Pure Appl. Biol.,13(4):440-453, December, 2024
http://dx.doi.org/10.19045/bspab.2024.130039

Research Article

Enhancing Okra (*Abelmoschus esculentus* L. Moench) yield through optimized sowing techniques: A comparative study of tillage and seeding strategies

Shakir Amjad[1], Anila Qayyum[2], Nabila Qayyum[2], Sardar Ali Khan[3], Amani Mulk Khan[4], Ali Khan[1], Niamat Gul[4], Inam ul Haq[1] and Fahim Ullah[5*]

1. Department of Agricultural Mechanization and Renewable Energy Technologies, FCPS, The University of Agriculture, Peshawar, Pakistan
2. Institute of Biotechnology Genetic Engineering, The University of Agriculture, Peshawar, 25130, Khyber Pakhtunkhwa, Pakistan
3. Department of Plant Breeding and Genetics, FCPS, The University of Agriculture, Peshawar, 25130, Khyber Pakhtunkhwa, Pakistan
4. Department of Plant Protection, FCPS, The University of Agriculture, Peshawar, 25130, Khyber Pakhtunkhwa, Pakistan
5. Institute of Energy, School of Energy and Power Engineering, Jiangsu University, Jiangsu 212013, China

**Corresponding author's email: fahimullah320@yahoo.com*

Citation
Shakir Amjad, Anila Qayyum, Nabila Qayyum, Sardar Ali Khan, Amani Mulk Khan, Ali Khan, Niamat Gul, Inam ul Haq and Fahim Ullah. Enhancing Okra (*Abelmoschus esculentus* L. Moench) yield through optimized sowing techniques: A comparative study of tillage and seeding strategies. Pure and Applied Biology. Vol. 13, Issue 4, pp440-453. http://dx.doi.org/10.19045/bspab.2024.130039

Received: 23/01/2024 Revised: 20/03/2024 Accepted: 27/03/2024 Online First: 01/04/2024

Abstract

Around the world, Okra (*Abelmoschus esculentus L. Moench*) is a popular vegetable crop. This study conducted a field experiment with different tillage practices and sowing techniques on okra production in the spring of 2021 at the University of Agriculture, Peshawar's Research Farm. The experiment was replicated three times using RCBD design with different Sowing methods (flat seed bed "S1" and ridge S2") and tillage practices (Cultivator T1" + Rotavator T2"). The statistical analysis results concluded that the sowing techniques significantly affected all the parameters except the Length of Okra fruits (cm). Similarly, Tillage treatment had a non-significant effect on all the parameters except the weight of okra fruit per plant. The interaction effect showed that the highest value of days to emergence was found in S1T2 (8.67) while the lowest was found in S2T2 (6.33), followed by the highest days to 1st Okra flowing was found in S1T2 (47.7) while the lowest was found in S2T2 (44.3). Therefore, the maximum number of okra plants in plot-1 was recorded in S2T2 (30.0) concerning S1T1, which was noted up to (26.7). Furthermore, from the results, the utmost weight of okra fruit per plant, plant height, and Okra yield was found in S2T2, S2T2, and S2T2 with 29.42g, 118.5cm and 731.53Kg.ha^{-1}, while the 24.38g, 116.51cm and 669.70Kg.ha^{-1} nethermost value were as noted in S1T1, S2T1 and S1T1 methods respectively. At last, from the experimental results, it was concluded and recommended that the Ridge (S2) sowing method increased the Okra growth yields.

Keywords: Crop production; Okra (*Abelmoschus esculentus L*); Sowing method (flat seed bed and ridge) and Tillage practices (Cultivator + Rotavator)

Introduction

Okra is commonly known as lady fingers or Bhindi. It belongs to the genus (*Abelmoschus esculentus L.*) and the family *Malvaceae*. Okra is a vital financial vegetable grown worldwide in tropical, subtropical, and warm-temperate regions. Okra is suitable for agribusiness as a plot crop and for extensive stable farms. The fresh fruit of okra is a green pod with several immature white seeds. Okra is a multipurpose plant with new leaves, flowers, and pods on a small scale for oil extraction. It contains vitamins A and C and is a source of calcium, iron, niacin, and medicinal properties [1]. Pakistan grows two types of okra crop, *i.e.*, local (Fsd-1, Fsd-2, Mirpurkhas-I, and II) and imported varieties (Emerald, Clemson, Perpins dwarf, Pussa green, Pussaswani, and PussaKranti) [2]. Okra is essential to the growth of a society's economy. It is a perennial herbaceous plant cultivated twice a year, in the spring and summer. Okra is primarily farmed for its young, nutritious green fruits. Okra is regarded as a low-fat food and a high source of protein.

The fiber in fresh okra is both soluble and insoluble. Soluble fiber may help reduce the risk of heart disease. Insoluble fiber, on the other hand, keeps the digestive tract healthy and efficient. Fresh okra fruit fiber reduces sugar retention, making it a potentially beneficial anti-diabetic meal [3]. Okra fruit is good for asthma (a common condition affecting the respiratory tract) and normalizes blood sugar and cholesterol levels [4]. Fresh okra fruit helps control goiter (irregular growth of the thyroid gland) because of its high iodine content [5]. Okra is mainly consumed raw or uncooked and cooked. Its tender pods and stalks are to generate energy from biomass.

Moisture, soil conditions, and agronomic techniques influence its yield. [6] Okra production has a wide range of climatic needs, as it is a warm-climate tropical swamp plant prone to starvation or water shortages. Temperatures between 24 to 40 °C during the day and above 23°C at night are required. Due to the importance of different tillage practices and seeding techniques in increasing okra harvest and seed production for okra yields, the current research examines the presentation of other types of okra varieties (Sabz Pari) on various sowing and tillage practices for the best seed production under the climatic conditions of agriculture by Peshawar K.P.K. According to another study, the ideal temperature for high-yielding okra is 25 to 30°C [7].

Tillage is an essential technological method for increasing agricultural productivity, especially in the food sector. The tillage technique reduces weeds, prevents soil erosion, and keeps the soil hydrated to prepare the seedbed for the emergence of seedlings for various crop yields. Soil management strategies affect the long-term use of soil resources and soil improvement through different cultivation methods [8]. Tillage is directly related to the soil environment. Deep tillage improves the physic-chemical conditions of the soil. Tillage increases crop yields while protecting the soil [9]. Tillage is one of the most important practices in crop production as it helps establish seedlings, germinate seeds, and grow plants by improving the soil bed environment. Tillage contributes up to 25% of total crop production among the many variables of crop production [10].

Agriculturists generally utilize the old broadcast methods of sowing that have so many impediments, that is, rough distributions of seed quality, seed depth, and seed lying spotted being chosen by flora and fauna. Raised bed, flatbed, and ridge bed sowing methods increase the production of various vegetable crops, which can result in good self-sufficiency in food and nutrition [11, 12]. The study aimed to see how different sowing procedures affected the

outcome. (Flatbed and Ridge bed) on okra growth, yield production, and financial efficiency, assess the practicability of varying sowing methods regarding economic benefits **[13]**.

Okra is a well-liked food in Pakistan, and using contemporary agricultural gear increases output. Tillage and seeding techniques have a direct impact on okra yield. More advanced farming machinery has a direct impact on the soil. Farmers are looking for a sewing technique to yield a large amount of okra fruit. The study aims to determine how different tillage and sowing methods affect fresh okra fruits. Various sowing methods are used in developed countries to increase Okra yield. The optimal seeding method is not specified for a high yield of okra. Therefore, the optimal sowing methods should be found. In addition, the interaction of tillage and sowing methods should be specific.

Materials and Methods

Research site

The University of Agriculture Peshawar's Research Farm studies farms at latitude 34.0206°N and longitude 71.4815°E. Their research site has a salty loam texture with higher field capacity. The recorded ambient temperature (maximum and minimum in ^{0}C) precipitation or rainfall (mm) during the research period is in (Table 1). The okra alternation field was prepared using tillage implemented on April 21, 2021. While the seedbed was sown after two days of seedbed preparation, twelve-timer irrigations were applied to the Okra field. The details are shown in (Table 1). The (Fig. 1) shows the map of the experimental site where the experiments were performed.

Table 1. Meteorological data for the Experimental period from April to Jun 2021

Month	Maximum Temperature	Minimum Temperature	Average Rainfall (mm)
April	31.6 ^{0}C	16.7 ^{0}C	20.2 mm
May	37.1 ^{0}C	21.5 ^{0}C	9.2 mm
Jun	40.6^{0}C	24.9 ^{0}C	0 mm
Details of Okra production			
Details		**Date**	
Tillage		21	April 2021
Sowing		23	April 2021
Irrigation		30	April 2021
		7	May 2021
		14	May 2021
		21	May 2021
		28	May 2021
		5	Jun 2021
		12	Jun 2021
		19	Jun 2021
		26	Jun 2021
		3	July 2021
		10	July 2021
		17	July 2021

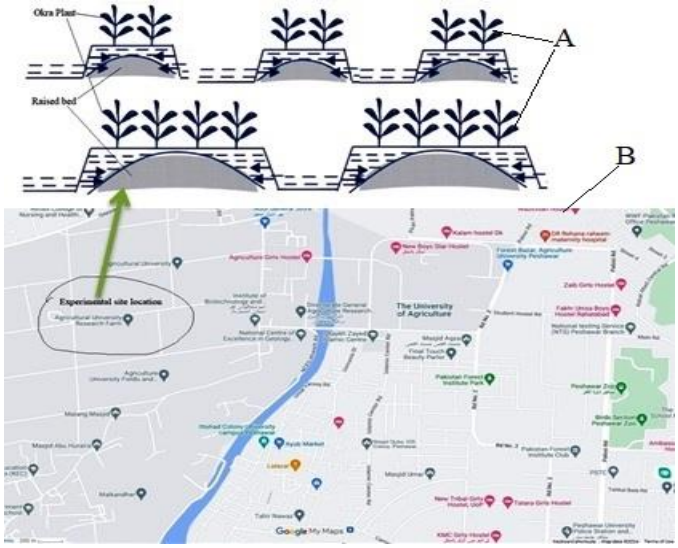

Figure 1. (A) show the okra planted crop in filed and (B) Map showing the experimental site location

Experimental procedure

On April 21, 2021, the okra alternation field with tillage twelve-timer irrigations, while the seedbed followed two days of seedbed preparation. The total experimental plot was 114m^{2,} and the plot size for each treatment was 1.9x5 m^2. In every plot, the Cultivator was utilized twice as the primary tillage, and the Cultivator and Rotavator were the two secondary tillage methods employed as factors. The research used two types of sowing methods (flat and ridge) to find the optimal method for okra production—the okra variety Sabz Pari @ of sowing 20 kg ha^{-1} at a single spot. Thinning was done after germination to ensure that only one plant remained. In each plot, the plant-to-plant and row-to-row distances were kept constant at 30-90 cm, respectively. The fertilizers (N: P_2O_5: K_2O) were in the prescribed ratio of 100:60:50 kg ha$^{-1,}$ respectively, in weekly irrigation applications during the agricultural stages. Regular interweaving guarantees that the crop develops to a suitable size. Each plot has five randomly selected samples to gather the observations. Two factors were studied in the research, i.e., tillage and sowing technique. Tillage had two levels, i.e., T1 (Cultivator (2) + Cultivator (2) + plank), T2 (Cultivator (2) + Rotavator), while the sowing technique S1 (Flat Bed) and S2 (Ridge). The parameters of the research were Days to emergence of Okra, Number of okra plants per plot, Number of okra fruit per Plant, Days to first okra flowering, Weight of Okra fruit Per Plant, Length of Okra fruit, Plant Height (cm), Okra yield (kg ha^{-1}). Each plot's okra fruit yield was measured using randomly selected samples from each treatment. By converting kg m^{-2} to kg ha^{-1}, okra production (kg ha^{-1}) was expected.

$$\text{Yield ha}^{-1} = \frac{\text{Total picking fruit weight}}{\text{plot area (m}^2\text{)}} \times 10000 \text{ m}^2$$

Statistical analysis

The Okra yield parameters data were analyzed statistically by ANOVA methods of Randomized Statistically Block, and Statistix-8.1 software created the design. At a probability value of 5%, the treatment means using the least significant difference method [12]. The analysis of variance is in (Table 2).

Table 2. Analysis of variance for treatments in the research

Source of variance	Degree Freedom	SS	MS	F
Replication (R)	2	S.S. (R)	S.S. (R)/2	M.S. (R)/M.S. (E)
Tillage (T)	1	S.S. (T)	S.S. (T)/1	M.S. (T)/M.S. (E)
Sowing techniques (S)	1	S.S. (S)	S.S. (S)/1	M.S. (S)/M.S. (E)
T×S	1	S.S. (T×S)	S.S. (T×S)/1	M.S. (T × S)/M.S. (E)
Error	6	S.S. (E)	S.S. (E)/6	
Total	11	S.S. (Total)		

Results and Discussion

Days to the emergence of okra

The (Table 3) shows that the statistical analysis showed that the sowing method and interaction of sowing with tillage had a significant effect on the days of the emergence of okra. The highest value of days of emergence (8.67) was found in S1T2, while the lowest (6.33) was found in S2T2, as shown in (Fig. 2). The R^2 offers about an 80% relationship between the treatments applied and the days of the emergence of okra. In the treatments S2T1 and S1T1, the days of emergence of okra recorded were 7.33 and 8.33, respectively.

Table 3. Statistical analysis of days of the emergence of okra

Source	DF	SS	MS	F	P
Replication	2	2.1667	1.08333	100.00	0.0001
Sowing	1	8.3333	8.33333	4.00	0.0924
Tillage	1	0.3333	0.33333	0.0071	
Sowing×Tiilage	1	1.3333	16.00		
Error	6	0.5000	0.08333		
Total	11	12.6667			

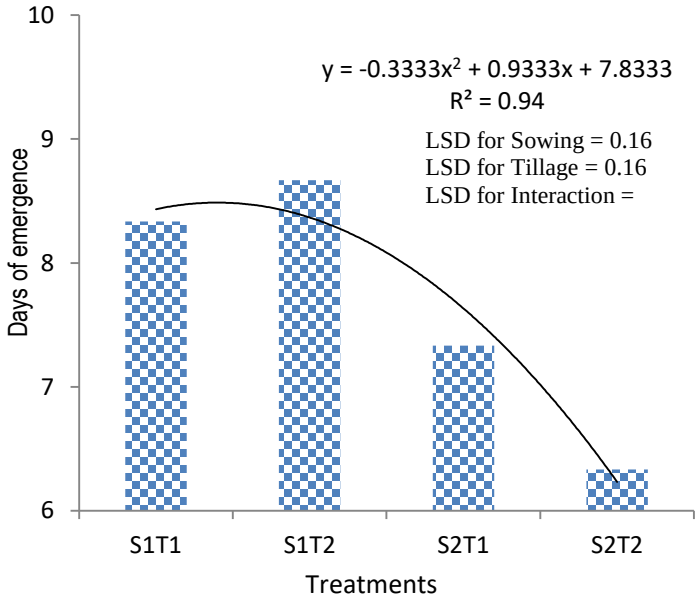

Figure 2. Days of emergence affected by the treatments applied

The results are similar to those of [13]. In flatbed sowing, the days of emergence are due to less Rainfall and water use efficiency, whereas, in a rigid seed bed, water is available to seed for much more time than in the flat seed bed. Similar results to [14] reported that the difference in sowing dates and time was the leading cause of seedlings' emergence, continued existence, and vigor. These results are similar to [15], who described the fast emergence of plants. When comparing normal tillage to profound furrowing, they discovered 3% more plants. Furthermore, compared to other methods, flat seed bed sowing produced more plants [16].

Number of okra plants per plot

The statistical analysis showed that the sowing method significantly affected the number of okra plants per plot, as shown in (Table 4). The highest number of okra plants per plot (30.0) was found in S2T2, while the lowest (26.7) was in S1T1. The R^2 shows a 99% relationship between the treatments applied and the number of okra plants per plot. In the treatments, S2T1 and S1T2, the number of okra plants recorded per plot was 27.7 and 29, respectively, as shown in (Fig. 3).

The results are similar to [17]. They conducted two years of research experience to find out the effect of different tillage methods on soil physical qualities and watermelon crop production, as well as the influence of varying tillage techniques on the number of okra plants per plot, which is non-significant.

Table 4. The statistical analysis of okra plants per plot

Source	DF	SS	MS	F	P
Replication	2	4.66667	2.33333	21.00	0.0038
Sowing	1	16.3333	16.3333	3.86	0.0927
Tillage	1	3.00000	3.00000	0.00	1.0000
Sowing×Tillage	1	1.394E-29	1.394E-29		
Error	6	4.66667	0.77778		
Total	11	28.6667			

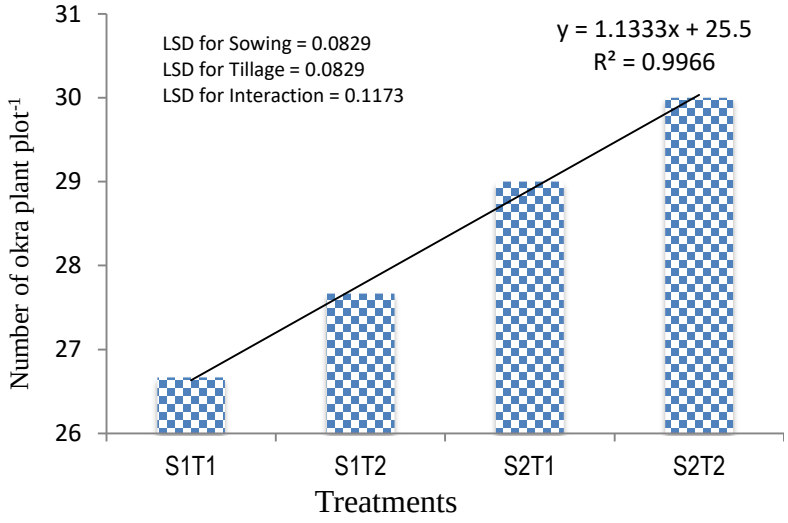

Figure 3. Number of okra plant plot^{-1} as affected by the treatments applied

The statistical analysis showed that the sowing method with tillage significantly affected how much okra fruit each plant produced, as shown in (Table 5). The highest value of the number of okra fruit per plant (3.74) was found in S2T2, while the lowest (3.09) was found in S1T1, as shown in (Fig. 4). The R^2 shows a 99% relationship between the treatments applied and the Number of okra fruit per plan in the treatments S1T2 and S2T1. The number of okra fruit per plant recorded was 3.09 and 3.19, respectively.

Table 5. Statistical analysis of okra fruit each plant

Source	DF	SS	MS	F	P
Replication	2	0.02312	0.01156		
Sowing	1	0.73508	0.73508	35.62	0.0010
Tillage	1	0.07521	0.07521	3.64	0.1048
Sowing×Tiilage	1	0.00908	0.00908	0.44	0.5319
Error	6	0.12382	0.02064		
Total	11	0.96629			

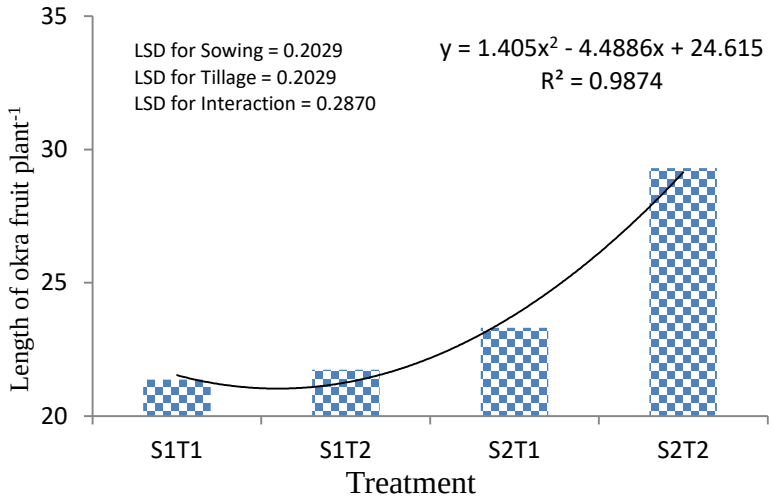

Figure 4. Length of Okra Fruit/plant as affected by the treatments applied

The outcomes align with the study's conclusion. **[18]** documented the beneficial impact of pinching on developing reproductive organs in Butternuts. When smaller plant populations are compared to large ones, the number of pods, inflorescence branches, bolls per plant, and cotton boll weight increase similarly. **[19]** Found that plant height, the Number of monopodial and sympodial branches, and the Number of monopodial and sympodial branches all increased.

Days to 1st okra flowering

The statistical analysis showed that the sowing method and tillage practices significantly affected the days of 1st Okra flowering, as shown in (Table 6). The highest value days to 1st Okra streaming (47.7) were found in S1T2, while the lowest (44.3) was in S2T2. The R^2 shows a 70% relationship between the treatments applied and the days to 1st okra flowing. In the treatments S2T1 and S1T1, the first days of okra's flowering recorded were (46.3) and (47) respectively, as shown in (Fig. 5).

Table 6. The statistical analysis of 1st Okra flowering

Source	DF	SS	MS	F	P
Replication	2	4.66667	2.33333	21.00	0.0038
Sowing	1	16.3333	16.3333	3.86	0.0927
Tillage	1	3.00000	3.00000	0.00	1.0000
Sowing×Tiilage	1	1.394E-29	1.394E-29		
Error	6	4.66667	0.77778		
Total	11	28.6667			

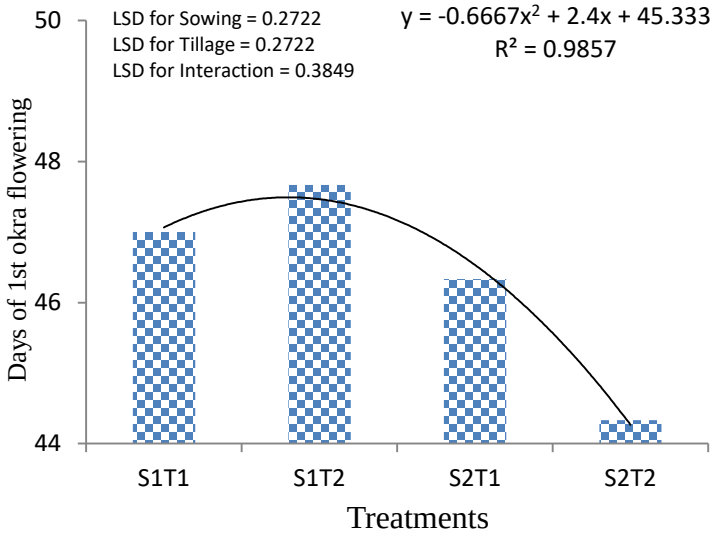

Figure 5. Days of first okra flower, as affected by the treatments, applied

The results are similar to those of [4]. They stated tillage is a primary mechanical factor affecting okra growth and development. High pulverize seed beds had optimum characteristics in terms of rapid okra flowering. The Rotavator crushes the seed beds for the optimum growth of okra. The result showed that a flat seedbed is better than ridges in terms of first okra flowering, but these results conflict with [20], who concluded that a ridge seedbed is better than a flat seedbed for producing rapid flowering. The difference in the results may be due to taking more days for emergence in a ridged bed than in a flatbed.

Length of Okra fruit

The (Table 7) shows the statistical analysis that the sowing method and tillage's interaction significantly affected the okra fruit's length. The highest length value of okra fruit (29.30) was found in S2T2, while the lowest (31.37) was in S1T1. The R^2 shows an 80% relationship between the treatments applied and the length of okra fruit. In the treatments S1T2 and S2T1, the Lengths of okra fruit recorded were 21.74 and 23.31, respectively, as shown in (Fig. 6).

The results are similar to the findings by [21, 22]; they observed that the length of okra fruit is significantly different from the fruit length of different okra varieties used in the research. The results are similar to those of [23]. They found that deep tillage enhances the okra fruit length compared to shallow tillage and non-tillage. The deep tillage increases the plant's nutrient use efficiency. Thus, height nutrient uptake increases the fruit's length. On the other hand, [24] concluded that ridge planting increases the fruit length of the crop.

Table 7. shows the statistical analysis of the length of okra fruit affected

Source	DF	SS	MS	F	P
Replication	2	42.515	21.2574		
Sowing	1	67.783	21.2574	2.42	0.1705
Tillage	1	30.210	30.2101	1.08	0.3387
Sowing×Tiilage	1	23.745	23.7445	0.85	0.3924
Error	6	167.822	27.9703		
Total	11	332.074			

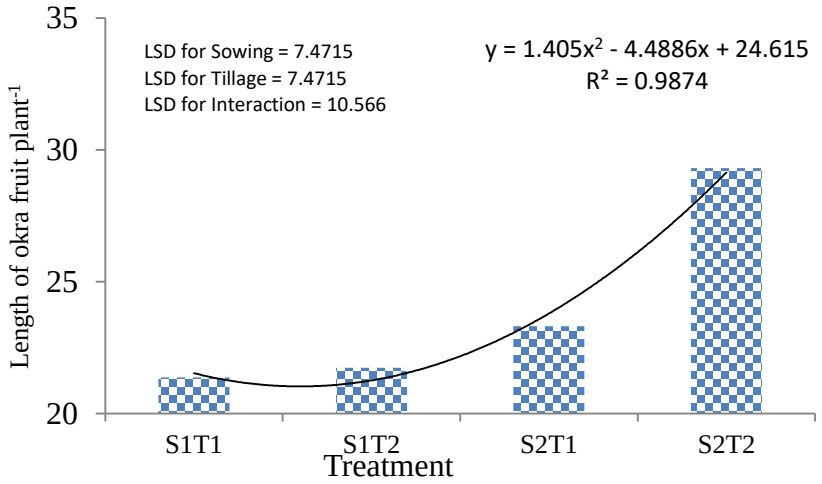

Figure 6. Length of Okra Fruit, as affected by the treatments applied

Weight of Okra fruit per plant

The (Table 8) shows the statistical analysis that shows that the sowing method, the interaction of sowing methods, and the weight of okra fruit per plant^{-1} were significantly affected by tillage techniques. The highest weight of okra fruit per plant (29.42) was found in S2T2, while the lowest (24.38) was found in S1T1, as shown in (Fig. 7). The R^2 indicates that there is about 92% relationship found between the treatments applied and the weight of okra fruit per plant. In the treatments S1T2 and S2T1, the weight of okra fruit per plant recorded was 25.42 and 26.49, respectively.

The results were similarly reported by **[24, 25]**. They experimented with a higher average fruit weight, which could be related to enhanced fruit length and width produced by plants grown using various tillage and sowing techniques. **[26]** Deep tillage operations led to increased cotton rounded mature fruit of the cotton plant weight, ascribed to the remarkable growth of cotton crops. In flat seed bed planted cotton, well-spaced plants exhibited much improved light infiltration throughout the growing period, resulting in higher boll weight than flat seed poor cotton. In addition, comparing flat sowing with earthling up to flat sowing with earthling down, it was discovered that it yielded an enormous boll weight **[27, 28]**.

Table 8. shows the statistical analysis of the weight of okra fruit per plant^{-1}

Source	DF	SS	MS	F	P
Replication	2	3.1641	1.5821		
Sowing	1	27.8465	27.8465	15.36	0.0078
Tillage	1	11.8405	11.8405	6.53	0.0432
Sowing×Tiilage	1	2.6696	2.6696	1.47	0.2706
Error	6	10.8783	1.8131		
Total	11	56.3992			

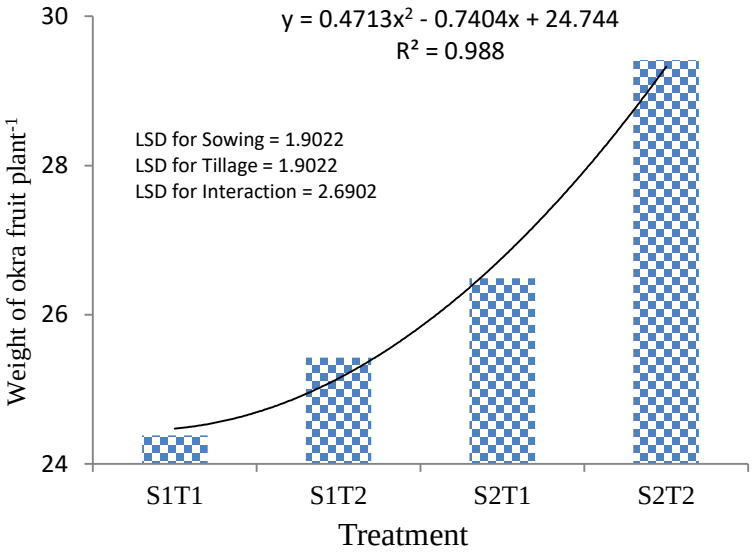

Figure 7. Weight of Okra Fruit per Plant plot as affected by the treatments applied

Plant height (cm)

The (Table 9) shows the statistical analysis that the sowing method and interaction with tillage significantly affected the plant height. The highest value of plant height (118.5) was found in S2T2, while the lowest (116.51) was found in S2T1, as shown in (Fig. 8). The R^2 indicates an 88% relationship between the treatments applied and the plant height in the treatments S1T2 and S1T2. The plant height recorded was 98.52 and 95.46, respectively. Comparable results were noted for field beans **[29]**. The plant height effect is caused by the auxin hormone change for cell stretching and produced by plants in apical parts, which are expelled and redirect the buds of apical portion branches created, causing the reduction in plant height. **[15]** The results show that the different sowing methods significantly affected the growth and cotton yields. The number of plants in cm harvested by flat seed bed sowing at 20-25 cm inter-row to row to distances to condensed inter-row spacing increased the number of plants. **[18]** The results are similar to the expulsion of apical buds, limiting the perpendicular growth of plants to the changes over the photosynthesis process towards leaves; as a result, more horizontal branches happen..

Table 9. Shows the statistical analysis of the affected plant height

Source	DF	SS	MS	F	P
Replication	2	169.93	84.96		
Sowing	1	1240.94	1240.94	35.62	0.0010
Tillage	1	16.54	16.54	3.64	0.1048
Sowing×Tiilage	1	1.51	1.51	0.44	0.5319
Error	6	50.31	8.39		
Total	11	1479.23			

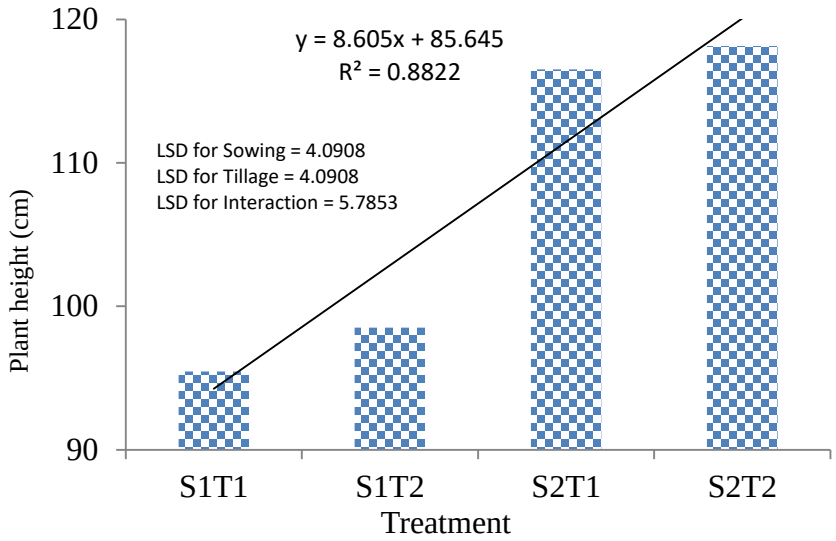

Figure 8. Plant Height as affected by the treatments applied

Okra yield (kg ha^{-1})

The (Table 10) shows the statistical analysis that the sowing method and interaction with tillage significantly affected the okra yield (kg ha^{-1}). The highest value of okra yield (731.53 kg ha^{-1}) was found in S2T2, while the lowest (669.70 kg ha^{-1}) was in S1T1. The R^2 shows about a 99% relationship between the treatments applied and the okra yield in the treatments S1T2 and S2T1. The okra yield recorded was 688.40 kg ha^{-1} and 710.73 kg ha$^{-1,}$ respectively, as shown in (Fig. 9).

These results essentially corroborated the findings of **[30, 31]** concerning okra. They discovered a substantial relationship between okra yield and tillage and planting techniques. In the treatment combinations of sowing techniques and tillage practices, Sabz Pari was significantly superior over other treatment combinations. Higher fruit yield to the favorable response of S1T1 on growth and yield attributes Days to emergence of Okra, Days to first okra flowering, the number of okra plants per plot, weight of okra fruit per Plant, Length of okra fruit plant, Plant Height, Okra yield (kg ha^{-1}).

Table 10. Shows the statistical analysis of the affected okra yield (kg ha^{-1})

Source	DF	SS	MS	F	P
Replication	2	189.76	94.88		
Sowing	1	5311.76	5311.76	16.36	0.0068
Tillage	1	1169.99	1169.99	3.60	0.1064
Sowing×Tiilage	1	3.28	2. 3.28	0.01	0.9233
Error	6	1948.05	324.67		
Total	11	8622.83			

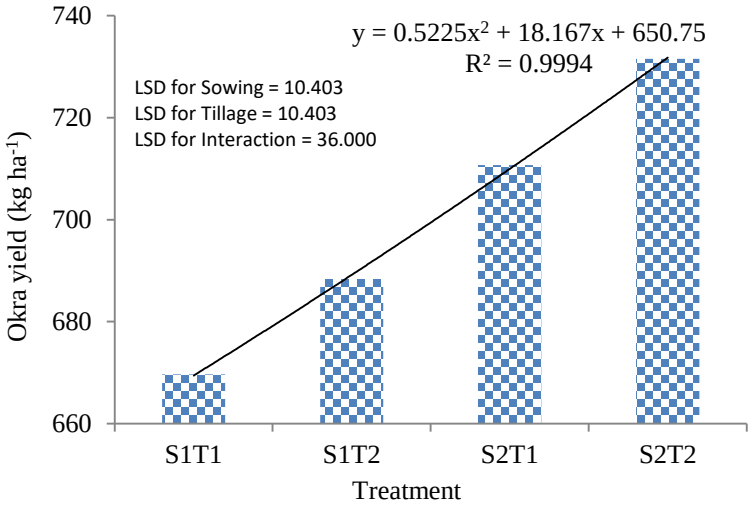

Figure 9. Okra yield (kg ha^{-1}) as affected by the treatments applied

Conclusions and Recommendations

The sowing techniques and tillage experiment on okra production was performed at University Research Farm, the University of Agriculture Peshawar, from April 21 to July 22, 2021. The experimental results concluded that tillage practices significantly affected the weight of okra fruit plant^{-1}. Similarly, from the results, the highest okra fruit weight was noted when the techniques/methods of Cultivator + Rotavator were applied. Therefore, the statistical analysis showed that sowing techniques significantly affected all the okra production parameters except the okra fruit length. The results showed that the interaction of sowing techniques and tillage practices significantly affects the Days to emergence and Days to 1st flowering.

From the experimental results, the following recommendation concludes. According to the study, ridge-sowing techniques produced better results in all parameters. So, based on the results, we recommend the Ridge sowing method for high crop yields. Another recommendation was drawn from the study's results: Cultivator twice followed by plank and Rotavator had no significant effect, so these tillage treatments should be substituted.

Authors' contributions

Conceived and designed the experiments: S Amjad, Performed the experiments: S Amjad, A Qayyum & N Qayyum, Analyzed the data: SA Khan & AM Khan, Contributed materials/ analysis/ tools: A Khan, N Gul & IU Haq, Wrote the paper: F Ullah.

Acknowledgments

We thank all the contributors to this research work for supporting and providing research facilities for this study.

References

1. Appah S & Aikins SHM (2020). Interactive Effect of Land Preparation

Methods and Weeding Frequency on Seasonal Soil Properties and Maize Yield. *Eur J of Agr and Food Sci* 2(5).
2. Anjum SA, Raza MM, Ullah S, Yousaf MM, Mujtaba A, Hussain M, Shah MJ, Ahmad B & Ahmad I (2019). Influence of Different Tillage Practices on Yield of Autumn Planted Maize (Zea mays L.). *Pak J of Agri Res* 32(2).
3. Angelique T, Etienne N, Innocent M, Wansim, Ngnadong, Li C, Hao TQ, Shio BJ, Hai JB (2020). The Combined Effect of Different Sowing Methods and Seed Rates on the Quality Features and Yield of Winter Wheat. *Agr* 10(5): 153.
4. Ali A, Nabi G, Irshad M, Khan MN, Israr M, Shamsher A, Javed R & Ali W (2020). Pinching effects on growth and yield of okra. *Pure and Appl Biol* 11(1): 35-145.
5. Anjum SA, Raza MM, Ullah S, Yousaf MM, Mujtaba A, Hussain M, Shah MJ, Ahmad B & Ahmad I (2019). Influence of different tillage practices on yield of autumn planted maize (Zea mays L.). *Pak J of Agri Res* 32(2): 293-301.
6. Ali L, Anum W, Hussin G & Shahid M (2017). Enhancement in cotton (Gossypium hirsutum L.) crop yield by water use efficiency under various planting techniques. *Reg Agr Res Ins* 63100 Bahawalpur, Pakistan.
7. Ali A, Nabi G, Irshad M, Khan MN, Israr M, Ali S, R Javed & Ali W (2021). Pinching effects on growth and yield of okra. *Pure and Appl Biol* 11(1): 135-145.
8. Birbal RK, Nehra N & Malik YS (2018). Effect of spacing and nitrogen on fruit yield of okra cv. *Varsha Uphar*. *Haryana Uni J Res* 25: 47–51.
9. Delate K, Heller B & Shade J (2021). Organic cotton production may alleviate the environmental impacts of intensive conventional cotton production. *Ren Agr and Food Sys* 6: 405–412.
10. Ehsanullah, Shahzad MA, Anjum SA, Zohaib A, Ishfaq M & Warraich EA (2017). Effect of Different Sowing Methods and Planting Densities on Growth, Yield, Fiber Quality and Economic Efficacy of Cotton. *Pak J Agr Res* 30(1): 5-7.
11. Fekadu GH (2015). Nutritional Quality and Health Benefits of "Okra" (Abelmoschus esculentus): A Review. *Inter J of Nut and Food Sci* 4(2):208.
12. Gemede HF, Ratta N, Haki GD, Woldegiorgis AZ, Beyene F (2015) Nutritional Quality and Health Benefits of Okra (Abelmoschus esculentus): A Review. *J Food Pro Technol* 6: 458.
13. Hongo S, Dzefack ZSC, Vernyuy LN, Minami S, Mizuno K, Otsuka R & Yasuoka H (2022). Predicting bush meat biomass from species composition captured by camera traps: Implications for locally based wildlife monitoring. *J of Appl Ecol* 59(10): 2567-2580.
14. Jonathan EA & Brisibe EA (2015). Morphological Characterization and Yield Traits Analysis in Some Selected Varieties of Okra (*Abelmoschus esculentus* L. Moench). *Adv in Crop Sci and Technol* 04(01).
15. Khan MA & Rab A (2019). Plant Spacing Affects the Growth and Seed Production of Okra Varieties. *Sar J of Agr* 35(3).
16. Kshash BH (2016). Okra Grower's Knowledge of Cultivation Practices: A Case Study. *Inter J of Veg Sci* 23(2): 80–86.
17. Księżak J, Bojarszczuk J & Staniak M (2018). Comparison of maize yield and soil chemical properties under maize (Zea mays L.) grown in monoculture and crop rotation. *J Elem* 23(2): 531-543.
18. Khursheed S, Simmons C, Wani SA (2016) Conservation Tillage: impacts on soil physical conditions–an overview. *Adv Plants Agr Res* 9(2): 342-346.

19. Mushtaq Z, Asghar H & Zahir ZA (2021). Comparative growth analysis of Okra (Abelmoschus esculentus) in the presence of PGPR and press mud in chromium contaminated soil. *Chemosp* 262: 127865.
20. Mueen-ud-din, Kalsoom, Ali LM, Anjum QM & Khalid L (2015). Demonstration and Evaluation of Various Tillage Practices and Farm Yard Manure on the Yield of Wheat in Ecological Zone of Vehari Punjab Pakistan. *Inter J of Res in Agr and Fore* 2(4): 25-31.
21. Mihretu Y, Wayessa G, Adugna D (2015). Multivariate Analysis among Okra (*Abelmoschus esculentus* (L.) Moench) Collection in South Western Ethiopia. *J Plant Sci* 9: 43–50.
22. Ramzan M, Uddin S, Shah S, Ahmad M, Ali S, Bashir A & Din SU (2016). Tillage and mulching effect on weed dynamics and yield components of maize crop in district Peshawar under semi-arid environment. *Pak J of Weed Sci Res* 22(1).
23. Raza A, Nawaz M, Chattha M, Khan I, Chattha MB, Kharal M, Anjum FH, Hussain F, Iqbal MM, Aslam MT, Amin MZ & Hassan MU (2021). Comparative study of different organic mulches for increased wheat productivity district Faisalabad, Punjab, Pakistan. *Inter J of Agr Ext* 9(3).
24. Sood R & Kaur R (2019). Effect of Sowing Time on Performance of Okra [Abelmoschus esculentus (L.) Moench] Varieties under Jalandhar Conditions. *Inter J of Curr Microbiol and Appl Sci* 8(12): 568–576.
25. Swapna N, Shahana F, Reddy TP, Kumar GP Venkataiah M (2023). Enhancement of Soybean (Glycine max L.) Productivity through Sowing Methods and Seed Rates in Telangana State. *Leg Res-An Inter J* 46(2): 181-185.
26. Sood R & Kaur R (2019). Effect of Sowing Time on Performance of Okra [Abelmoschus esculentus (L.) Moench] Varieties under Jalandhar Conditions. *Inter J of Curr Microbiol and Appl Sci* 8(12): 568–576.
27. Tutu SK, Mloza Banda HR Tfwala C (2022). Yield, nutritional composition, and consumer acceptability of sweet potato cultivars cultivated with soil amendments in the Middleveld of Eswatini. *South Afr J of Plant and Soil* 39(3): 187–197.
28. Tian S, Ning T,Wang Y, Liu Z, Li G, Li Z & Lal R (2016). Crop yield and soil carbon responses to tillage method changes in North China. *Soil and Till Res* 163: 207–213.
29. Undie & Litio U (2018). Influence of planting date and harvesting sequence on growth and fruit/seed yields in West African Okra {Abelmoschus caillei [A. Chev (Stevels)]}. *Inter J of Agr and Earth Sci* 4(4): 8-17.
30. Yonas M, Garedew W & Debela A (2014). Multivariate Analysis among Okra (Abelmoschus esculentus (L.) Moench) Collection in South Western Ethiopia. *J of Plant Sci* 9(2): 43–50.
31. Mushtaq Z, Asghar H & Zahir ZA (2021). Comparative growth analysis of Okra (Abelmoschus esculentus) in the presence of PGPR and press mud in chromium contaminated soil. *Chemos* 262: 127865.