production greatly varies with pod length, diameter, pod number, and the number of primary branches in all four varieties, i.e., Arka Anamika, Chiranjeevi F1, Gunjan, and JK 1666. Among those four okra varieties, Arka Anamika performed well in production, with the highest yield and early flowering. Therefore, through our experimental findings, we recommend Arka Anamika as a suitable variety to farmers for effective yield and productivity in the Morang district. However, a single field trial, may not be enough to provide a valid conclusion. Thus, to get the right findings, several trials need to be conducted in locations with diverse climatic situations.

Author's declaration

The authors declare no irreconcilable circumstances. All the authors have provided equal contribution.

Acknowledgements

We express our sincere gratitude and admiration to our college Girija Prasad Koirala College of Agriculture and Research Center (GPCAR), for providing supplies, and learning platforms.

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