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Effect of sowing dates and planting distances on quantitative attributes of Okra [*Abelmoschus esculentus* (L.) Moench] cv. Kashi Pragati

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Abstract
Okra [*Abelmoschus esculentus* (L.) Moench] is one of the much widespread vegetable crops owing to ease in cultivation, quite dependable yield, and acclimatization to variable moisture conditions, and soil types. A field experiment was undertaken to find out the individual as well as the interaction effects along with the suitable combinations of sowing date and planting distance to evaluate the growth, yield, and quality of okra at two locations viz., Vegetable Research Farm, I.Ag.Scs., BHU, Varanasi and Lalganj Village, Mirzapur, Uttar Pradesh during the year 2015 and 2016. Among the different treatments intermediate spacing (60 × 60 cm) with D_3 (30th June sowing) performed better than other treatments for most of the growth, flowering, yield, and quality characteristics, followed by closer spacing (60 × 45 cm) with D_3 (30th June sowing) therefore this combination can be recommended after conducting more trials so as to arrive at conclusive findings for the farmers of Varanasi, Mirzapur, and adjoining areas.

Keywords: Okra, planting distances, sowing dates, multi-locations, interaction effect

Introduction

Okra [*Abelmoschus esculentus* (L.) Moench] is a polyploidy with chromosome number 2n=30 and commonly known as Lady's finger and Bhindi (Hindi) in India. It belongs to the family Malvaceae. Okra has originated from Ethiopia in Africa (Khalid *et al.*, 2005) [11] and was first cultivated by Egyptians in the 12th century (Thompson *et al.*, 1979) [29]. It is now widely cultivated throughout the tropics and sub-tropics, as well as in the warmer parts of the temperate regions of the world (Farinde *et al.*, 2007) [7]. The genus *Abelmoschus* contains about 150 known species with *esculentus* as the species of cultivated okra. The crop is quite popular due to its easy cultivation, dependable yield adaptability to varying moisture conditions (resistant to drought and water-logging) and soil types and is also tolerant to wide variation in rainfall. Due to its wide adaptability and nutritional importance okra is successfully cultivated in other countries also like China, Thailand, Egypt, Nigeria, Sudan, South Africa, Ghana, Pakistan, Cyprus, Brazil, and the Caribbean.

The economic importance of okra cannot be overemphasized; all plant parts are fully used (Farinde *et al*., 2007) [7]. Tender okra fruits are very popular as a vegetable among all classes of people around the world (Talukder *et al.*, 2003) [28]. It is a nutritious vegetable which is an important source of carbohydrate, protein, vitamins A, B, C, calcium, potassium, dietary fibres, and minerals and hence, plays a vital role in the human diet (Rashwan, 2011) [21]. Young immature fruits can be consumed in many different forms i.e., raw, steamed, boiled, or fried (Farinde *et al*., 2007) [7]. It has added nutritional value as it is the best source of iodine and calcium. It contains a fair amount of vitamin C (30 mg/100 g), calcium (90 mg/100 g) and iron (1.5 mg/100 g) (Pal *et al*., 1952) [19]. It also contains 6.60 to10 per cent crude fibre, 14.40 to 18.60 per cent protein and 8.20 to 9.15 per cent ash of the total weight and is also rich source of vitamin B_6 and folic acid. Dry seeds of okra contain about 20 to 30 per cent crude protein. 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 (18-20 per cent) and the oil yield from okra crop is 794 kg/ha, while its mucilage is utilized for medicinal purposes. Industrially, okra mucilage which is extracted from the root, fruit and stem of the plant, is usually used for paper production, confectionery products and also used for cleaning the cane juice from which jaggery or brown sugar is prepared (Chauhan, 1972) [5]. Okra seeds may be roasted and ground to form a non-caffeinated substitute for coffee (Onyishi, 2011) [18].

Its medicinal value has also been reported in curing ulcers and relief from hemorrhoids. The asserted okra is useful against spermatorrhoea, chronic dysentery and genitor-urinary disorders (Adams, 1975) [1]. Seed protein is rich in tryptophan (94 mg/g) and also contains adequate amount of Sulphur containing amino acid (189 mg/g) the combination of which make okra seeds exceptionally useful in reducing human malnutrition.

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 also 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) [22]. 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 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 lead 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) [9]. 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) [15]. 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 spacings. 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 or 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. This may affect plant performance and yield (Zibelo *et al.,* 2016) [31]. While, the optimum plant population produces higher yield and also provides added economic advantage of early harvest. Generally in okra, the yield and number of fruits per unit area increase with increase in crop density, whereas the yield and number of fruits per plant decrease with low plant density. High plant density increases the number of fruits per unit area, but the average weight of fruit decreases with increased plant density. One of the most important factors influencing okra plant is optimum spacing, as it allows plant to develop to their full potential above and underneath the ground. Adequate space ensures less competition for sunlight, nutrients and moisture and also reduces overlapping from adjacent okra plants within the population which enable the plants to utilize their energy for maximum branching, increased fruit length, width, weight and increased number of seeds per fruit (Kumar *et al.*, 2016) [12].

Materials and Methods

The present investigation was planned and carried out in two locations i.e., Vegetable Research Farm, Department of Horticulture, Institute of Agricultural Sciences, Banaras of Hindu University, Varanasi and second one is Lalganj village of Mirzapur district of Uttar Pradesh during the year 2015 and 2016. 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. The seeds were planted on raised ridges with different sowing dates and planting spacings. 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 100 kg/ha nitrogen, 60 kg/ha phosphorus, 50 kg/ha potassium to the soil. The experimental plot was irrigated during the cropping period on need based conditions. In order to maintain the uninterrupted growth of the crop, four weedings were carried out as per the requirement. For recording of the observations five plants from the total population were randomly selected since, all the plants get the identical environmental conditions and different characters taken under study are days to 50% germination, plant height (cm), number of branches per plant, leaf area (cm^2), inter nodal length (cm), number of nodes per plant, fruit yield per plant (kg), and fruit yield (q/ha). The observations recorded were summed up and divided by five to get the mean value. The experiment was laid out in Randomized Complete Block Design with three replications. Three sowing dates at ten days interval i.e., 10^{th} (D_1), 20^{th} (D_2), and 30^{th} June (D_3), and three planting distances i.e., 60 ×45 cm (S_1), 60 × 60 cm (S_2), and 60 × 75 cm (S_3) and their interactions were followed at two different locations. Statistical analysis of data collected was based on the procedure for Randomized Complete Block Design (RCBD) for factorial experiment as outlined by Steel and Torrie (1980) [27].

Results and Discussion

The findings on planting distances, sowing dates and their interaction had shown significant effect on plant height, portraying their importance on growth, yield, and quality characters in okra.

During the year 2015 and 2016 at both the locations, spacing S_2 (60 × 60) and S_3 (60 × 75 cm) exhibited equal minimum number of days to 50% germination, while the sowing date D_2 at location I in the year 2015 and all the sowing dates of location II in the year in 2015 as well as for both the locations in the year 2016 took minimum number of days to 50% germination. In case of interaction, all the treatments except

S_1D_1, S_1D_2 and S_1D_3 recorded minimum number of days to 50% germination at both the locations during both the years (Table 1). This could be due to the effect of prevailing environmental conditions such as temperature, light and humidity affecting the seed germination. Similar findings regarding the effect of spacing on germination has been reported by Amjad *et al*. (2001) [2] and Shujat *et al*. (2006) [25].

The data pertaining to plant height (Table 2), the spacing S_1 (60 × 45 cm) and sowing date D_1 (10th June) along with the interaction S_1D_1 (60 × 45 cm and 10th June sowing) exhibited maximum value for plant height during both the years at both the locations. This could be attributed to the competition for light and other growth resources among the crops due to crowding at closer spacing's, thereby resulting in the production of taller plants. Similar findings in respect to spacing and date of sowing has been reported by Okosun *et al*. (2006) [17]; Moniruzzaman *et al*. (2007) [13]; Ijoyah *et al*. (2010) [10]; Maurya *et al*. (2013) [14]; Mushayabasa *et al*. (2014) [16]; Elhag and Ahmed (2014) [6] and Ghannad *et al.* (2014) [9].

In case of number of branches per plant as shown in Table 3 during the year 2015, at both the locations spacing S_2 (60 × 60 cm) was found to exhibit the maximum value, whereas for the year 2016, spacing S_1 (60 × 45 cm) was found to be superior, while regarding the sowing dates, D_3 (30th June) sowing registered maximum number of branches at location 1 in 2015 as well as at both the locations in 2016, whereas D_1 (10th June) sowing at location II in 2015 recorded maximum value for both the locations in 2015. The interaction effect on spacing and sowing date indicates that S_2D_3 and S_1D_3 exhibited highest number of branches in 2015 and 2016 respectively. This might be due to the micro-climate in the growing area which favors closer and intermediate spacing affecting the number of branches. These findings are in accordance with Sajjan *et al*. (2002) [23], who reported similar result that plants spaced at intermediate spacing produced the maximum number of branches. Similarly, for sowing date Asadipour and Madani (2014) [3] reported that delayed sowing increased the number of branches per plant.

From the Table 4 it is clear that during both the years 2015 and 2016, at both the locations spacing S_2 (60 × 60 cm) registered maximum internodal length, whereas in case of sowing dates D_1 (10th June sowing) in year 2015 at location I registered maximum internodal length. In the year 2015 at location II, D_2 (20th June) sowing registered maximum internodal length, while in the year 2016 at both the locations D_1 (10th June) sowing recorded maximum internodal length. The data pertaining to interaction effect on spacing and sowing dates, S_2D_1 registered maximum value in the year 2015 at location I, while at location II in same year S_2D_3 registered maximum internodal length. In the year 2016 at both the locations S_2D_1 registered the maximum internodal length. Internodal length is an important yield character in okra. The maximum internodal length exhibited in S_2 (60 × 60 cm) could be due to the favorable condition of moisture supply, clear weather conditions with optimum temperature throughout the growth period, which is in agreement with the finding of Sarkar *et al*. (2014) [24] and Ghannad *et al.* (2014) [9], who reported that maximum internodal length produced at closest spacing.

The data pertaining to the leaf area at 45 days after sowing (Table 5) in year 2015 at location I, S_2 spacing (60 × 60 cm) registered maximum leaf area, while in the year 2016 at both the locations S_3 spacing (60 × 75 cm) recorded the maximum leaf area at 45 days after sowing. In respect of sowing dates in the year 2015 at both the locations D_2 (20th June) sowing recorded maximum leaf area at 45 days after sowing, while in the year 2016 at both the location D_3 (30th June sowing) recorded the maximum leaf area at 45 days after sowing. The data pertaining to interaction effect on spacing and sowing dates indicate that, in the year 2015 at location I, S_2D_2 gave the maximum leaf area, while at location II of same year S_3D_1 recorded maximum leaf area. In the year 2016 at location I, S_2D_3 recorded maximum leaf area at 45 days, whereas at location II of the same year S_3D_2 recorded the maximum leaf area. The number of vegetative leaf area per plant decreased with increase in plant population density. The result is in conformity with the findings of Ijoyah *et al.* (2010) [10]; Maurya *et al*. (2013) [14] and Madisa *et al*. (2015) [13], who reported similar result that wider spaced plant resulted in largest leaf area per plant than plants spaced at closer spacing. In respect to dates of sowing the findings of Asadipour and Madani (2014) [3] are in accordance with the present finding.

In the year 2015 at location I and in the year 2016 at location II, spacing S_2 (60 × 60 cm) exhibited the maximum leaf area, while in the year 2015 at location II and in 2016 at location I, S_3 (60 × 75 cm) exhibited maximum leaf area at 60 days after sowing. With respect to date of sowing in the year 2015 at location I and in 2016 at both the locations D_3 (30th June sowing) exhibited the maximum leaf area at 60 days after sowing, while in year 2015 at location II, D_2 (20th June sowing) exhibited maximum leaf area at 60 days after sowing. In case of interaction effect of spacing and sowing dates in the year 2015 at location I and in the year 2016 at location II S_2D_3 registered maximum leaf area at 60 days after sowing, while in the year 2015 at location II S_2D_2 recorded maximum leaf area and S_3D_3 recorded maximum value in 2016 at location I as demonstrated in Table 6. The leaf area increased with increase in plant spacing, as they have less intra plant competition for the resources, such as nutrients, and helped the okra plant to utilize its energy properly in the production of leaves. Ijoyah *et al.* (2010) [10] and Madisa *et al.* (2015) [13] reported similar results that wider spaced plant resulted in largest leaf area than plants spaced at closer spacing. In respect to dates of sowing Asadipour and Madani (2014) [3] reported similar results.

Considering the number of nodes per plant (Table 7) in the year 2015 at both the locations and in the year 2016 at location II, S_2 spacing (60 × 60 cm) registered maximum number of nodes, while in the year 2016 at location I; S_1 spacing (60 × 45 cm) produced maximum number of nodes per plant. In respect of dates of sowing D_3 (30th June sowing) registered maximum number of nodes in both the years at both the locations. In case of interaction effect of spacing and sowing dates in the year 2015 at location I, S_2D_2 recorded maximum leaf area; while at location II in the year 2015 and at location I in the year 2016, S_1D_3 recorded maximum number of nodes per plant. In the year 2016 at location II, S_2D_2 recorded the maximum number of nodes per plant. These results are in accordance to the findings of Singh *et al*. (2013) [26].

From the Table 8, it is clear that in both the years 2015 and 2016 as well as at over all locations S_2 spacing (60 × 60 cm) registered the maximum fruit yield per plant (kg), while in case of sowing dates D_3 (30th June) sowing registered the maximum fruit yield per plant. In respect of interaction effect of spacing and sowing dates, S_1D_3 exhibited the highest fruit yield per plant in the year 2015 at location I, while in 2015 at location II and in the year 2016 at both the locations S_2 D_3 registered highest fruit yield per plant. These results are in accordance with the findings of Talukder *et al*. (2003) [28], Firoz *et al*. (2007) [8] and Bake *et al*. (2017) [4].

During the years 2015 and 2016 at both the locations, S_2 spacing (60 × 60 cm) exhibited the maximum fruit yield (q/ha), while in case of sowing dates, D_1 (10th June) sowing registered maximum fruit yield (q/ha). The data pertaining to the interaction effect of spacing and sowing dates, in the year 2015 at both the locations and in the year 2016 at location II, S_2D_1 registered the maximum fruit yield per plant, while in the year 2016 at location I; S_1D_1 exhibited the highest fruit yield per plant (Table 9). Talukder *et al*. (2003) [28] and Paththiniage *et al*. (2008) [20] reported similar results in respect of spacing, while in case of date of sowing similar findings have been reported by Yogesh *et al*. (2001) [30] who reported that early sowing gave higher fruit yield than late sowing.

Among the various treatments intermediate spacing (60 × 60 cm) with D_3 (30th June) sowing performed better than other treatments for most of the quantitative traits, followed by closer spacing (60 × 45 cm) with D_3 (30th June) sowing. The maximum plant height, number of branches per plant, internodal length, fruit length, and number of nodes per plant were obtained in closer spacing (60 × 45 cm), while days to 50% germination, fruit yield per plant (kg), and fruit yield (q/ha) were obtained in intermediate spacing (60 × 60 cm).

Similarly, seeds sown on D_3 (30th June) registered maximum number of branches, internodal length, leaf area at 45 days and 60 days, number of nodes per plant, days to 50% flowering, node at which first flower appears, days to first fruit setting, fruit length, fruit width, number of fruits per plant, average fruit weight, fruit yield per plant, number of seeds per fruit, seed yield per plant and 100 seed weight. Based on these findings, okra seeds sown on D_3 (30th June) with intermediate spacing (60 × 60 cm) is therefore recommended for the farmers of Varanasi district and adjoining areas. However, more trials need to be conducted at different locations so as to arrive at conclusive findings for optimum sowing dates and spacing to be adopted by farmers.

Table 1: Effect of spacing and sowing dates on days to 50% germination

Treatment	2015		2016	
	Location I	Location II	Location I	Location II
Spacings				
S_1	5.78	5.33	5.33	5.33
S_2	5.00	5.00	5.00	5.00
S_3	5.00	5.00	5.00	5.00
S.E.	0.19	0.33	0.33	0.33
C.D. at 5%	NS	NS	NS	NS
Sowing dates				
D_1	5.33	5.11	5.11	5.11
D_2	5.11	5.11	5.11	5.11
D_3	5.33	5.11	5.11	5.11
S.E.	0.06	0.11	0.11	0.11
C.D. at 5%	0.19	NS	NS	NS
Interactions (spacing and sowing date)				
S_1D_1	6.00	5.33	5.33	5.33
S_1D_2	5.33	5.33	5.33	5.33
S_1D_3	6.00	5.33	5.33	5.33
S_2D_1	5.00	5.00	5.00	5.00
S_2D_2	5.00	5.00	5.00	5.00
S_2D_3	5.00	5.00	5.00	5.00
S_3D_1	5.00	5.00	5.00	5.00
S_3D_2	5.00	5.00	5.00	5.00
S_3D_3	5.00	5.00	5.00	5.00
S.E.	0.27	0.27	0.27	0.27
C.D. at 5%	0.57	0.57	0.57	0.57

Table 2: Effect of spacing and sowing dates on plant height (cm)

Treatment	2015		2016	
	Location I	Location II	Location I	Location II
Spacings				
S_1	81.05	80.85	85.94	84.04
S_2	71.91	72.13	73.63	74.03
S_3	73.44	72.61	71.57	72.00
S.E	1.31	1.90	1.50	1.84
C.D. at 5%	5.146	7.45	5.90	7.24
Sowing dates				
D_1	79.86	78.71	82.37	83.01
D_2	74.70	74.73	75.76	75.93
D_3	71.84	72.15	73.01	71.13
S.E.	0.77	0.76	1.12	0.80
C.D. at 5%	2.32	2.28	3.37	2.42
Interactions (spacing and sowing date)				
S_1D_1	87.10	86.86	95.83	94.00
S_1D_2	81.03	80.60	83.80	83.80
S_1D_3	75.03	75.10	78.20	74.33
S_2 D_1	76.93	76.06	78.53	81.33
S_2D_2	69.46	69.86	72.20	72.33
S_2D_3	69.33	70.46	70.16	68.43
S_3D_1	75.56	73.20	72.76	73.70
S_3D_2	73.60	73.73	71.30	71.66
S_3D_3	71.16	70.90	70.66	70.63
S.E.	1.89	1.86	2.75	1.97
C.D. at 5%	4.01	3.95	5.83	4.19

Table 3: Effect of spacing and sowing dates on number of branches

Treatment	2015		2016	
	Location I	Location II	Location I	Location II
Spacings				
S_1	2.77	2.62	3.80	3.91
S_2	3.64	3.26	3.48	3.35
S_3	1.62	2.07	3.01	2.96
S.E.	0.40	0.16	0.40	0.13
C.D. at 5%	NS	NS	NS	0.54
Sowing dates				
D_1	2.26	2.71	2.87	2.75
D_2	2.68	2.57	3.36	3.34
D_3	3.08	2.67	4.05	4.13
S.E.	0.19	0.12	0.22	0.13
C.D. at 5%	0.57	NS	0.68	0.40
Interactions (spacing and sowing date)				
S_1D_1	2.13	2.46	3.33	3.46
S_1D_2	3.00	2.60	3.70	3.83
S_1D_3	3.20	2.80	4.36	4.43
S_2D_1	3.20	2.80	2.60	2.36
S_2D_2	3.26	3.26	3.53	3.53
S_2D_3	4.46	3.73	4.33	4.16
S_3D_1	1.46	2.86	2.70	2.43
S_3D_2	1.80	1.86	2.86	2.66
S_3D_3	1.60	1.50	3.46	3.80
S.E.	0.46	0.31	0.56	0.33
C.D. at 5%	0.99	0.67	1.19	0.70

Table 4: Effect of spacing and sowing dates on internodal length (cm)

Treatment	2015		2016	
	Location I	Location II	Location I	Location II
Spacing				
S_1	2.84	3.21	3.51	3.51
S_2	3.21	3.31	3.58	3.51
S_3	2.73	3.21	3.27	3.35
S.E	0.25	0.01	0.04	0.34
C.D. at 5%	NS	0.07	0.17	NS
Sowing dates				
D_1	3.24	3.12	3.76	3.61
D_2	3.01	3.31	3.56	3.46
D_3	2.53	3.30	3.04	3.30
S.E	0.13	0.07	0.15	0.20
C.D. at 5%	0.41	NS	0.45	NS
Interactions (spacing and sowing date)				
S_1D_1	2.83	3.03	3.80	3.50
S_1D_2	3.03	3.40	3.76	3.40
S_1D_3	2.66	3.20	2.96	3.63
S_2D_1	3.83	3.20	3.96	3.83
S_2D_2	3.26	3.03	3.60	3.66
S_2D_3	2.53	3.70	3.20	3.03
S_3D_1	3.06	3.13	3.53	3.50
S_3D_2	2.73	3.50	3.33	3.33
S_3D_3	2.40	3.00	2.96	3.23
S.E.	0.33	0.17	0.37	0.49
C.D. at 5%	0.71	0.36	0.78	1.04

Table 5: Effect of spacing and sowing dates on leaf area at 45 days after sowing

Treatment	2015		2016	
	Location I	Location II	Location I	Location II
Spacing				
S_1	130.33	121.08	138.92	138.48
S_2	134.75	120.77	150.78	146.68
S_3	128.11	128.37	186.96	190.76
S.E.	0.55	0.39	1.51	1.99
C.D. at 5%	2.16	1.53	5.93	7.82
Sowing dates				
D_1	130.97	123.13	138.87	135.72
D_2	137.37	123.97	166.16	168.20
D_3	124.84	123.13	171.63	172.02
S.E.	0.41	0.30	0.95	0.93
C.D. at 5%	1.24	NS	2.876	2.81
Interactions (spacing and sowing date)				
S_1D_1	122.40	115.46	132.33	128.30
S_1D_2	151.20	125.46	140.80	135.00
S_1D_3	117.40	122.33	143.63	152.16
S_2D_1	123.53	119.33	132.00	129.40
S_2D_2	152.20	121.46	156.33	151.50
S_2D_3	128.53	121.53	164.03	159.16
S_3D_1	147.00	134.60	152.30	149.46
S_3D_2	108.73	125.00	201.36	218.10
S_3D_3	128.60	125.53	207.23	204.73
S.E.	1.01	0.74	2.34	2.29
C.D. at 5%	2.16	1.57	4.98	4.86

Table 6: Effect of spacing and sowing dates on leaf area at 60 days after sowing

Treatment	2015		2016	
	Location I	Location II	Location I	Location II
Spacings				
S_1	244.82	176.04	259.41	285.23
S_2	282.98	227.48	318.01	342.48
S_3	244.20	227.95	357.01	310.47
S.E	0.74	0.55	18.90	2.45
C.D. at 5%	2.93	2.16	NS	9.63
Sowing dates				
D_1	229.92	185.55	283.17	244.18
D_2	243.72	226.46	306.13	334.68
D_3	298.36	219.46	345.12	359.32
S.E	0.40	0.34	8.30	1.25
C.D. at 5%	1.20	1.04	24.88	3.75
Interactions (spacing and sowing date)				
S_1D_1	231.33	128.53	252.90	223.63
S_1D_2	223.50	208.00	255.63	308.30
S_1D_3	279.63	191.60	269.70	323.76
S_2D_1	233.70	211.26	265.83	278.60
S_2D_2	281.40	251.46	319.83	366.00
S_2D_3	333.86	219.73	368.36	382.86
S_3D_1	224.73	216.86	330.80	230.33
S_3D_2	226.26	219.93	342.93	329.76
S_3D_3	281.60	247.06	397.30	371.33
S.E.	0.98	0.85	2.33	3.07
C.D. at 5%	2.08	1.82	4.31	6.50

Table 7: Effect of spacing and sowing dates on number of nodes per plant

Treatment	2015		2016	
	Location I	Location II	Location I	Location II
Spacings				
S_1	20.40	21.06	24.04	21.36
S_2	20.93	21.42	23.30	22.28
S_3	18.28	19.42	18.85	18.16
S.E	0.12	0.18	0.28	0.36
C.D. at 5%	0.50	0.74	NS	1.41
Sowing dates				
D_1	18.54	19.70	21.34	19.58
D_2	19.52	20.33	22.00	21.04
D_3	21.55	21.87	22.85	21.18
S.E.	0.24	0.27	0.27	0.35
C.D. at 5%	0.74	0.83	0.81	1.05
Interactions (spacing and sowing date)				
S_1D_1	19.43	19.76	23.80	19.70
S_1D_2	19.53	20.60	23.73	22.56
S_1D_3	22.23	22.83	24.60	21.83
S_2D_1	19.03	21.26	21.50	21.56
S_2D_2	20.93	21.23	24.16	23.06
S_2D_3	22.83	21.76	24.23	22.23
S_3D_1	17.16	18.06	18.73	17.50
S_3D_2	18.10	19.16	18.10	17.50
S_3D_3	19.60	21.03	19.73	19.50
S.E.	0.60	0.68	0.66	0.86
C.D. at 5%	1.29	1.44	1.41	1.82

Table 8: Effect of spacing and sowing dates on fruit yield per plant (kg)

Treatment	2015		2016	
	Location I	Location II	Location I	Location II
Spacings				
S_1	147.56	147.20	158.44	153.34
S_2	159.20	156.06	162.43	156.72
S_3	121.48	120.44	122.72	119.25
S.E.	2.83	1.98	2.40	3.12
C.D. at 5%	11.13	7.79	9.43	12.27
Sowing dates				
D_1	129.35	122.11	134.61	126.45
D_2	138.88	136.67	143.84	140.82
D_3	160.01	159.92	165.14	162.02
S.E.	1.62	1.69	2.08	1.81
C.D. at 5%	4.85	5.06	6.25	5.43
Interactions (spacing and sowing date)				
S_1D_1	135.66	133.10	145.30	135.26
S_1D_2	137.13	135.10	154.76	147.43
S_1D_3	169.90	173.40	175.26	177.33
S_2D_1	139.26	136.13	142.63	137.73
S_2D_2	160.03	157.10	162.43	152.10
S_2D_3	178.30	174.96	182.23	180.33
S_3D_1	113.13	112.10	115.90	106.36
S_3D_2	119.50	117.83	114.33	123.00
S_3D_3	131.83	131.40	137.93	128.40
S.E.	3.96	4.14	5.10	4.44
C.D. at 5%	8.41	8.77	10.82	9.41

Table 9: Effect of spacing and sowing dates on fruit yield (q/ha)

Treatment	2015		2016	
	Location I	Location II	Location I	Location II
Spacings				
S_1	41.56	41.26	44.66	43.14
S_2	44.66	43.76	46.11	43.91
S_3	34.36	34.08	35.97	33.60
S.E.	0.70	0.64	0.71	0.78
C.D. at 5%	2.77	2.52	2.81	3.07
Sowing dates				
D_1	47.84	47.04	49.88	47.00
D_2	37.53	36.90	40.50	38.02
D_3	35.22	35.17	36.36	35.63
S.E.	0.45	0.49	0.90	0.50
C.D. at 5%	1.35	1.47	2.72	1.52
Interactions (spacing and sowing date)				
S_1D_1	50.16	49.20	53.60	50.66
S_1D_2	37.13	36.46	41.76	39.76
S_1D_3	37.40	38.13	38.63	39.00
S_2D_1	51.53	50.36	52.70	51.00
S_2D_2	43.20	42.43	45.53	41.06
S_2D_3	39.26	38.50	40.10	39.66
S_3D_1	41.83	41.56	43.36	39.33
S_3D_2	32.26	31.80	34.20	33.23
S_3D_3	29.00	28.90	30.36	28.23
S.E.	1.11	1.20	1.22	1.24
C.D. at 5%	2.35	2.55	4.71	2.63

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