Journal of Experimental Agriculture International

43(7): 93-102, 2021; Article no.JEAI.72994
ISSN: 2457-0591
(Past name: American Journal of Experimental Agriculture, Past ISSN: 2231-0606)

Effect of Sowing Dates, Phosphorous and Potassium Fertilizer Rates on Phenological, Growth and Yield Aspects of Okra (*Abelmoschus esculentus L*) in Hamelmalo Subzone, Eritrea

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Authors' contributions

This work was carried out in collaboration between both authors. The first author BK executed the study and the second author GSR composed, managed the literature review and wrote the draft of this manuscript. The statistical analysis done by author BK and the manuscript has been reviewed and analysed by author GSR. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JEAI/2021/v43i730717
Editor(s):
(1) Dr. Mirjana Bulatovic-Danilovich, West Virginia University, USA.
(2) Dr. Daniele De Wrachien, State University of Milan, Italy.
Reviewers:
(1) Sory SISSOKO, University of Sciences, Techniques and Technologies of Bamako (USTTB) , West Africa.
(2) Maguje Masa Malko , Wolaita Sodo University, Ethiopia.
Complete Peer review History: https://www.sdiarticle4.com/review-history/72994

Original Research Article

Received 20 June 2021
Accepted 30 August 2021
Published 06 September 2021

ABSTRACT

The field experiment was conducted, in the fields of Hamelmalo Agricultural College, to evaluate the response of sowing-dates and PK (Phosphorous and Potassium) fertilizer levels on phenological aspects, yield and yield components of okra (*Abelmoschus esculentus* L). The experiment was done through a factorial randomized complete block design (RCBD) where each treatment was replicated three times. The two factors were: sowing-dates which was composed of three sowing dates; namely, *middle kiremti* (end of July *i.e.,* mid-summer), *late kiremti* (middle of August- late-summer) and *early qewee* (early September-early autumn) and P: K fertilizers which was composed of five rates (0kg/ha, 125 kg/ha (75:50), 150 kg/ha (90:60), 175 kg/ha (105:70) and 200 kg/ha (120:80). Results showed that, the highest significant mean values of leaf area (389.4cm^2), leaf numbers (28.2) were recorded from middle *kiremti* sowing date coupled with 320kg/ha and 175kg/ha PK rates

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respectively. Besides this the highest significant values of both number of fruits (43.8) and total yield (15.26t/ha) were obtained from highest PK rate coupled with *late kiremti* and *middle kiremti* respectively. The sole effects of the PK rates as well as the sowing dates were found to be significant on all the parameters mentioned above including individual fruit weight. It is therefore the sowing during *late kiremti* coupled with application of 200kg/ha kg/ha was the best for getting the best economic returns.

Keywords: Okra; sowing dates; phosphorous and potassium fertilizer; phenology and yield.

1. INTRODUCTION

Okra (*Abelmoschus esculentus* L. family: Malvaceae) is an annual vegetable crop mainly grown in the tropical regions of the world during spring and summer seasons [1]. Ethiopia is believed to be the center of origin [2]. Okra is mainly grown for its edible fruit that can be used both in green and dried forms. The tender fruits are those to be harvested and can be utilized as a cooked vegetable [1]. It is a very rich source of fiber, proteins, vitamins, minerals and carbohydrates [3]. It also accounts for its appreciable medicinal values as it is capable of curing many ailments like peptic ulcer as indicated by [4]. According to Indian Horticulture Database-2011, The total area and production under okra is reported to be 1148.0 thousand ha and 7896.3 thousand tons). Many authors reported on the effect of planting time on the growth and yield of okra [5,6,7]. In Eritrea, it is mainly grown in the lowlands and the mid-lowland areas *i.e*., in the regions of Anseba, Debub, Northern Red Sea and Gash Barka with Gash Barka accounting for the largest area under cultivation (514 ha) with an average yield of 10t/ha [8]. As per the statistical data obtained from 2010 up to 2014 [9], the average yield/ha in Eritrea is 8.82t/ha. This low yield is possibly due to lack of inputs (fertilizers, irrigation water and quality seed), insect pests (jassids, whiteflies and aphids), diseases (blights and leaf curls) [10] and lack of awareness about the proper dates of sowing.

Sowing date has a great impact on the productivity of okra. With the availability of various cultivars that can do well in diversified climatic conditions, it is possible to produce okra all the year round especially in the tropics. However, proper date of sowing has to be considered for every cultivar [11]. According to Tindal, [12], different cultivars require different climatic conditions and good cultivars sown at improper time give poor yield. Dealing with the proper date of sowing is not merely concerned for fulfilling of appropriate development of the plant, but also is a means of disease escaping that can influence yield indirectly (Sutton, 1966). Okra crop needs a proper sowing date depending upon climatic conditions, soil and variety so that its critical stage should coincide with favorable weather conditions [13].

Soil fertility is one of the most important inputs contributing to crop production because it increases productivity and improves yield quantity and quality [14]. NPK fertilizer application is a major input that can regulate the growth and development of plants where it can enhance the leaf area [15]. Adequate NPK application can result in to production of better yield of fresh fruits [16]. For a healthy crop, Nitrogen, phosphorus and potassium is the basic requirement at 120, 90 and 60 kg/ha respectively [17]. Therefore, this study was conducted to determine the ideal sowing dates and proper PK fertilizer ratios to get best economic returns (by using *Pusa sawani* cultivar) of okra.

2. MATERIALS AND METHODS

2.1 Location of the Experiment

The experiment was conducted at the experimental fields of Hamelmalo Agricultural College (HAC), located at 15º 55` 12.92N latitude and 38º 27`46.9E longitude with an altitude of 1280 meters above sea level. The average annual rainfall and temperature of the area are 459 mm and 24˚C, respectively, and the soil of the experimental site is sandy loam with pH ranging 6-7 [18].

2.2 Field Preparation and Seed Sowing

The field of the experimental site was ploughed and harrowed using tractor mounted equipment to make the soil into a fine tilth, then the land was divided into three blocks each comprising 15 plots. Plots were sunken beds of 3 x 3.6-meter dimensions forming plot area of 10.8 m^2. At the final stage of bed preparation, half sack (approx. 40kg) of farmyard manure was applied in all the plots except in the control treatments. One week before sowing, plots were well watered, then according to the different sowing date treatments; three seeds per hole were sown manually at a depth of 1.5 cm. The okra seeds (*Pusa sawani* cultivar) were sown maintaining the space between rows 50cm and between plants 30cm. Thinning was done after germination for keeping one plant per hole.

2.3 Experimental Design and Treatments

The experiment was laid out by a factorial randomized complete block design (RCBD) with three replications each. The two factors deployed in this research were sowing dates and inorganic fertilizer levels. Three sowing dates; the first sowing date (*middle kiremti* -S_1) was at the end of July, after twenty days the second sowing date (*late kiremti* -S_2) mid-August and the third last sowing date (*early qewee* -S_3) (after twenty days) was early September. Five P:K rates with the ratio of 3:2 for all treatments were maintained as, $(PK)_1$= 0kg/ha [control], $(PK)_2$= 125kg /ha, $(PK)_3$=150kg/ha, $(PK)_4$=175kg/ha and $(PK)_5$=200kg/ha.

2.4 Data Collection

Six plants were randomly selected and tagged in each plot for data collection of the vegetative and yield parameters. The emergence started in about a week time, counting of the emerged seedlings was done in the second week from the respective sowing dates, for assuring better estimate of the emergence percentage by the formula. percentage of emerged seedlings=number of emerged seedlings per plot/total sees sown per plot x 100. The date of emergence was recorded when 50% of the seeds germinated in each plot. For stand count, the number of plants that stood healthy was counted after a month. These were the plants from which the yield is expected, contributing to the overall production. The length of the plants was measured from the basal portion of the stem to the top of the terminal shoot and was recorded up to the flowering time in four different periods starting from the 25^{th} day after sowing at 11-day interval. It was recorded by measuring the perimeter of the stem, through a thread at the midpoint between the shoot junction with the root and the point where the first branch proliferates. This was also recorded four times up to the time of blooming starting from the 25^{th} day after sowing at 11-day interval. The number of days required for the commencement of harvesting was counted from the dates that the seeds were sown. The total weight of pods that were borne on an individual plant was measured by getting the mean value from the six sample plants. The total fresh yield was obtained by the summation of the weights of all the pods harvested from all the pickings. Length was obtained by measuring of pods from its basal end excluding the stalk up to its terminal end. Diameter was obtained by measuring the maximum transverse width of the pod in its central portion.

2.5 Statistical Analysis

GENSTAT software (2011) was used for the analysis of variance (ANOVA) and means were compared at 5% level of significance.

3. RESULTS AND DISCUSSION

3.1 Percentage of Seedling Emergence

Sowing dates showed significant difference in the percentage of emergence of okra seedlings with second sowing date recording the highest value (91.3%) which was found to be significantly superior as compared to the other sowing dates (Table 1). The higher temperature experienced during the month of August could have been the cause for the highest value obtained for from second sowing date. The result of this experiment was found to be in agreement with the findings of Amjad et al., [17], in which the germination percentage tend to remain constant from the beginning of the monsoon season until the time where the temperature starts to decrease. The PK fertilizer rates and the interaction treatments did not influence the percentage of seedling emergence significantly (Table 1). This finding was found to be at par with the results of the prior research indicating that, an increase in Phosphorous-Potassium rates up to 90:60 (kg/ha) has no impact on the increment of the germination percentage [19]. The outcomes of the research conducted by Amjad et al., [20] was also noticed to be in line with the findings of this research, where the interaction treatments of sowing time with different PK rates were observed not to show any sort of variation on the germination percentage.

3.2 Percentage of Stand Count

There was existed a significant difference in the stand counts of okra plants among the sowing dates. S_2 resulted into a significantly highest number of okra plant stands (60.9%) as compared to the other sowing dates (Table 1). The highest stand count value recorded in the S_2 was majorly attributed to the increased value of its germination percentage in relation to the other sowing dates. The fertilizer treatments and the interaction treatments, however, were not found to have a significant influence on the number of okra plant stands. The result of this was not found to be in line with the findings of Sajid et al., [19] confirming that an increase in phosphorous-potassium rates up to 90:60 (kg/ha) has a positive impact on the survival of the plants (Table 1).

3.3 Number of Days for First Harvest

There was a significant difference in the earliness for the commencement of harvesting among the sowing dates, where the sowing dates S_1 and S_2 varied insignificantly between each other. However, the third sowing date (S_3) was significantly different from both S_1 and S_2. The earliest harvesting (62.13 DAS) was recorded from the second date of sowing (S_2), followed by the first date of sowing (S_1) possessing a value of 63.6 DAS, whereas the last date of sowing (S_3) recorded the latest start of harvesting (65.93) DAS (Table 2). The earliness for the commencement of harvesting is possibly attributed to the climatic conditions that prevailed during the vegetative period of the plants, i.e., cool climate prolonging the period of vegetative period. However, both the PK fertilizer rates and the interaction treatments did not produce any significant impact on earliness of harvesting. Despite, the earliest harvesting was seen in $(PK)_5$ by a value of 63.33 DAS and also in S_2 $(PK)_5$ and S_2 $(PK)_4$ both possessing the same values of 61.33 DAS (Table 2).

3.4 Pod Weight per Plant

Individual plants pod weight was significantly influenced by the sowing date, PK fertilizer rates and the interaction treatments. S_1 recorded the highest value of individual plants pod weight (276.3g) and it was followed by S_2 by (258.1g) and the least value (195.8g) was obtained from the last date of sowing (S_3). Though the two first two sowing dates were found to have results which are statistically similar, they were both significantly superior to S_3 (Table 2). Thus, the pod weight of the individual plants was going down with the delay in the time of sowing possibly due to the decrease of temperature which could result into lower rate of growth and development, which in turn affects the pod weight negatively. The finding of this research tends to be in complete agreement with the results obtained from Mike, [11] indicating that individual plants pod weight decreases as the sowing time was delayed from the end of June onwards. As for the PK fertilizer rates, $(PK)_5$ used to register the highest value (288g) followed by $(PK)_3$ recording a value of (260g) and the lowest pod weight of the individual plants (191.9g) was recorded from $(PK)_1$. Despite the fact that $(PK)_5$ recording the highest value, was statistically similar to the results of both $(PK)_3$ and $(PK)_4$. The individual plants pod weight having being significantly influenced by the interaction treatments, recorded the highest discrepancy value of 219.8g which was obtained between the treatments S_1 $(PK)_5$ (348.8g) and $S_3(PK)_1$ (129g) (Table 2).

3.5 Total Yield

Although the interaction of sowing dates with the PK fertilizer rated did not have any significant impact, both the sowing dates and PK fertilizer treatments individually showed significant differences on the total yield of okra pods. As for the sowing dates S_2 experienced the highest value of total yield attaining 14.6t/ha followed by S_1 recording a value of 13.31t/ha. Both S_1 and S_2 were found to be significantly superior as compared to S_3 recording the least value (9.36t/ha). This observation fits with the result of Mike, [11] and Dilruba et.al [21] who has reported that okra sown during the warmer months significantly gave better yields as compared to cooler months. Whereas, it was found in contradict with the findings of Amjad et al., [17] carried out during the months of March and April reporting that the sowing dates have had no impact on the green pod yields. Besides this the reports made by Sutton (1966) was also observed to differ with the findings of this research, stating that the best yields were obtained from the seeds sown during the spring than that of summer.

The PK fertilizer treatments also showed a significant variation on the total yield of okra pods. The highest value 15.59t/ha was recorded from $(PK)_5$, followed by $(PK)_4$ recording a value of 12.88t/ha whereas the least value (9.86t/ha) was obtained from $(PK)_1$. The total yield obtained from $(PK)_5$, was found to be significantly superior only as compared to the values of the two least PK rates. In contrast with the result obtained from this experiment, Naheed et al., [22] and Thakur et al., [23] have reported that the highest yield was obtained by application of 90:60 kg/ha of P_2O_5 and K_2O respectively. In addition to this Mitra, [24] and Amjad et al., [17] also forwarded contradictory statements as compared to the findings of this research reporting that the various doses of the PK fertilizer were not having any significant impact on the total yield. However, this result was noticed to be in agreement with the findings of Firoz, [25] reporting that there was an appreciable variation among the various PK fertilizer rates (Table 2).

3.6 Pod Diameter

All the sowing dates, PK-fertilizer rates and the interaction treatments did not show any significant variation on the diameter of okra pods. Mike, [11] and Ashoka et al., [26] found that sowing dates used to influence the pod diameter significantly, and thus contradicting with the results of this experiment. As for the PK fertilizer treatments, this experiment was also seen to be in disagreement with the reports of Firoz, [25] who has observed a significant effect of various PK rates on the diameter of the pods.

3.7 Pod Length

Neither the sowing dates nor the PK fertilizer treatments tend show a significant variation on the length of the okra pods. Besides, this interaction treatment also did not show any significant effect on the length of okra pods. Mike, [11] and Ashoka et al., [26] both reporting significant variations of length of the pods caused by the different sowing dates were not found to be in line with the results obtained from this research. The findings of Firoz, [25] stating that there had been an appreciable variation among the various PK fertilizer rates on the length of the pods in turn disagreed with the results of this experiment.

3.8 Unmarketable Yield

All the three dates of sowings noted significantly different values of unmarketable yield of okra. The least mean value was observed from S_3 (0.97%) followed by S_2 (4.74%) and the highest wastage was seen in S_1 having a value of 10.64%. The great economic loss of the product observed in S_1 was due to the favorable climatic conditions to the insect pests predominantly *Aphids* and *Jassids* enabling them multiply rapidly, thereby causing blemishes and scars on the surface of the pods, which could possibly have a negative impact to the eye appeal of the consumers. The effects of the fertilizer rates as well as the interaction treatments however, were not found to contribute to an insignificant variation on the unmarketable yield of okra pods (Table 3).

3.9 Plant Height

Plant height was significantly influenced by the sowing date treatments in all the periods of data collection. S_3 was found to exhibit the highest plant height values (14.74cm and 28.29cm) in the first two successive periods of data recording, whereas the trend reversed in the third and fourth periods where S_1 has started to show the highest significant values (55.3cm and 87.8cm) respectively. At the end of the harvest period, significant variation was observed in the maximum plant height of okra plants among the sowing dates in which the second date of sowing (S_2) was found to possess a significantly highest value (206.5cm) than the others, whereas S_1 and S_3 were varying negligibly with each other. Since the vegetative growth is enhanced by increased temperature, the S_1 and S_2 treatment being exposed to the longer periods of warm temperature coupled with low-rate pest attack could possibly result in the increased plant heights (Fig. 1). The findings of Mike, (2010), suit with the outcomes of this research illustrating that there had been a significant increase in plant height for the sowing dates performed during the incipience of warmer periods. However, it was contrary with the results of Amjad et al., [17] in which they the dates of sowings did not have a significant impact on plant height.

Plant height was significantly influenced by the PK fertilizer rates in all the periods of data recordings including at the end of harvesting. The highest values 12.88cm, 29.81cm, 55.6 cm and 205.4cm were all recorded from $(PK)_5$ in the first three successive periods and also in the last period during the end of harvesting whereas $(PK)_3$ resulted in the highest value of plant height (83.8cm) in the fourth period (Fig. 1). The better response of okra plants towards the increased rates of PK is mainly due to increment of the availability of the nutrients to the plants. Mitra, [24] and Firoz, [25] supported the findings of this experiment in which the PK fertilizer rates influenced the plant height significantly. However, the interaction treatments contributed to an insignificant difference on plant heights in all the periods, except on the 2^{nd} period of data recording. In this period, $S_3(PK)_5$ was seen to attain the highest value (34.1 cm) followed by

$S_3(PK)_3$ (33.2 cm) while the least value was recorded from $S_1(PK)_2$ (18.27 cm). The finding of Amjad et al., [17] illustrating that the interaction of the dates of sowings with the PK rates tend to have a significant influence on the plant height was in turn found to contradict with the results of this experiment for the majority of the periods (Fig. 1).

3.10 Stem Circumference

The sowing date was found to have a significant impact on the stem circumference only on the third and fourth periods with S_1 recording the highest significant values 6.05cm and 6.74cm in both third and fourth periods respectively. The effects of the PK fertilizer treatments on the circumference of the stem were found to exhibit significant differences in all the four periods of data recording. In all the four periods the highest values (2.81cm, 4.29cm, 5.43cm and 6.21cm) and the lowest values (1.81cm, 3.09cm, 4.5cm and 5.33cm) were recorded from $(PK)_5$ and $(PK)_1$ respectively in the sequential periods. The interaction treatments however showed a significant effect on the stem circumference only on the second period with $S_1(PK)_5$ recording significantly superior value (4.7 cm) (Fig. 2).

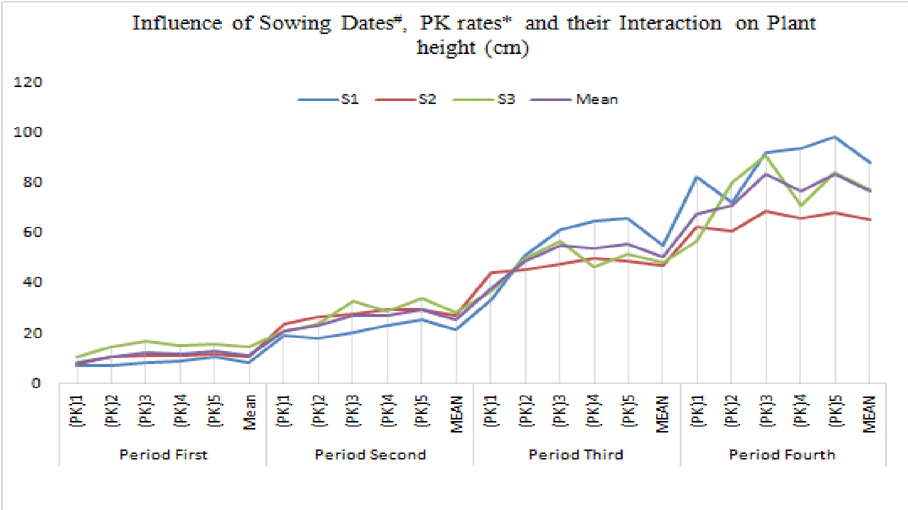

Fig. 1. Influence of Sowing Dates, PK rates and their Interaction on the Plant height

** $(PK)_1$=0kg/ha; $(PK)_2$=125kg/ha; $(PK)_3$=150kg/ha; $(PK)_4$=175kg/ha and $(PK)_5$=200kg/ha; # S_1 = first sowing date (middle kiremti); $S_{2=}$ second sowing date (late kiremti); $S_{3=}$ third sowing date (early qewee).*

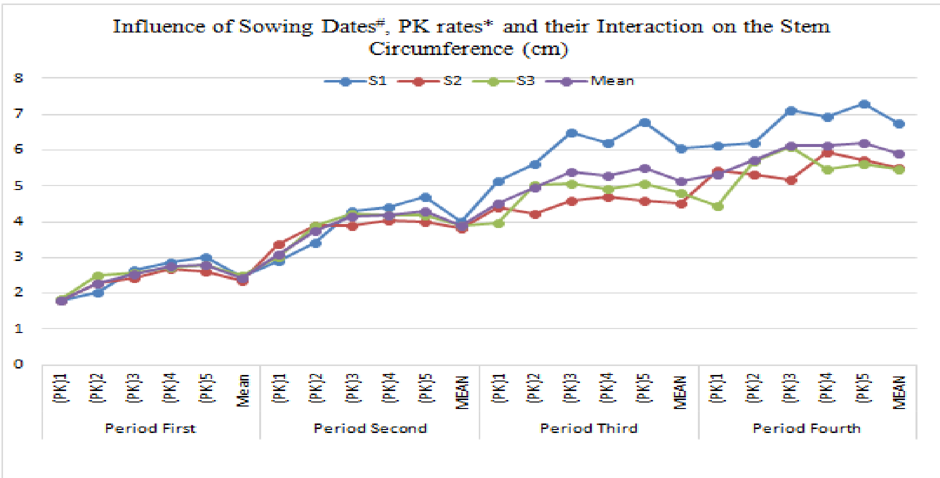

Fig. 2. Influence of Sowing Dates, PK rates and their Interaction on the Stem Circumference

** $(PK)_1$=0kg/ha; $(PK)_2$=125kg/ha; $(PK)_3$=150kg/ha; $(PK)_4$=175kg/ha and $(PK)_5$=200kg/ha; # S_1 = first sowing date (middle kiremti); $S_{2=}$ second sowing date (late kiremti); $S_{3=}$ third sowing date (early qewee)*

Table 1. Interaction effect of sowing date and PK fertilizer on phenology of Okra

Treatments*	Seedling emergence %				Days to seedling emergence				Stand count %			
	First Sowing Date	**Second Sowing Date**	**Third Sowing Date**	**Mean**	**First Sowing Date**	**Second Sowing Date**	**Third Sowing Date**	**Mean**	**First Sowing Date**	**Second Sowing Date**	**Third Sowing Date**	**Mean**
$(PK)_1$	94	88.9	79.2	87.4	6	7	7	6.67	58.3	57.3	50	55.2
$(PK)_2$	73.6	90.7	73.6	79.3	6	7	7	6.67	48.7	62	46.7	52.4
$(PK)_3$	70.8	92.6	74.6	79.3	6	7	7	6.67	44.7	63	51.3	53
$(PK)_4$	80.1	90.3	75	81.8	6	7	7	6.67	53.7	57.7	54	55.1
$(PK)_5$	82.8	94	81.9	86.3	6	7	7	6.67	53.3	64.3	56	57.9
Mean	80.3	91.3	76.9	82.8	6	7	7	6.67	51.7	60.9	51.6	54.7
LSD (5%)	SD	PK	SDXPK		SD	PK	SDXPK		SD	PK	SDXPK	
	S	NS	NS		NS	NS	NS		S	NS	NS	
	6.4	-	-		-	-	-		6.47	-	-	
CV%	10.3				0				15.8			

** $(PK)_1$=0kg/ha; $(PK)_2$=125kg/ha; $(PK)_3$=150kg/ha; $(PK)_4$=175kg/ha and $(PK)_5$=200kg/ha.*

Table 2. Effect of Sowing Dates, PK Fertilizer Rates and their Interactions on Phenological and Vegetative Parameters of Okra

Treatments*	Number of days to first harvesting				Individual plants pod weight (g)				Total yield (t/ha)			
	First Sowing Date	**Second Sowing Date**	**Third Sowing Date**	**Mean**	**First Sowing Date**	**Second Sowing Date**	**Third Sowing Date**	**Mean**	**First Sowing Date**	**Second Sowing Date**	**Third Sowing Date**	**Mean**
$(PK)_1$	65	64	63.67	64.22	201.8	244.8	129	191.9	10.67	12.97	5.94	9.86
$(PK)_2$	63.67	62	65.67	63.78	252.4	215.8	217.8	228.7	11.37	12.34	9.4	11.03
$(PK)_3$	66	62	65	64.33	323.2	215.6	241.1	260	13.68	12.89	11.68	12.75
$(PK)_4$	61.67	61.33	68.33	63.78	255.1	293.2	197.1	248.5	13.04	15.83	9.77	12.88
$(PK)_5$	61.67	61.33	67	63.33	348.8	321.1	194	288	17.78	18.97	10.03	15.59
Mean	63.6	62.13	65.93	63.89	276.3	258.1	195.8	243.4	13.31	14.6	9.36	12.42
LSD (5%)	SD	PK	SDXPK		SD	PK	SDXPK		SD	PK	SD X PK	
	S	NS	NS		S	S	S		S	S	NS	
	2.293	-	-		30.88	39.87	69.05		2.245	2.898	-	
CV%	4.8				17				24.2			

** $(PK)_1$=0kg/ha; $(PK)_2$=125kg/ha; $(PK)_3$=150kg/ha; $(PK)_4$=175kg/ha and $(PK)_5$=200kg/ha.*

Table 3. Effect of sowing dates, PK fertilizer rates and their interactions on Phenological and vegetative parameters of Okra

Treatments*	Pod diameter (cm)				Pod Length (cm)				Un-marketable yield (%)			
	First Sowing Date	Second Sowing Date	Third Sowing Date	Mean	First Sowing Date	Second Sowing Date	Third Sowing Date	Mean	First Sowing Date	Second Sowing Date	Third Sowing Date	Mean
$(PK)_1$	1.58	1.59	1.51	1.56	6.72	7.23	6.33	6.76	11.69	2.64	3.36	5.9
$(PK)_2$	1.55	1.53	1.63	1.57	7.31	6.84	6.94	7.03	14.74	4.91	0.19	6.61
$(PK)_3$	1.7	1.59	1.6	1.63	7.46	7.13	7.05	7.21	8.05	4.26	0.1	4.13
$(PK)_4$	1.6	1.68	1.63	1.64	7.29	7.51	7.09	7.3	9.07	5.36	0.6	5.01
$(PK)_5$	1.58	1.66	1.65	1.63	7.35	7.01	7.08	7.15	9.66	6.52	0.62	5.6
Mean	1.6	1.61	1.6	1.61	7.23	7.14	6.9	7.09	10.64	4.74	0.97	5.45
LSD (5%)	SD PK SDxPK				SD PK SDXPK				SD PK SD X PK			
	NS NS NS				NS NS NS				S NS NS			
	- - -				- - -				2.685 - -			
CV%	5				5.5				14.7			

** $(PK)_1$=0kg/ha; $(PK)_2$=125kg/ha; $(PK)_3$=150kg/ha; $(PK)_4$=175kg/ha and $(PK)_5$=200kg/ha.*

4. CONCLUSION

This research was carried out to evaluate the response of sowing-dates and Phosphorous and Potassium fertilizer rates on different growth, yield and yield aspects of okra (*Abelmoschus esculentus* L). three sowing dates and rates of fertilizers was composed at five rates (0kg/ha, 125 kg/ha (75:50), 150 kg/ha (90:60), 175 kg/ha (105:70) and 200 kg/ha (120:80). The highest significant mean values of leaf area, leaf numbers were recorded from middle *kiremti* sowing date. The highest significant values of both number of fruits and total yield were obtained from highest PK rate combined with *late kiremti* and *middle kiremti* respectively. The sole effects of the PK rates as well as the sowing dates were found to be significant on all the parameters mentioned above including individual fruit weight. It is, therefore, the sowing during *late kiremti* coupled with application of 200kg/ha kg/ha was the best for getting the best economic returns.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

ACKNOWLEDGEMENTS

The authors are grateful to Department of Horticulture, Hamelmalo Agricultural College for the logistic support and the authors acknowledge the immense help of scholars whose articles are cited and included in reference of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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