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EFFECT OF DIFFERENT SOWING TIME AND PLANTING DISTANCE ON GROWTH, YIELD AND QUALITY OF OKRA [*ABELMOSCHUS ESCULENTUS* (L.) MOENCH]

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ABSTRACT

The experiment entitled "Effect of different sowing time and planting distance on growth, yield and quality of okra [*Abelmoschus esculentus* (L.) Moench]" was conducted at the farm of Polytechnic in Horticulture, Junagadh Agricultural University, Junagadh during the year 2022 in summer season. Total nine treatment combinations comprising three sowing time *viz.*, 2nd fortnight of February (S_1), 2nd fortnight of March (S_2), 2nd fortnight of April (S_3) and three planting distance *viz.*, 45 cm × 30 cm (D_1), 60 cm × 30 cm (D_2), 75 cm × 30 cm (D_3) were allocated in Randomized Block Design with factorial concept in three replications. Result showed that okra seeds sown on 2nd fortnight of March (S_2) recorded maximum plant height (98.64 cm), number of primary branches (2.18), number of flowering nodes (16.87), days to last picking (90.11), pod length (12.91 cm), pod diameter (2.10 cm), number of pods per plant (15.22), average weight of 10 pods (120.52 g), total number of pickings (13.78), marketable pod yield (1.92 kg/net plot), marketable pod yield (4.62 t/ha), maximum chlorophyll content (28.44 SPAD) and maximum ascorbic acid content (6.57 mg/100 g). However, okra seed sown on 2nd fortnight of April reported minimum days to 50 % flowering (42.89) and first picking (46.78). In case of planting distance 75 cm × 30 cm recorded maximum plant height (82.20 cm), pod length (11.94 cm), pod diameter (1.96 cm), number of pods per plant (13.86), average weight of 10 pods (112.54 g) and ascorbic acid content (6.53 mg/100 g). However, maximum marketable pod yield per net plot (1.88 kg) and marketable pod yield per hectare (4.36 t) was recorded in treatment D_1 (45 cm × 30 cm). Interaction effect of sowing time 2nd fortnight of April and planting distance 60 cm × 30 cm recorded minimum days to 50 % flowering (41.67) and first picking (45.33). Whereas, among interaction of sowing time 2nd fortnight of March and planting distance 60 cm × 30 cm (S_2D_2) noted maximum number of flowering nodes (18.97) at final harvest, number of pods per plant (14.83), marketable pod yield per net plot (2.46 kg) and marketable pod yield per hectare (5.61 t).

Key words : Fortnight, Marketable pod yield, Okra, Planting distance, Sowing time.

Introduction

Okra [*Abelmoschus esculentus* (L.) Moench] is one of the most important export-oriented vegetable crops of India. It is an important warm season vegetable crop which is cultivated in the Mediterranean regions as well as tropical and sub-tropical regions of the world. Although okra is primarily a rainfed crop, it also comes up well under irrigated conditions during *kharif* and summer seasons. Okra is one of the most important and popular vegetable in Indian diet. Besides being vegetable, it has also medicinal and industrial importance. It is grown for tender fruits, which are used for cooking. Also, these tender green fruits used in making curries, soups or in canned, fried, dehydrated or frozen forms for off season consumption. It can be boiled and served as salad or cut into pieces and served with soup. The root and stem of okra plants are used for cleaning the cane juice in the manufacture of jaggery and sugar (Chauhan, 1972). Its ripe seeds are roasted, ground and used as a substitute for coffee in Turkey (Mehta, 1959). Matured fruits and stem contain crude fibre are used in paper industry.

Extracts from the seeds of the okra is an alternative source for edible oil. The greenish yellow edible oil has a pleasant taste and odour, and is high in unsaturated fats such as oleic acid and linoleic acid. The oil content of the seed is quite high at about 40 %. Also, useful against genitourinary disorders, spermatorrhoea and chronic dysentery (Nandkarni, 1927).

During the year of 2021-22 in India, total production of okra was 6414 ('000) MT from an area of 523 ('000) hectares with productivity of 12.26 MT/ha (Anonymous[a], 2021-22). In Gujarat, total production of okra was 1019.42 ('000) Tonnes from an area of 85.15 ('000) hectares with 11.97 t/ha productivity (Anonymous, 2021-22b).

The growth, yield and quality of okra are hampered severely by inefficient production methods or lack of knowledge about the best cultivation and management practices, low awareness on the nutritional and health benefits, low quality seed standards and limited market access. Its production and productivity are seriously affected due to the use of local varieties (low yielding), sub or supra optimal plant density (improper inter and intra row spacing), inappropriate planting dates, soil nutrients and severe attack of various insect pests, diseases and weeds (Saha *et al*., 1989). The importance of sowing dates and spacing in okra cannot be overlooked as it affects different plant characters. Sowing dates have great impact on the seed production, growth, yield and quality of okra. The different cultivars require different sowing times, as good cultivars sown at improper time give poor yield. Therefore, proper and suitable date of sowing is critical to increase the production of okra. Plant sown at proper time gets advantage of climatic factors, has high growth duration, receives proper rainfall and experience optimal temperature during establishment and the early vegetative stage. As a result, fresh fruit yield and economic returns can be obtained. Improper sowing dates leads to shorter duration, inadequate utilization of rainfall, experiences cool temperature during establishment and the early vegetative stage, and fruit takes longer time to reach marketable size. The delayed sowing causes decreased fruit yield of okra (Ghannad *et al*., 2014). Proper sowing time gives high fresh weight of fruit, more number of fruits per plant and ultimately increases fruit yield per plant.

The planting density plays a significant role in okra. Lack of optimum plant spacing results in poor growth, low yield and poor quality fruits while high plant density may lead to vigorous growth, poor quality fruits and low yield due to intra specific competition, (Moniruzzaman *et al*., 2007). Plant spacing is a major problem faced by farmers in its production. The use of spacing in crop production is very important, because it reduces competition between plants and weeds. When proper spacing is followed in okra cultivation, it increases the growth, yield and quality. The optimum plant density is the key element for high yield of okra, as plant growth and yield are affected by spacing. One of the major aspects of crop ecology, production and management, which often limit crop production, is adoption of improper plant spacing systems in the field. This reduces the number of plants per hectare or causes overcrowding, making weeding and other farm operations difficult. With increased plant population, yield per unit area increases up to a certain limit, beyond which the yield decreases due to limitation in utilizing the natural resources required for plant growth. Overcrowding of seedlings or plants in a particular area spot may lead or increase competition among adjacent plants for available essential growth resources like sunlight, space, water and nutrients, as well as for aerial space for canopy formation. It also prevents profuse branching and production of nodes on the branches for flowering, fruit setting and decreases plant growth, yield and quality.

Materials and Methods

This experiment was conducted during the summer season of year 2022 located at Polytechnic in Horticulture, Junagadh Agricultural University, Junagadh. This experiment was laid out in Randomized Block Design with factorial concept and replicated thrice with the following treatments such as S_1- 2nd fortnight of February, S_2- 2nd fortnight of March, S_3- 2nd fortnight of April as factor-S and D_1- 45 cm × 30 cm, D_2- 60 cm × 30 cm, D_3- 75 cm × 30 cm as factor-B with three replications. The plot was thoroughly ploughed and brought to the fine tilth. Harrowing and planking were done before the execution of layout of the experimental field. The required area was marked and 27 plots were prepared according to the layout plan. About two to three seeds were sown at one place then thinning of seedlings was performed maintaining one plant per stand after germination. Fertilizers were applied at the rate of 150 kg/ha nitrogen and 50 kg/ha phosphorus to the soil. The experimental plot was irrigated during the cropping period on need based conditions.

Results and Discussion

Effect of different sowing time and planting distance with their interaction effect on growth, yield and quality parameters are tabulated in Tables 1, 2, 3 and 4.

Table 1 : Effect of different sowing time and planting distance on growth parameters of okra (*Abelmoschus esculentus* (L.) Moench).

Treatment	Plant height (cm)	No. of primary branches per plant	Days to last picking
Factor A: Sowing time (S) (Three levels)			
S_1: 2nd fortnight of February	77.57	1.62	87.44
S_2: 2nd fortnight of March	98.64	2.18	90.11
S_3: 2nd fortnight of April	58.63	1.44	79.89
S. Em ±	0.753	0.045	0.895
C. D. at 5 %	2.14	0.13	2.45
Factor B: Planting distance (D) (Three levels)			
D_1: 45 cm × 30 cm	75.56	1.73	86.67
D_2: 60 cm × 30 cm	77.08	1.78	84.78
D_3: 75 cm × 30 cm	82.20	1.73	86.00
S. Em ±	0.753	0.045	0.859
C. D. at 5 %	2.14	NS	NS
Interaction (S X D)			
S. Em ±	1.304	0.078	1.489
C. D. at 5 %	NS	NS	NS
C. V. %	6.01	7.76	6.00

Growth Parameters

Sowing time

The data revealed that sowing time had discernible effect on some of the growth parameters *viz.*, plant height, number of primary branches, days to 50 % flowering, number of flowering nodes at final harvest, days to first picking as well as days to last picking.

The okra seeds sown on 2nd fortnight of March executed significantly maximum plant height (98.64 cm), number of primary branches (2.18), number of flowering nodes (16.87) and maximum days to last picking (90.11) rest to other treatments. However, minimum days to 50% flowering (42.89) and to first picking (46.78) observed in treatment S_3 (2nd fortnight of April). These results are in conformity with Hussain *et al.* (2006), Firoz *et al.* (2007), Sood and Kaur (2019), Dash *et al.* (2013), Ijoyah *et al.* (2010), Kumar *et al.* (2016) and Morwal and Patel (2017) in okra.

Planting distance

All the growth parameters except plant height were not significantly influenced by the different planting distance. The spacing of 75 cm × 30 cm executed significantly the maximum plant height (82.20 cm). Similar results were witnessed by Ram *et al.* (2013), Morwal and Patel (2017) and Bake *et al.* (2017) in okra.

Interaction effect

The growth parameters were significantly influenced by interaction effect of sowing time and planting distance. Minimum days taken to 50% flowering (41.67) and minimum days taken to first picking (45.33) recorded in treatment combination S_3D_2 (2nd fortnight of April + 60 cm × 30 cm). Likewise, significantly maximum number of flowering nodes (18.97) at final harvest observed in treatment combination S_2D_2 (2nd fortnight of March + 60 cm × 30 cm). These results are in conformity with Hussain *et al.* (2006) in okra.

Yield Parameters

Sowing time

The investigation data demonstrated that the different sowing time had a significant impact on the yield parameters, such as pod length, pod diameter, average weight of 10 pods, number of pods per plant, total number of pickings, marketable pod yield per net plot and per hectare.

The okra seeds sown on 2nd fortnight of March executed significantly maximum pod length (12.91 cm), pod diameter (2.10 cm), number of pods per plant (15.22), average weight of 10 pod (120.52 g), total number of pickings (13.78), marketable pod yield per net plot (1.92 kg) and marketable pod yield per hectare (4.62 t). These findings are in close confirmative with the result of Undie and Litio (2018), Morwal and Patel (2017), Bake *et al.* (2017), Ghannad *et al.* (2014) and Ijoyah *et al.* (2010) in okra.

Planting distance

The data revealed that different planting distance had

Table 2 : Effect of different sowing time and planting distance on growth parameters of okra [*Abelmoschus esculentus* (L.) Moench].

Treatment	Days to 50% flowering	Number of flowering nodes at final harvest	Days to first picking
Factor A: Sowing time (S) (Three levels)			
S_1: 2nd fortnight of February	47.56	16.02	52.33
S_2: 2nd fortnight of March	45.56	16.87	50.00
S_3: 2nd fortnight of April	42.89	12.02	46.78
S. Em ±	0.676	0.365	0.739
C. D. at 5 %	1.92	1.04	1.64
Factor B: Planting distance (D) (Three levels)			
D_1: 45 cm × 30 cm	46.11	14.77	50.56
D_2: 60 cm × 30 cm	44.78	15.59	49.22
D_3: 75 cm × 30 cm	45.11	14.56	49.33
S. Em ±	0.676	0.365	0.739
C. D. at 5 %	NS	NS	NS
Interaction (S X D)			
S_1D_1	51.67	17.13	56.33
S_1D_2	46.00	15.70	51.33
S_1D_3	45.00	15.23	49.33
S_2D_1	43.67	16.27	48.33
S_2D_2	46.67	18.97	51.00
S_2D_3	46.33	15.37	50.67
S_3D_1	43.00	10.90	47.00
S_3D_2	41.67	12.10	45.33
S_3D_3	44.00	13.07	48.00
S. Em ±	1.171	0.632	1.280
C. D. at 5 %	3.33	1.80	3.64
C. V. %	8.47	7.31	6.46

significant influence on pod length, pod diameter, average weight of 10 pods, number of pods per plant, total number of pickings, marketable pod yield per net plot and per hectare.

Significantly the maximum pod length (11.94 cm), pod diameter (1.96 cm) and average weight of 10 pod (112.54 g) observed in treatment D_3 (45 cm × 30 cm). Likewise, significantly the maximum number of pods per plant (13.86) observed in treatment D_2 (60 cm × 30 cm) and maximum total number of pickings (12.44) recorded in treatment D_1 (45 cm × 30 cm) as well as treatment D_2 (60 cm × 30 cm). Significantly the highest marketable pod yield per net plot (1.88 kg) and marketable pod yield per hectare (4.36 t) noted in treatment D_1 (45 cm × 30 cm). These findings are in close confirmative with the result of Maurya *et al.* (2013), Monniruzaman *et al.* (2007), Morwal and Patel (2017) and Bake *et al.* (2017) in okra.

Interaction effect

The yield parameters were significantly influenced by interaction effect of sowing time and planting distance. The maximum number of pods per plant (16.73) observed in treatment combination S_2D_3 (2nd fortnight of March + 75 cm × 30 cm). Likewise, the highest marketable pod yield per net plot (2.46 kg) reported in treatment combination S_2D_2 (2nd fortnight of March + 60 cm × 30 cm) and the highest marketable pod yield per hectare (5.61 t) noted in treatment combination S_1D_1 (2nd fortnight of February + 45 cm × 30 cm) as well as treatment combination S_2D_2 (2nd fortnight of March + 60 cm × 30 cm). These findings are in close confirmative with the result of Undie and Litio, 2018, Morwal and Patel (2017), Bake *et al.* (2017), Ghannad *et al.* (2014) and Ijoyah *et al.* (2010) in okra.

Quality Parameters

Sowing time

The quality parameters were significantly influenced by the different sowing time. The okra seeds sown on 2nd fortnight of March recorded significantly the maximum

Table 3 : Effect of different sowing time and planting distance on yield parameters of okra [*Abelmoschus esculentus* (L.) Moench].

Treatment	Pod length (cm)	Pod diameter (cm)	Average weight of 10 pods (g)	Total number of pickings
Factor A: Sowing time (S) (Three levels)				
S_1: 2nd fortnight of February	11.05	1.86	107.94	12.56
S_2: 2nd fortnight of March	12.91	2.10	120.52	13.78
S_3: 2nd fortnight of April	10.15	1.63	93.76	10.11
S. Em ±	0.152	0.062	1.838	0.225
C. D. at 5 %	0.43	0.18	5.23	0.64
Factor B: Planting distance (D) (Three levels)				
D_1: 45 cm × 30 cm	10.79	1.73	101.51	12.44
D_2: 60 cm × 30 cm	11.37	1.89	108.17	12.44
D_3: 75 cm × 30 cm	11.94	1.96	112.54	11.56
S. Em ±	0.152	0.062	1.838	0.225
C. D. at 5 %	0.43	0.18	5.23	0.64
Interaction (S X D)				
S. Em ±	0.263	0.107	3.184	0.389
C. D. at 5 %	NS	NS	NS	NS
C. V. %	8.01	9.91	7.13	6.54

Table 4 : Effect of different sowing time and planting distance on yield parameters of okra [*Abelmoschus esculentus* (L.) Moench].

Treatment	Number of pods per plant	Marketable pod yield (kg/net plot)	Marketable pod yield (t/ha)
Factor A: Sowing time (S) (Three levels)			
S_1: 2nd fortnight of February	14.52	1.78	4.26
S_2: 2nd fortnight of March	15.22	1.92	4.62
S_3: 2nd fortnight of April	9.90	0.95	2.33
S. Em ±	0.205	0.039	0.099
C. D. at 5 %	0.58	0.11	0.28
Factor B: Planting distance (D) (Three levels)			
D_1: 45 cm × 30 cm	12.10	1.88	4.36
D_2: 60 cm × 30 cm	13.86	1.82	4.20
D_3: 75 cm × 30 cm	13.69	0.95	2.64
S. Em ±	0.205	0.039	0.099
C. D. at 5 %	0.58	0.11	0.28
Interaction (S X D)			
S_1D_1	13.07	2.42	5.61
S_1D_2	16.03	2.02	4.68
S_1D_3	14.47	0.89	2.48
S_2D_1	14.10	2.16	4.99
S_2D_2	14.83	2.46	5.61
S_2D_3	16.73	1.17	3.25
S_3D_1	9.13	1.07	2.49
S_3D_2	10.70	1.00	2.31
S_3D_3	9.87	0.78	2.18
S. Em ±	0.355	0.067	0.172
C. D. at 5 %	1.01	0.19	0.49
C. V. %	8.66	7.48	7.48

Table 5 : Effect of different sowing time and planting distance on quality parameters of okra]*Abelmoschus esculentus* (L.) Moench].

Treatment	Chlorophyll content (SPAD)	Ascorbic acid content (mg/100 g)
Factor A: Sowing time (S) (Three levels)		
S_1: 2nd fortnight of February	25.98	6.47
S_2: 2nd fortnight of March	28.44	6.57
S_3: 2nd fortnight of April	24.47	6.26
S. Em ±	0.202	0.044
C. D. at 5 %	0.57	0.13
Factor B: Planting distance (D) (Three levels)		
D_1: 45 cm × 30 cm	25.67	6.36
D_2: 60 cm × 30 cm	26.99	6.40
D_3: 75 cm × 30 cm	26.23	6.53
S. Em ±	0.202	0.044
C. D. at 5 %	0.57	0.13
Interaction (S X D)		
S. Em ±	0.349	0.077
C. D. at 5 %	NS	NS
C. V. %	4.30	5.08

chlorophyll content (28.44 SPAD) and maximum ascorbic acid content (6.57 mg/100 g). However, crude fibre content exerted non-significant influence by sowing time. This findings are in close conformity with the results of Kumar *et al.* (2015) in onion.

Planting distance

The quality parameters were also significantly influenced by different planting distance. The plant spacing of 60 cm × 30 cm executed maximum chlorophyll content (26.99 SPAD) while maximum ascorbic acid content (6.53 mg/100 g) was observed in treatment D_3 (75 cm × 30 cm). Though, different planting distance had non-significant effect on crude fibre content of okra pods. These findings are in close conformity with the results of Kumar *et al.* (2015).

Interaction effect

The interaction effect of different sowing time and planting distance exerted non-significant influence on all three quality parameters.

Conclusion

Based on the results obtained from present investigation it can be concluded that okra seeds sown on 2nd fortnight of March (S_2) gave better performance in vegetative, flowering and yield parameters, whereas, seeds sown at wider spacing (D_3: 75 cm × 30 cm) has performed better for vegetative and quality parameters. Though, the highest marketable pod yield was obtained from the plants with closer spacing (D_2: 60 cm × 30 cm). In case of interaction effect of time of sowing and planting distance, the maximum marketable pod yield was recorded in plants, which were sown on 2nd fortnight of March at the spacing of 60 cm × 30 cm (S_2D_2). Hence, for maximum yield as well as gross, net return and B: C ratio okra should be sown on 2nd fortnight of March at the spacing of 60 cm × 30 cm.

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