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Economic and Agronomic Evaluation of Okra (Abelmoschus Esculentus L.) Under Different Sowing Dates and Varieties in Chitwan, Nepal

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ABSTRACT

Okra (Abelmoschus esculentus L.) is an important vegetable crop in Nepal; however, its productivity and profitability are considerably affected by inappropriate sowing time and insect pest infestation, particularly okra jassid (Amrasca biguttula biguttula Ishida). The present study was conducted at the Horticulture Farm of Agriculture and Forestry University, Rampur, Chitwan, Nepal, from April to August 2021 to evaluate the agronomic and economic performance of different sowing dates and okra varieties. The experiment was arranged in a two-factor factorial randomized complete block design with three replications, consisting of three sowing dates (April 13, April 25, and May 8) and three varieties (Arka Anamika, NOH-05, and Venus). The results revealed that sowing date significantly influenced the growth, yield, and profitability of okra. The May 8 sowing produced the highest plant height (42.63 cm), fruit yield (11.82 mt ha^{-1}), gross return (NRs. 1,182,000 ha^{-1}), net return (NRs. 732,250 ha^{-1}), and benefit–cost ratio (2.63). Among the tested varieties, NOH-05 recorded the highest fruit yield (11.18 mt ha^{-1}) and benefit–cost ratio (2.25). Regression analysis showed a significant negative relationship between leaf damage score and fruit yield (R2=0.5885, $p<0.05$), suggesting that increased jassid damage substantially reduced crop productivity. The findings indicate that delayed sowing during early May, together with cultivation of the NOH-05 variety, can improve yield, reduce pest-related damage, and enhance profitability under the subtropical conditions of Nepal. The study highlights the importance of optimizing sowing time and varietal selection as a cost-effective and environmentally sustainable approach for improving okra production. .

INTRODUCTION

Vegetables constitute an important component of the human diet and contribute significantly to human nutrition by supplying minerals, vitamins, dietary fiber, carbohydrates, proteins, and energy (Hanif *et al.*, 2006). In Nepal, vegetable production reached 4,153,157 mt from an area of 289,839 ha, with an average productivity of 14.32 mt ha^{1} (MoALD, 2023). Increasing population growth, urbanization, export opportunities, and awareness regarding nutritional benefits have substantially increased the demand for vegetable production in Nepal (Dhungana, 2022). Vegetables are regarded as high-value crops under the APP (1995) and contribute significantly to the agricultural economy. Horticultural crops contribute approximately 27% to the total agricultural gross domestic product of Nepal (Thapa *et al.*, 2019), among which vegetables contribute the largest share. Nepal cultivates more than 200 vegetable crops under diverse agro-climatic conditions, with nearly 50 cultivated commercially (Poudel, 2013). Among these crops, okra (Abelmoschus esculentus L.) is an important warm-season vegetable cultivated widely in tropical and subtropical regions. In Nepal, okra is commonly grown in districts such as Jhapa, Morang, Saptari, Dhanusha, Mahottari, Rautahat, Bara, Chitwan, and Kailali (Regmi *et al.*, 2020). The crop occupies about 9,397 ha with production of 112,260 mt and productivity of 11.95 mt ha^{1} in Nepal, while Chitwan district alone contributes 4,730 mt from 353 ha with productivity of 13.40 mt ha^{1} (MoALD, 2023). Okra is nutritionally important because every 100 g of green pod contains approximately 1.9 g protein, 6.4 g carbohydrates, 1.2 g fibre, 13 mg vitamin C, and 66 mg calcium (Ofori *et al.*, 2020). Due to its nutritional value, market demand, and income-generating potential, okra has become an important cash and subsistence vegetable crop in Nepal.

Despite its economic importance, okra production is constrained by several insect pests and unfavorable environmental conditions. Sap-sucking pests such as aphids (Aphis gossypii Glover), whiteflies (Bemisia tabaci Genn.), and jassids (Amrasca biguttula biguttula Ishida) considerably reduce crop growth and productivity (Sushil *et al.*, 2019). Yield loss caused by sucking pests and fruit borers may reach up to 69% under severe infestation conditions (Mani *et al.*, 2005). Among these pests, okra jassid is considered one of the most destructive pests affecting okra production (Iqbal *et al.*, 2008), causing yield losses of up to 50% (Halder *et al.*, 2016). Jassid infestation causes yellowing, curling, reddening, and necrosis of leaves, resulting in reduced photosynthetic activity, stunted growth, and lower yield (Senapati &

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Khan, 1978; Li *et al.*, 2018; Al-Hamadany & Al-Karboli, 2017). Similarly, Chauhan *et al.* (2021) reported that severe leafhopper infestation reduced plant height by 49.8% and leaf number by 45.1%. Planting time also plays an important role in determining crop growth, pest incidence, yield, and economic return in okra cultivation. Early sowing may expose crops to high temperature and moisture stress, whereas delayed sowing may alter pest incidence and crop growth dynamics during flowering and fruiting stages (Singh *et al.*, 2013). Climatic factors such as temperature, rainfall, relative humidity, and photoperiod strongly influence vegetative growth, flowering behavior, and yield formation in okra. Several studies have reported significant effects of sowing date on growth and yield attributes of okra and other vegetable crops (Moniruzzaman *et al.*, 2007; Madhu *et al.*, 2018; Moula *et al.*, 2018).

Varietal selection is equally important because genetic variation among cultivars influences pest tolerance, vegetative growth, fruit characteristics, and yield performance (Rajesh *et al.*, 2018; Sarada *et al.*, 2018). Farmers commonly rely on repeated pesticide applications to manage insect pests in okra; however, excessive and indiscriminate pesticide use may lead to pest resistance, pest resurgence, pesticide residues, environmental pollution, and health hazards (Mohammad *et al.*, 2018). Therefore, identification of suitable sowing dates together with tolerant or high-yielding varieties can provide a cost-effective and environmentally sustainable approach for minimizing pest damage and improving crop productivity. Although several studies have evaluated the effect of sowing dates and varietal performance in okra, limited information is available under the agro-climatic conditions of Chitwan, Nepal, particularly regarding the combined influence of sowing dates and varieties on growth, yield, leaf damage, and economic return. Therefore, the present study was conducted to evaluate the effect of different sowing dates and okra varieties on growth parameters, yield attributes, leaf damage caused by okra jassid, and economic performance, and to identify the most suitable sowing date and variety for profitable okra cultivation under the subtropical conditions of Chitwan, Nepal.

MATERIALS AND METHODS

Experimental Site and Climatic Conditions

The field experiment was conducted from April to August 2021 at the Horticulture Farm of Agriculture and Forestry University, Rampur, Chitwan, Nepal, located at 27°37' N latitude and 84°25' E longitude with an elevation of 256 masl (Subedi *et al.*, 2020) (Figure 1). The experimental site lies in the inner Terai region of Nepal and experiences a subtropical climate characterized by three distinct seasons: rainy (June–October), cool winter (November–February), and hot summer (March–May).

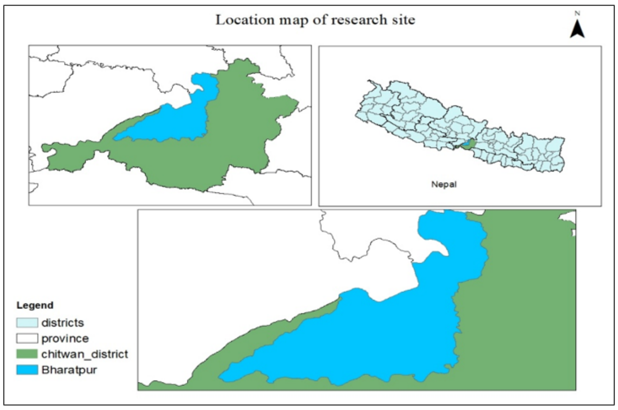

Figure 1: Map of Nepal showing the research area

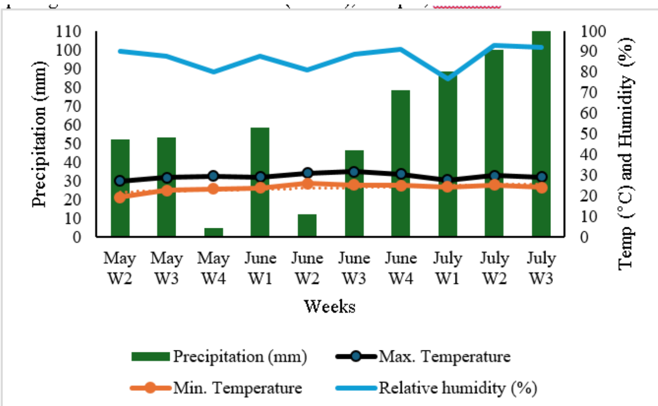

Figure 2: Weekly precipitation, temperature, and relative humidity during the experimental period at Rampur, Chitwan, Nepal, 2021.
Note: Left axis: precipitation; right axis: temperature and relative humidity. W = week.

Meteorological data, including maximum and minimum temperature, relative humidity, and rainfall during the cropping period, were obtained from the meteorological station of the National Maize Research Program (NMRP), Nepal Agricultural Research Council (NARC), Rampur, Chitwan. Weather conditions prevailing during the experimental period are presented in Figure 2.

Experimental Design and Treatments

The experiment was laid out in a two-factor factorial randomized complete block design (Factorial RCBD) with nine treatment combinations and three replications. The treatment details and treatment combinations are presented in Tables 1 and 2, respectively. The experimental field consisted of 27 plots, with each individual plot measuring 2 m × 3 m (6 m²). Spacing between replications and plots was maintained at 1 m and 0.5 m, respectively.

Crop Establishment and Management Practices

Seeds of the three okra varieties were obtained from a local agrovet in Narayanghat, Chitwan. Before sowing, seeds were soaked in water for 16–20 h to enhance germination. Pre-germinated seeds were sown manually at a spacing of 60 cm between rows and 30 cm between plants with 2–3 seeds per hill. Thinning was performed after seedling establishment to maintain a uniform plant population. The field was prepared through primary tillage followed by harrowing and leveling. Well-decomposed farmyard manure (FYM) was incorporated during final land preparation at the rate of 20 mt ha-1. Fertilizer was applied at the recommended dose of 200:180:60 kg N:P:K ha^{-1}. Full doses of phosphorus and potassium and half of the nitrogen were applied as a basal application, while the remaining nitrogen was top-dressed in two equal splits at 25 and 45 days after sowing (DAS). Irrigation was applied as required throughout the cropping period. Initially, light irrigation was provided frequently to ensure proper seedling establishment, followed by irrigation at 5–7 day intervals depending on crop requirement. Hand weeding and intercultural operations were carried out at regular intervals to maintain optimum crop growth. Plant protection measures were kept minimal during the experimental period to allow natural infestation of okra jassid for assessment purposes. Fruits were harvested manually at 2–3 day intervals when pods were tender, green, and marketable.

Table 1: Treatment details used in the experiment

Factors	**Treatments**
Factor A: Sowing dates	April 13 (Early sowing)
	April 25 (Mid sowing)
	May 8 (Late sowing)
Factor B: Varieties	Arka Anamika
	NOH-05
	Venus

Table 2: Details of the treatment combinations and their symbols at Rampur, Chitwan, 2021

S.N.	**Treatment with symbol**	**Treatment Description**
1	T1= V1S1	Arka Anamika× April 13
2	T2=V1S2	Arka Anamika× April 25
3	T3= V1S3	Arka Anamika× May 8
4	T4= V2S1	NOH-05×April 13
5	T5= V2S2	NOH-05×April 25
6	T6= V2S3	NOH-05×May 8
7	T7= V3S1	Venus× April 13
8	T8= V3S2	Venus× April 25
9	T9= V3S3	Venus× May 8

Data Collection

Growth Parameters and Yield Attributes

Data on plant growth and yield attributes were recorded from randomly selected sample plants in each plot. Observations included plant height, number of leaves per plant, stem circumference, number of fruits per plant, fruit length, fruit diameter, fruit weight per plant, and fruit yield. Plant height was measured from the soil surface to the terminal growing point using a meter scale at 30, 45, 60, and 74 DAS and expressed in centimeters (cm). The number of leaves per plant was counted at the same growth stages. Stem circumference was measured using a Vernier calliper and expressed in millimeters (mm). Fruit length and diameter were measured using a scale and Vernier calliper, respectively. Fruit weight was recorded using a digital weighing balance, and total fruit yield was converted into metric tons per hectare (mt ha^{-1}).

Damage Scoring

The severity of foliage damage caused by okra jassid was assessed using a 0–5 damage rating scale described by Neupane (2000) (Table 3). Damage scoring was initiated 30 days after sowing (DAS) and subsequently recorded at 15day intervals until the commencement of harvesting. Lower levels of foliage damage were assigned lower scores, whereas increasing severity of yellowing, curling, and necrosis symptoms received higher scores.

Table 3: Rating scale for estimation of severity of damage by okra jassid (Both nymphs and adults)

S.N.	Description of foliage	Score
1	No yellowing of leaves	0
2	Very few lower leaves show yellowing symptoms	1
3	Fewer lower leaves show yellowing symptoms	2
4	Many lower leaves and some upper leaves show yellowing symptoms, and upper leaves show curling symptoms	3
5	All the lower, most of the middle, and some upper leaves are showing yellowing symptoms, middle and upper leaves are showing dark brick red patches	4
6	All the lower, middle, and upper leaves showing yellow symptoms; all the middle and upper leaves showing curling symptoms, and most or all of the leaves having dark brick-red patches (Necrosis); several plants crumbled	5

Economic Analysis

Economic analysis was carried out to evaluate the profitability of okra cultivation under different sowing dates and varietal combinations. The total cost of cultivation was estimated by summing all variable production costs incurred during crop production, including land preparation, seed, farmyard manure (FYM), fertilizers, irrigation, labor, intercultural operations, plant protection measures, harvesting, and marketing expenses. All input and labor costs were calculated on a hectare basis using the prevailing local market rates during the experimental period.

Gross return was estimated from the total marketable fruit yield and prevailing local market price of okra during the harvesting period. Net return and benefit–cost (B:C) ratio were calculated using the following formulas:

"Gross return (NRs./ha)=Total production (kg ha-1)×Market price (NRs./kg)"

Where:

- Gross return = total monetary value obtained from marketable fruit yield
- Total production = total marketable fruit yield per hectare
- Market price = prevailing market price of okra during harvesting

Net return was calculated as:

"Net return=Gross return-Total cost of cultivation"

Where:

- Net return = profit obtained after deducting total production cost
- Total cost of cultivation = total expenditure incurred during crop production

The benefit–cost (B:C) ratio was calculated using the following equation:

$$\text{B:C ratio} = \frac{\text{Gross return}}{\text{Total cost of cultivation}}$$

Where:

- B:C ratio = ratio of total return to total production cost
- A higher B/C ratio indicates greater economic profitability and production efficiency

Economic indicators such as total production cost, gross return, net return, and benefit–cost ratio were compared among different sowing dates and okra varieties to identify the most economically profitable treatment combination under the agro-climatic conditions of Rampur, Chitwan, Nepal.

Statistical Analysis

The recorded data were initially tabulated in Microsoft Excel (version 2403) and subsequently analyzed using R-Studio with R version 4.3.0. Data were analyzed using two-way analysis of variance (ANOVA) under a factorial randomized complete block design (RCBD) to evaluate the effects of sowing dates, varieties, and their interaction effects. Treatment means were separated using Duncan's Multiple Range Test (DMRT) at the 5% level of significance

RESULTS AND DISCUSSION

Effect of Sowing Dates and Varieties on Plant Growth Parameters

Effect of Sowing Dates and Varieties on Plant Height

The variance analysis indicated a significant effect of sowing date on plant height (Table 4). The May 8 sowing produced the tallest plants, while the April 13 sowing resulted in the shortest plants. By 30 DAS, plants sown on May 8 reached 8.17 cm in height, contrasting with 6.28 cm for those sown on April 13. The tallest plant (14.88 cm) was recorded on the May 8 sown crop at 45 DAS, while the shortest plant (12.98 cm) was obtained on the April 13 sown crop. At 60 DAS, maximum plant height (25.95 cm) was observed on the May 8 sown crop, while the shortest plant (23.88 cm) was obtained on the April 13 sown crop. At 74 DAS, okra with maximum height (42.63 cm) was obtained on the May 8 sown crop, while the plant with minimum height (36.76 cm) was observed on the April 13 sown crop. The result showed that there was an insignificant effect of variety on plant height. The interaction effect of sowing dates and varieties on plant height was found to be non-significant throughout the observation period.

Effect of Sowing Dates and Varieties on the Number of Leaves

The number of leaves varied significantly among the different sowing dates (Table 5). At 30 DAS, the May 8 sowing produced the highest leaf count (4.58), while the April 13 sowing had the lowest number of leaves (3.45), which was statistically similar to the April 25 sowing. At 45 DAS, okra that was sown late had the highest leaf count, reaching 10.88 leaves per plant. In contrast, the April 13 sowing resulted in the lowest leaf count of 8.53 leaves. At 60 DAS, the highest number of leaves (22.34) was observed on May 8 sowing, while the lowest number of leaves (21.13) was recorded on April 13 sowing, which was statistically at par with April 25 sowing. At 74 DAS, the highest number of leaves (31.17) was recorded on the May 8 sowing, which was statistically at par with the April 25 sowing. The lowest number of leaves (27.80) was recorded on April 13 sowing. The effect of variety on the number of leaves was found to be insignificant. Similarly, the interaction effect of sowing dates and varieties on leaf number remained non-significant throughout the study period.

Table 4: Effects of sowing dates and varieties on plant height of okra at Rampur, Chitwan, Nepal, 2021

Treatments	30 DAS	45 DAS	60 DAS	74 DAS
Factor A: Sowing dates				
13-Apr	6.28^{b}	12.98^{c}	23.88^{c}	36.76^{c}
25-Apr	7.06^{b}	13.92^{b}	24.89^{b}	39.55^{b}
8-May	8.17^{a}	14.88^{a}	25.95^{a}	42.63^{a}
SEm (±)	0.25	0.17	0.16	0.39
LSD (0.05)	0.72	0.49	0.46	1.00
F-test	***	***	***	***
CV (%)	10.66	3.58	2	2.95
Factor B: Varieties				
Arka Anamika	7.21	13.92w	24.75	39.35
NOH-05	7.03	13.82	24.84	39.34
Venus	7.28	14.05	25.12	40.24
SEm (±)	0.25	0.17	0.16	0.39
LSD (0.05)	NS	NS	NS	NS
CV (%)	10.66	3.58	1.93	2.95

*Note: Means followed by the same letter within a column are not significantly different at the 5% level of significance according to Duncan's Multiple Range Test (DMRT). *** Significant at P<0.001; NS = non-significant; DAS = days after sowing; CV = coefficient of variation; SEm = standard error of mean.*

Effect of Sowing Dates And Varieties on Stem Circumference

At 30 DAS, sowing date had a significant effect on stem circumference (Table 6). The highest stem circumference (3.89 mm) was observed on the May 8 sowing, while the lowest stem circumference was obtained on the April 13 sowing. There was an insignificant effect of varieties on stem circumference at 30 DAS. At both 45 and 60 DAS, neither sowing date nor variety had a significant impact on stem circumference. At 74 DAS, the date of sowing significantly affected stem circumference. The highest stem circumference was recorded for the May 8 sowing (13.13 mm), while the lowest was observed for the April 25 sowing (12.69 mm). Variety did not significantly impact the stem circumference of okra. The interaction effect between sowing dates and varieties on stem circumference was found to be non-significant throughout the observation period.

Effect of Sowing Dates and Varieties on Yield Attributes

The effect of sowing dates and varieties on yield parameters of okra is presented in Table 7. Average fruit length was found to be statistically significant among different dates of sowing. The longest fruit (13.17 cm)

Table 5: Effect of date of sowing and varieties on the number of leaves of okra at Rampur, Chitwan, Nepal, 2021

Treatments	30 DAS	45 DAS	60 DAS	74 DAS
Factor A: Sowing dates				
13-Apr	3.45[b]	8.53[c]	21.13[b]	27.80[b]
25-Apr	3.48[b]	9.52[b]	21.16[b]	31.03[a]
8-May	4.58[a]	10.88[a]	22.34[a]	31.17[a]
SEm (±)	0.65	1.04	1.55	0.26
LSD (0.05)	0.33	0.53	0.68	0.79
F-test	***	***	**	***
CV (%)	8.59	5.46	3.15	3
Factor B: Varieties				
Arka Anamika	3.65	9.52	21.51	29.87
NOH-05	3.91	9.81	21.54	30.27
Venus	3.96	9.6	21.57	29.86
F-test	NS	NS	NS	NS
CV (%)	8.59	5.46	3.15	2.64

*Note: Means followed by the same letter within a column are not significantly different at the 5% level of significance according to Duncan's Multiple Range Test (DMRT). ** and *** indicate significance at P<0.01 and P<0.001, respectively; NS = non-significant; DAS = days after sowing; CV = coefficient of variation; SEm = standard error of mean.*

Table 6: Effect of date of sowing and varieties on the stem circumference of okra in Rampur Chitwan, Nepal, 2021

Treatments	30 DAS	45 DAS	60 DAS	74 DAS
Factor A: Sowing dates				
13-Apr	2.75[b]	6.73	10.73	12.73[b]
25-Apr	2.91[b]	6.66	10.69	12.69[b]
8-May	3.89[a]	6.93	10.85	13.13[a]
SEm (±)	0.59	0.08	0.08	0.12
LSD (0.05)	0.5	NS	NS	0.37
F-test	***	NS	NS	*
CV (%)	15.72	3.37	2.23	2.9
Factor B: Varieties				
Arka Anamika	2.98	6.65	10.68	12.75
NOH-05	3.28	6.82	10.79	12.9
Venus	3.28	6.85	10.8	12.9
F-test	NS	NS	NS	NS
CV (%)	15.72	3.37	2.23	2.9

*Note: Means followed by the same letter within a column are not significantly different at the 5% level of significance according to Duncan's Multiple Range Test (DMRT). * and *** indicate significance at P<0.05 and P<0.001, respectively; NS = non-significant; DAS = days after sowing; CV = coefficient of variation; SEm = standard error of mean.*

was recorded from the May 8 sowing. The shortest fruit (11.76 cm) was recorded from the April 13 sowing, which was statistically at par with April 25 sowing. The effect of variety on average fruit length was found to be statistically insignificant. The result showed that there was an insignificant effect of the date of sowing on the average diameter of fruit. However, a significant result was obtained on average fruit diameter in the case of variety. The Venus variety had the highest fruit diameter (15.16 mm), followed by Arka Anamika (15.08 mm), whereas the lowest fruit diameter was found in the NOH-05 variety. A significant result was obtained in the case of number of fruits per plant at different sowing dates. The highest number of fruits per plant (17.39) was found in the May 8 sowing. The lowest number of fruits per plant (15.74) was found in the April 13 sowing, followed by the April 25 sowing (16.06). The number of fruits per plant was also significantly affected by variety. The highest number of fruits per plant (16.75) was found in the NOH-05 variety, which was statistically at par with the Venus variety. The lowest number of fruits was found in the Arka Anamika variety (15.90).

Fruit weight per plant was found to be significant among different dates of sowing. The highest fruit weight per plant was observed in the May 8 sowing (227.4 g), while the lowest fruit weight per plant was obtained in the April 13 sowing (225.82 g). Significant differences among varieties were also observed. The highest fruit weight per plant (226.74 g) was obtained in the NOH-05 variety, which was statistically at par with Venus, whereas the lowest fruit weight per plant (226.04 g) was recorded in Arka Anamika. Date of sowing also had a significant effect on fruit weight per plot. The highest fruit weight per plot (7.36 kg) was obtained from the May 8 sowing, while the lowest fruit weight per plot (5.90 kg) was obtained from the April 13 sowing. Among the varieties, NOH-05 produced the highest fruit weight per plot (6.72 kg), whereas Arka Anamika produced the lowest fruit weight per plot (6.17 kg). The interaction effect of sowing dates and varieties on yield attributes was found to be non-significant.

Effect of Sowing Dates and Varieties on the Yield of Okra

Date of sowing had a substantial impact on fruit yield per hectare (Table 8). The highest fruit yield per hectare (11.82 mt ha-1) was obtained at late sowing (May 8), whereas the lowest fruit yield per hectare (10.18 mt ha-1) was obtained at early sowing (April 13). Fruit yield per hectare was also significantly affected by variety. The highest fruit yield per hectare (11.18 mt ha-1) was found in the NOH-05 variety, while the lowest fruit yield per hectare (10.34 mt ha-1) was observed in Arka Anamika. The interaction effect between sowing dates and varieties on fruit yield was found to be non-significant.

Correlation Between Fruit Yield and Leaf Damage Score

The regression analysis revealed a negative relationship between leaf damage score and okra yield (Figure 3). As the leaf damage score increased, yield decreased gradually. The fitted regression equation $y=-2.0904x+13.522$ indicates that for every one-unit increase in leaf damage score, the yield decreased by approximately 2.09 mt ha-1 . The coefficient of determination ($R2=0.5885$, $p < 0.05$) showed that about 58.85% of the variation in yield was explained by the leaf damage score. This suggests that higher leaf damage considerably reduced crop productivity.

Table 7: Effect of date of sowing and varieties on yield parameters of okra at Rampur, Chitwan, Nepal, 2021

Treatments	Fruit length (cm)	Fruit diameter (mm)	Fruits per plant	Fruit weight plant^{-1} (g)	Fruit weight plot^{-1} (kg)
Factor A: Sowing dates					
13-Apr	11.76^{b}	15	15.74^{c}	225.82^{c}	5.90^{c}
25-Apr	12.37^{b}	15	16.06^{b}	226.13^{b}	6.19^{b}
8-May	13.17^{a}	15	17.39^{a}	227.40^{a}	7.36^{a}
SEm (±)	0.22	0.06	0.08	0.08	0.07
LSD (0.05)	0.67	NS	0.24	0.25	0.21
F-test	**	NS	***	***	***
CV (%)	5.36	1.27	1.47	2	3.2
Factor B: Varieties					
Arka Anamika	12.7	15.08^{a}	15.90^{b}	226.04^{b}	6.17^{b}
NOH-05	12.61	13.84^{b}	16.75^{a}	226.74^{a}	6.72^{a}
Venus	12	15.16^{a}	16.56^{a}	226.57^{a}	6.57^{a}
F-test	NS	***	***	***	***
CV (%)	5.36	1.27	1.47	1.52	3.2

*Note: Means followed by the same letter within a column are not significantly different at the 5% level of significance according to Duncan's Multiple Range Test (DMRT). ** and *** indicate significance at P<0.01 and P<0.001, respectively; NS = non-significant; CV = coefficient of variation; SEm = standard error of mean.*

Economics of Okra Cultivation

Cost of Cultivation

The estimated base cost of okra cultivation, excluding irrigation, was NRs. 445,750 per hectare (Table 9). Among the different cost components, harvesting and marketing labor accounted for the highest share of the total production cost, followed by seed cost and fertilizer expenses. Harvesting and marketing required intensive labor involvement, resulting in comparatively higher expenditure. Fertilizer inputs, including urea, DAP, and MOP, also contributed substantially to the total cultivation cost. Labor charges for weeding and seed sowing represented important operational expenses during crop management. In addition, fungicide application and land

Table 8: Effect of sowing dates and varieties on yield of okra at Rampur, Chitwan, Nepal, 2021

Treatments	Yield (mt ha^{-1})
Factor A: Sowing dates	
13-Apr	10.18^{c}
25-Apr	10.52^{b}
8-May	11.82^{a}
SEm (±)	0.08
LSD (0.05)	0.24
F-test	***
CV (%)	2.22
Factor B: Varieties	
Arka Anamika	10.34^{b}
NOH-05	11.18^{a}
Venus	10.99time
SEm (±)	0.08
LSD (0.05)	0.24
F-test	***
CV (%)	2.22

*Note: Means followed by the same letter within a column are not significantly different at the 5% level of significance according to Duncan's Multiple Range Test (DMRT). *** indicates significance at P<0.001; CV = coefficient of variation; SEm = standard error of mean.*

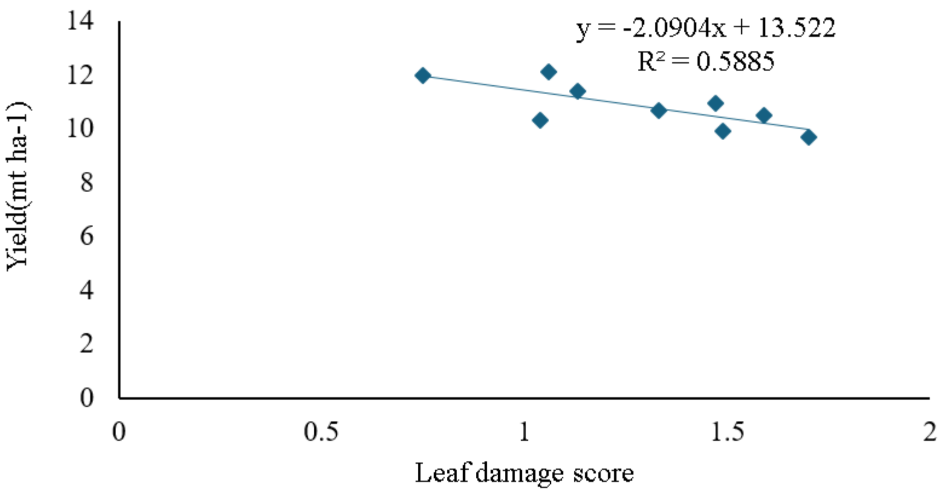

Figure 3: Correlation between fruit yield and leaf damage score in Rampur, Chitwan, 2021

preparation costs were included as essential production inputs. Overall, labor and input costs together constituted the major proportion of okra production expenses.

Economic Analysis of Okra Under Different Sowing Dates

The economic analysis revealed substantial variation in profitability among different sowing dates of okra (Table 10). The highest gross return (NRs. 1,182,000 ha^{-1}), net return (NRs. 732,250 ha^{-1}), and benefit–cost (B:C) ratio (2.63) were recorded from the May 8 sowing. This was mainly attributed to higher marketable yield (11,820 kg ha^{-1}), comparatively higher market price during the harvesting period, and lower irrigation requirement. The April 25 sowing also produced favorable economic returns with a gross return of NRs. 999,400 ha^{-1} and a B:C ratio of 2.20. In contrast, the April 13 sowing recorded the lowest economic performance, with a gross return of NRs. 814,400 ha^{-1} and a B:C ratio of 1.61. The total production cost varied among sowing dates primarily due to differences in irrigation expenses. Earlier sowing required comparatively higher irrigation costs, resulting in increased overall production expenditure. The April 13 sowing incurred the highest irrigation cost (NRs. 60,000 ha^{-1}), whereas the May 8 sowing required the lowest irrigation expenditure (NRs. 4,000 ha^{-1}). Reduced irrigation requirement, together with higher yield and better market price, contributed to the

Table 9: Estimated base cost of okra cultivation excluding irrigation cost (NRs/ha) using sowing dates and varieties at Rampur, Chitwan, 2021

Variables	Unit	Rate (Rs.)	Quantity	Cost (Rs.)
Land preparation by tractor	Lumpsum	—	—	30,000
Fertilizers: Urea, DAP and MOP	Lumpsum	—	—	80,900
Seed cost	kg	3,500	25	87,500
Labor for weeding	Person	1,000	60	60,000
Seed sowing labor charge	Person	1,000	30	30,000
Harvesting and marketing labor charge	Person	600	250	150,000
Fungicides cost	Packets	350	21	7,350
Total cost of cultivation				445,750

Note: Irrigation cost varied among sowing dates and was calculated separately during the economic analysis.

Table 10: Economic analysis of okra production under different sowing dates

Treatment combination	Base cost of cultivation excluding irrigation (Rs.)	Irrigation cost (Rs.)	Total production cost (Rs.)	Total production (kg ha-1)	Average price per kg (Rs.)	Gross return (Rs.)	Net return (Rs.)	B:C ratio
13-Apr	445,750	60,000	505,750	10,180	80	814,400	308,650	1.61
25-Apr	445,750	9,000	454,750	10,520	95	999,400	544,650	2.2
8-May	445,750	4,000	449,750	11,820	100	1,182,000	732,250	2.63
Grand Mean	445,750	24,333.33	470,083	10,840	91.67	998,600	528,516.67	2.12

Note:
Gross return = Total production × Average market price.
Net return = Gross return − Total production cost.
B:C ratio = Gross return ÷ Total production cost.

superior profitability of the May 8 sowing. Overall, the results indicated that delayed sowing up to May 8 was economically more advantageous under the experimental conditions, providing higher productivity and profitability compared to earlier sowing dates.

Economic Analysis of Different Okra Varieties

The economic analysis of different okra varieties revealed noticeable variation in production cost, gross return, net return, and profitability among the tested varieties (Table 11). The total production cost ranged from NRs. 444,750 ha^{-1} to NRs. 446,750 ha^{-1}. The highest production cost was recorded in NOH-05 (NRs. 446,750 ha^{-1}), whereas the lowest production cost was observed in Arka Anamika (NRs. 444,750 ha^{-1}). The variation in production cost among varieties was mainly due to differences in seed cost. Among the tested varieties, NOH-05 produced the highest total production (11,180 kg ha^{-1}), resulting in the highest gross return (NRs. 1,006,200 ha^{-1}) and net return (NRs. 559,450 ha^{-1}). Likewise, the highest benefit–cost (B:C) ratio (2.25) was also obtained from NOH-05, indicating its superior economic performance under the experimental conditions. The higher profitability of NOH-05 was primarily associated with its greater marketable yield.

Similarly, the variety Venus produced a gross return of NRs. 989,100 ha^{-1} with a net return of NRs. 543,350 ha^{-1} and a B:C ratio of 2.22. Arka Anamika recorded the lowest economic return among the tested varieties, with a gross return of NRs. 930,600 ha^{-1}, net return of NRs. 485,850 ha^{-1}, and B:C ratio of 2.09. Although differences in seed cost among varieties were relatively small, variation in yield performance substantially influenced the overall profitability. Overall, the findings indicated that NOH-05 was the most economically profitable okra variety, followed by Venus and Arka Anamika. The higher

Table 11: Benefit-cost ratio of different varieties of okra at Rampur, Chitwan, 2021

Treatment combination	Base cost of cultivation excluding varietal seed cost (NRs.)	Seed cost (NRs.)	Total production cost (NRs.)	Total production (kg ha-1)	Average price per kg (NRs.)	Gross return (NRs.)	Net return (NRs.)	B:C ratio
Arka Anamika	410,750	34,000	444,750	10,340	90	930,600	485,850	2.09
NOH-05	410,750	36,000	446,750	11,180	90	1,006,200	559,450	2.25
Venus	410,750	35,000	445,750	10,990	90	989,100	543,350	2.22
Grand Mean	410,750	35,000	445,750	10,837	90	975,300	529,550	2.19

net return and B:C ratio obtained from NOH-05 suggest that this variety may be more suitable for commercial okra cultivation under the agro-climatic conditions of Rampur, Chitwan, Nepal.

Discussions

Effect of Sowing Dates and Varieties on Growth Parameters of Okra

The study demonstrated that sowing date significantly influenced vegetative growth parameters of okra, whereas varietal effects on most growth traits remained non-significant. Among the tested sowing dates, May 8 sowing consistently produced taller plants, higher leaf number, and greater stem circumference compared to earlier sowing dates. This superior vegetative performance may be attributed to favorable environmental conditions during crop establishment, particularly optimum temperature, relative humidity, and soil moisture availability, which likely enhanced photosynthetic activity, nutrient uptake, and assimilate accumulation. In contrast, early sowing during mid-April may have exposed plants to comparatively higher temperature stress and lower soil moisture, thereby limiting vegetative development. Similar findings were reported by Madhu *et al.* (2018), Moniruzzaman *et al.* (2007), Ijoyah and Dzer (2012), Maurya (2013), and Gyawali *et al.* (2023), who observed improved vegetative growth under optimum sowing environments. Likewise, Honnaiah *et al.* (2021) reported that favorable climatic conditions positively influenced vegetative growth and biomass accumulation.

Furthermore, greater leaf production and thicker stems under May sowing indicate improved canopy development and enhanced assimilate translocation, which may have strengthened vegetative vigor and structural development. Similar observations were reported by Moula *et al.* (2018), Singh *et al.* (2020), and Arslan *et al.* (2018), who highlighted the role of favorable sowing environments in promoting stem development and photosynthetic efficiency. Although varietal differences were mostly non-significant, the comparatively higher stem circumference observed in the Venus variety may reflect inherent genetic variability related to vegetative vigor and nutrient-use efficiency. Comparable varietal variation in growth traits was also reported by Gudugi (2013), Ajayi *et al.* (2018), and Enujeke (2013). Overall, the findings suggest that sowing time exerts a stronger influence than varietal differences on vegetative growth of okra under subtropical conditions.

Effect of Sowing Dates and Varieties on Yield Attributes and Yield of Okra

The present study revealed that sowing date significantly affected yield attributes and fruit yield of okra, with May 8 sowing producing the highest fruit length, fruit number, fruit weight, and overall yield. The superior yield performance under late sowing may be associated with favorable environmental conditions during flowering and pod development, including optimum temperature, adequate moisture availability, and comparatively lower pest pressure. Moreover, improved vegetative growth under May sowing likely enhanced photosynthetic surface area and assimilate partitioning toward reproductive organs, thereby increasing fruit set and yield. Similar observations were reported by Gyawali *et al.* (2023), who found that optimum sowing environments improved yield through enhanced photosynthate partitioning and longer effective growth duration. Likewise, Moniruzzaman *et al.* (2007) emphasized the importance of appropriate sowing time for maximizing assimilate accumulation and fruit yield in okra. Similar relationships between vegetative growth and yield improvement were also reported by Katuwal *et al.* (2023). In contrast, a comparatively lower yield under April sowing may have resulted from higher temperature stress and greater irrigation requirements during crop establishment and reproductive development. Such unfavorable conditions may have reduced nutrient uptake efficiency, flower retention, and fruit setting. Ratna *et al.* (2018) reported that elevated temperature can reduce reducing sugar concentration in flowers, leading to pollination failure and flower abscission. Similar beneficial effects of optimum sowing time on okra yield were also reported by Moula *et al.* (2018), Singh *et al.*

(2013), and Madhu *et al.* (2018). Additionally, reduced jassid infestation during later sowing may have preserved chlorophyll content and photosynthetic efficiency, further contributing to improved yield performance.

Among the tested varieties, NOH-05 produced the highest fruit yield, fruit weight, and fruit number, indicating superior yield potential under the prevailing agro-climatic conditions. This higher productivity may be associated with greater genetic adaptability, improved photosynthetic efficiency, and stronger assimilate utilization capacity. Rajesh *et al.* (2018) reported that vegetative growth and canopy development directly influence photosynthesis and fruit productivity in okra, while Aliyu and Ajala (2016) attributed varietal yield differences to genetic potential and assimilate utilization efficiency. Although the Venus variety recorded the highest fruit diameter, NOH-05 achieved greater total productivity due to higher fruit numbers. Similar varietal differences in fruit characteristics were also reported by Sarada *et al.* (2018). Overall, the findings emphasize that optimum sowing time combined with suitable varietal selection is critical for maximizing okra productivity under subtropical conditions.

Relationship Between Leaf Damage and Fruit Yield

The present study demonstrated a significant negative relationship between leaf damage score and fruit yield, indicating that increased jassid infestation substantially reduced okra productivity. Increased leaf damage likely reduced chlorophyll content, photosynthetic activity, and assimilate production, thereby limiting carbohydrate translocation toward developing fruits and reducing marketable yield. Thus, severe foliage damage may directly impair plant physiological efficiency and reproductive performance. Moreover, comparatively lower leaf damage under May sowing may have contributed to improved vegetative growth and higher yield performance. Favorable environmental conditions during later sowing likely reduced pest population buildup and minimized feeding damage during sensitive growth stages. Similar findings were reported by Regmi *et al.* (2020), who observed greater jassid infestation under early planting conditions compared to later sowing dates. Reduced pest pressure under late sowing may therefore have preserved photosynthetic efficiency and supported better fruit development and yield accumulation. Variation in leaf damage among varieties may also be associated with inherent tolerance mechanisms. The comparatively lower damage score observed in the Venus variety may be related to morphological resistance traits such as higher leaf trichome density, which can reduce pest feeding and oviposition. Similar findings were reported by Kanher *et al.* (2016), who highlighted the importance of leaf pubescence in reducing jassid infestation. Overall, the findings suggest that appropriate sowing time together with tolerant varieties can serve as effective cultural strategies for minimizing pest damage and improving okra productivity under field conditions.

Economics of Okra Cultivation

The economic analysis revealed substantial variation in profitability among different sowing dates and okra varieties. Among the sowing dates, May 8 sowing produced the highest gross return, net return, and benefit–cost (B:C) ratio, indicating superior economic performance compared to earlier sowing dates. The higher profitability observed under late sowing was primarily associated with increased marketable yield, reduced irrigation requirement, lower pest-related losses, and favorable market conditions during harvesting. Favorable environmental conditions during May sowing likely improved resource-use efficiency and minimized production losses, thereby enhancing overall economic return. Similar findings were reported by Moniruzzaman *et al.* (2007), Madhu *et al.* (2018), and Gyawali *et al.* (2023), who observed that optimum sowing environments significantly improved yield and economic performance of okra through enhanced growth, efficient assimilate partitioning, and better resource utilization. Likewise, Ma *et al.* (2024) reported that adjusting sowing windows improved crop productivity and water-use efficiency by synchronizing crop growth with favorable environmental conditions.

Conversely, early sowing resulted in comparatively higher irrigation costs and lower profitability due to reduced yield performance and greater production stress. Higher irrigation requirements under April sowing suggest that crops established during hotter and drier conditions required greater water input for successful crop establishment. Elevated temperature stress during early sowing may also have reduced flower retention, fruit setting, and assimilate accumulation, ultimately lowering marketable yield and profitability. Similar observations were reported by Ratna *et al.* (2018), who noted that unfavorable temperature conditions negatively affected reproductive development and yield performance in okra. Furthermore, studies in vegetable production systems have consistently shown that optimum sowing windows improve productivity and reduce production costs through better utilization of environmental resources, improved water-use efficiency, and reduced stress conditions (Singh *et al.*, 2005; Moula *et al.*, 2018).

CONCLUSION

The present study demonstrated that sowing dates and varietal selection significantly influenced the growth, yield, pest damage, and economic performance of okra under Chitwan conditions. Among the tested sowing dates, the May 8 sowing produced superior vegetative growth, higher yield attributes, and maximum fruit yield compared to earlier sowing dates. Late sowing also reduced leaf damage caused by okra jassid, resulting in improved crop productivity and profitability. Among the tested varieties, NOH-05 exhibited the highest yield, gross return, net return, and benefit–cost ratio, indicating its superior economic potential under favorable environmental conditions. The regression analysis further confirmed that increased leaf damage significantly reduced fruit yield. Overall, the findings suggest that sowing okra during early May together with the cultivation of NOH-05 can improve productivity, reduce pest-related losses, and enhance economic returns under the agro-climatic conditions of Chitwan, Nepal.

Future Directions

Further research should be conducted across multiple locations and seasons to validate the performance of sowing dates and varieties under diverse agro-climatic conditions. Additional studies focusing on integrated pest management strategies, including resistant varieties, biological control agents, and eco-friendly pest management approaches, would be valuable for sustainable okra production. Future investigations may also evaluate the interaction of sowing dates with nutrient management, irrigation scheduling, and climate variability to develop location-specific production recommendations. Moreover, assessment of post-harvest quality, storage behavior, and market preferences of okra varieties could provide additional information for improving commercial production and marketing efficiency.

REFERENCES

Ajayi, E. O., Tairu, F. M., & Akinleye, O. C. (2018). Growth and yield of three varieties of tomato as influenced by staking and spacing. *Proceeding of 36th Annual Conference of Horticultural Society of Nigeria (Hortson)*, (pp.121–126).

Al-Hamadany, M.H., & Al-Karboli, H. H.(2017). First record of okra leafhopper, *Amrasca biguttula biguttula* Ishida on okra in Iraq. *International Journal of Agricultural Technology, 13*(3), 393–402.

Aliyu, U., & Ajala, A. A. (2016). Effect of variety and plant density on growth and yield of okra (*Abelmoschus Esculentus* (L.) Moench. *Journal of Agriculture and Veterinary Science, 9*(2), 38–42.

Agriculture Perspective Plan. (1995). Agriculture perspective plan. Agriculture Project Service Center, Kathmandu and John Meller Associates, Inc..

Arslan, N., Zulfiqar, U., Ishfaq, M., Ahmad, M., Anwar, M. N., Ullah, A., Nazar, I., Iqbal, A., & Anjum, M. Z. (2018). Weed control practices and varying sowing dates effects on seed production of pearl millet (*Pennisetum americanum* L.) under semi-arid environment. *American Journal of Plant Sciences, 9*(9), 1974–1986. https://doi.org/10.4236/ajps.2018.99143

Chauhan, V., Vashisht, S. D., Sharma, L., & Gandhi, V. (2021). A review on: Assessment of leaf hopper, management of *Earias vittella* and population dynamics of sucking pests of okra. *The Pharma Innovation Journal, 10*(8), 6-8.

Dhungana, J. (2022). Production economics and determinants for adoption of commercial vegetable production in Kathmandu, Nepal. *International Journal of Social Sciences and Management, 9*(3), 103–112. https://doi.org/10.3126/ijssm.v9i3.47032

Elhag, A.Z.,& Ahmed, A. A. (2014). Effect of cultivar and sowing date on okra (*Abelmoschus Esculentus* L . Moench) seed yield. *Universal Journal of Applied Science 2(3*), 64–67.

Enujeke, E. C. (2013). Effects of variety and spacing on growth characters of hybrid maize. *Asian Journal of Agriculture and Rural Development, 3(*5), 296–310.

Gudugi, I. A. S. (2013). Effect of cow dung and variety on the growth and yield of okra (*Abelmoschus esculentus* (L.). *Pelagia Research Library European Journal of Experimental Biology, 3*(2), 495–498.

Gyawali, P., Adhikari, B. B., Gyawali, P., & Katuwal, D. R. (2023). Effect of seed rates and sowing dates on productivity of wheat (*Triticum aestivum* L.). Turkish *Journal of Agriculture - Food Science and Technology, 11*(12), 2347–2355. https://doi.org/10.24925/turjaf.v11i12.2347-2355.6326

Halder, J., Sanwal, S. K., Deb, D., Rai, A. B., & Singh, B. (2016). Mechanisms of physical and biochemical basis of resistance against leafhopper (*Amrasca biguttula biguttula*) in different okra *(Abelmoschus esculentus)* genotypes. *Indian Journal of Agricultural Sciences, 86*(4), 481–484.

Hanif, R., Iqbal, Z., Iqbal, M., Hanif, S., & Rasheed, M. (2006). Use of vegetables as nutritional food: role in human health. *Journal of Agricultural and Biological Science, 1*(1), 18-22.

Honnaiah, P. A., Sridhara, S., Gopakkali, P., Ramesh, N., Mahmoud, E. A., Abdelmohsen, S. A. M., Alkallas, F. H., El-Ansary, D. O., & Elansary, H. O. (2021). Influence of sowing windows and genotypes on growth, radiation interception, conversion efficiency and yield of guar. *Saudi Journal of Biological Sciences, 28*(6), 3453–3460.

Ijoyah, M. O., & Dzer, D. M. (2012). Yield performance of okra (*Abelmoschus esculentus* L. Moench) and Maize *(Zea mays* L.) as affected by time of planting maize in Makurdi, Nigeria. *ISRN Agronomy, 2012,* 1–7.

Iqbal, J., Mansoor, H., Muhammad, A., Shahbaz, T., & Amjad, A. (2008). Screening of okra genotypes against jassid, *Amrasca biguttula biguttula* (Ishida) (Homoptera: Cicadellidae). *Pakistan Journal of Agricultural Sciences, 45*(4), 448–451.

Kanher, F. M., Syed, T. S., Abro, G. H., Jahangir, T. M., & Tunio, S. A. (2016). Some physio morphological leaf characters of gamma irradiated cotton lines to resistance against jassid *(Amrasca Devastans* Dist.). *Journal of Entomology and Zoology Studies, 4*, 80-85.

Katuwal, D. R., Bhandari, N., & Pokhrel, A. (2023). Response of different levels of nitrogen on growth and yield of cauliflower (*Brassica oleracea* var. *botrytis)* varieties. *Asian Journal of Agricultural and Horticultural Research, 10*(3), 105–114. https://doi.org/10.9734/AJAHR/2023/v10i3236

Hemadri, T., Vijaykumar, L., Somu, G., & Sharanabasava. (2018). Management of leafhopper, *Amrasca biguttula biguttula* (Hemiptera: Cicadellidae) in okra (*Abelmoschus* *esculentus*) through new insecticide molecules. *International Journal of Chemical Studies, 6*(2), 687–690.

Ma, Q., You, Y., Shen, Y., & Wang, Z. (2024). Adjusting sowing window to mitigate climate warming effects on forage oats production on the Tibetan Plateau. *Agricultural Water Management, 299,* 108712. https://doi.org/10.1016/j.agwat.2024.108712

Madhu, U., Begum, M., Salam, A., & Sarkar, S. K. (2018). Influence of sowing date on the growth and yield performance of wheat (*Triticum Aestivum* L.) varieties. *Archives of Agriculture and Environmental Science, 3*(1), 89–94.

Mani, M., Krishnamoorthy, A., & Gopalakrishnan, C. (2005). Biological control of lepidopterous pests of Horticultural crops in India-A review. *Agriculture Reviews, 26(*1), 39–49.

Maurya, R. P. (2013). Impact of plant spacing and picking interval on the growth, fruit quality and yield of okra (*Abelmoschus esculentus* (L.) Moench). *American Journal of Agriculture and Forestry, 1*(4), 48.

Ministry of Agriculture and Livestock Development.. (2023). *Statistical information on Nepalese agriculture 2078/79 (2021/22.* Planning & Development Cooperation Coordination Division, Statistics and Analysis Section.

Mohammad, A., Alam, S. N., Miah, M. R. U., Amin, M. R., & Saif, H. B. (2018). Bio-rational management packages of jassid and shoot and fruit borer of okra. *Bangladesh Journal of Agricultural Research, 43,* 323–332.

Moniruzzaman, M., Uddin, M., & Choudhury, A. (2007). Response of okra seed crop to sowing time and plant spacing in south- eastern hilly region of Bangladesh. *Bangladesh Journal of Agricultural Research, 32*(3), 393–402.

Moula, M., Mohamed, A., Elmorsy, A., & Farag, A. (2018). The action and interaction of different planting dates and organic fertilizers on the growth and yield of okra plants. *Journal of Agriculture and Ecology Research International, 14(*1), 1–14.

Neupane, F. P. (2000). Field evaluation of botanicals against the insect pests of okra [*Abelmoschus esculentus* (L.) Moench]. *Nepal Journal of Science and Technology, 2*(1), 95–100.

Ofori, J., Tortoe, C., & Agbenorhevi, J. K. (2020). Physicochemical and functional properties of dried okra *(Abelmoschus esculentus* L.) seed flour. *Food Science and Nutrition, 8*(8), 4291–4296.

Pokhrel, A., Subedi, S., Katuwal, D. R., Adhikari, B. B., & Shrestha, A. (2024). Assessing the economic and energy use efficiencies of hybrid and inbred rice varieties through omission-plot technique in Lamjung, Nepal. *Heliyon, 10*, e28848. https://doi.org/10.1016/j.heliyon.2024.e28848

Poudel, P. (2013). Marketing margin assessment of off-season vegetables value chain in surkhet dailekh road corridor. *Journal of Agriculture and Environment, 13*, 27–31.

Rajesh, J., Prasad, V. M., & Kerketta, A. (2018). Screening of okra [*Abelmoschus esculentus* (L.) Moench] hybrids for yellow vein mosaic virus (YVMV) resistance under Allahabad agro-climatic condition. *Journal of Pharmacognosy and Phytochemistry, 7*(6), 1770–1772.

Ratna, M., Sarker, R., Ara, R., Hossain, M. M., & Kamruzzaman, M. M. (2018). Performance of chilli (*Capsicum annuum* L.) lines with different plantation time during rainy season. *Archives of Agriculture and Environmental Science, 3(*3), 240–244.

Regmi, R., Poudel, S., Regmi, R. C., & Shrestha, J. (2020). Effect of sowing dates and nitrogen levels on population of okra jassids (*Amrasca biguttula biguttula Ishida*). *Indonesian Journal of Agricultural Research, 3*(2), 127–135.

Sarada, C., Rajani, A., Vijayalakshmi, T., Venkata Ramana, C., Sirisha, K., & Naran Naidu, L. (2018). Evaluation of okra hybrids in vertisols of Andhra Pradesh, India. *International Journal of Current Microbiology and Applied Sciences, 7*(03), 3050–3054.

Senapati, B., & Khan, S. R. (1978). Note on population fluctuation of *Amrasca biguttula biguttula* (Ishida) at Bhubaneswar. *Indian Journal of Agricultural Research, 12*(2), 97–98.

Shah, F. A. (2020). Performance of tomato cultivars transplanted on various dates under the agro-climatic conditions of district Buner. *Pure and Applied Biology, 10*(1), 416–429.

Singh, B. P., Singh, A. K., & Kumar, S. (2005). Sustainable vegetable production through efficient resource management. *United States Department of Agriculture Research Bulletin, 45,* 1–18.

Singh, Himanshu, K., & Nathiram, R. (2013). Effect of sowing dates and plant geometry on growth and yield of okra cv. Parbhani Kranti and Pusa A-4. *The Asian Journal of Horticulture, 8(*2), 772–774.

Singh, V. K., Vishvkarma, D., & Deepa, H. (2020). Effect of different date of sowing on vegetative growth of okra cv. Arka Anamika. *The Pharma Innovation, 9*(7), 449–451.

Subedi, B., Nath Giri, H., Prasad Shriwastav, C., Ram Khanal, B., & Paudel, M. (2020). Effect of different doses of nitrogen and boron on the performance of cauliflower (*Brassica oleracea* var. botrytis L.) in Chitwan, Nepal. *Azarian Journal of Agriculture, 7*(3), 76–83.

Sushil, S. N., Singh, J. P., Kapoor, K. S., & Chakraborty, A. (2019). *Integrated pest management (IPM) in okra (Abelmoschus esculentus) for export purpose.* Government of India, Directorate of Plant Protection, Quarantine and Storage, NH IV, Faridabad-121 001 (Haryana).

Thapa, M. B., KC, H. B., Subedi, G. D., Dhimal, S., & Regmi, R. K. (2019). *Contribution of horticulture sector in national economy.* In *Proceedings of the 10th National Horticulture Seminar 2019.* Nepal Horticulture Society.