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Effect of row spacing and fertilizer on growth and yield attributes of Okra

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Abstract : Study was conducted to determine the influence of within row spacing and fertilizer application on yield attributes of okra Var.Nirmal-20. It was revealed that plant height increased linearly with the increase in spacing, days to flowering was extended with high and low plant density. Fruit number per plant (FNP), Fruit length (FL), Fruit girth (FG) and fresh fruit weight (FFW) were also increased gradually with increase in with in row spacing and fertilizer application. Depending on spacing, LAI regressed linearly or cubically on DAP. Light intensity also increased gradually with in row spacing. Fruit yield per plot and per hectare was more with 20 cm spacing and 60:40:40 kg NPK treatment than others. Correlation studies revealed that relationship among many of the growth and yield attributing parameters showed positive and significant effect on fruit yield.

Keywords: Row spacing, Fertilizer, Okra, Yield

Introduction

Bhendi or Okra (*Abelmoschus esculentus* (L) Moench) is important vegetables, grown widely under varying climatic conditions. Interception of radiation by crop plants depends on the size and structure of the canopy which are determined by the leaf area index (LAI), leaf angle and orientation. Altering leaf area indices through plant population management is most commonly used for canopy modification (Kerby *et al.*, 1990). Optimising light interception through manipulation of plant spacing directly influence the yield. Fertilizers are added to the soil to supply elements which are essential for the growth of plants. The use of chemical fertilizer is necessary for supplying the nutrient requirements without disturbances to sustainability and soil health. Consequencely, further research is needed for better understanding of how within row plant competition and application of fertilizers along with manure affects the physiology, canopy development and fruit yield of okra. Thus this study was undertaken to investigate the influence of different within row spacing and amount of fertilizers for improvement in growth and yield attributes of Okra.

Materials and Methods

A field trial was laid out at ICAR RC NEH Region, AP Centre, Basar, Arunachal Pradesh, extends 26° 28¢ to 29° 28¢ N latitude and 91° 35¢ to 97° 27¢ E longitude, 631m above MSL for consecutive two seasons during Apr-July 2007-08. The soil in the farm is sandy clay loam with slightly acidic pH (5.6). Experiment was laid out in split plot design with three replications, having spacing trial in main plot and fertilizer trial in sub plots. Six different spacing *viz.*, 5, 10, 15, 20, 25 and 30 cm, denotes as S_1, S_2, S_3, S_4, S_5 and S_6 respectively with three different fertilizer dose of 30,20,20 kg NPK; 60, 40,40 kg NPK and 80, 60, 60 kg NPK, denotes as F_1, F_2 and F_3 respectively was executed. Soil was prepared to fine tilth and okra var Nirmal-20 was sown at appropriate seeding rates during April in both the years. Micro plot size of 3x2 m was maintained and 18, 12, 12 g/plot NPK; 36, 24, 24 g NPK and 42, 30, 30 g NPK/plot was applied in micro plots. 15 kg of FYM /plot which was equivalent to 25t/ha was applied in the well ploughed field 10 days before planting as an organic source to all the micro plots. Full dose of P, K and half dose of

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Table 1. Effect of WRS and fertilizer on growth parameters of okra plant

Treatments	Days to germination	Inter nodal length (cm)	Leaves per plant	Plant height (cm)	Days to first flowering	Days to 50% flowering	Days to pod formation	No of pods per plant
S_1F_1	5.29	7.20	14.53	85.83	65.30	71.23	3.19	7.70
S_1F_2	4.91	7.57	15.70	88.17	61.92	66.90	2.97	8.46
S_1F_3	4.84	7.88	17.41	90.94	61.67	64.86	3.04	8.59
S_2F_1	5.16	7.62	16.20	89.85	62.74	66.85	3.17	8.28
S_2F_2	5.08	8.04	17.18	94.60	59.13	63.73	3.06	8.63
S_2F_3	4.91	8.06	17.63	95.79	58.55	62.47	2.99	8.75
S_3F_1	5.07	8.53	17.50	95.82	60.59	64.32	3.03	9.63
S_3F_2	5.03	8.80	17.95	99.30	57.26	61.58	3.01	9.82
S_3F_3	4.92	8.64	18.84	101.24	56.70	59.49	3.04	9.91
S_4F_1	5.09	8.87	18.60	105.75	53.29	55.67	3.15	12.87
S_4F_2	4.95	9.47	19.50	112.63	48.47	51.20	3.07	13.44
S_4F_3	4.94	9.32	19.82	115.37	47.82	58.73	3.06	13.38
S_5F_1	5.03	8.89	16.37	114.59	55.76	57.58	3.98	15.70
S_5F_2	4.91	9.43	18.96	118.70	52.11	57.81	3.86	15.27
S_5F_3	4.87	9.54	19.40	119.32	51.93	58.14	3.82	16.40
S_6F_1	5.19	9.60	17.83	118.67	53.07	59.72	4.13	16.21
S_6F_2	5.00	10.03	18.91	120.74	53.30	59.66	4.10	16.32
S_6F_3	4.92	10.27	19.67	121.88	52.13	58.35	4.00	16.16
Main treatment means								
S_1	14.99	22.59^{d}	47.6^{d}	264.8^{e}	188.8^{a}	202.97^{a}	9.20^{a}	24.69^{a}
S_2	15.00	23.60^{cd}	50.9^{cd}	280.1^{d}	180.3^{ab}	192.94^{ab}	9.19^{a}	25.50^{b}
S_3	14.93	25.93^{c}	54.2^{c}	296.3^{c}	174.4^{b}	185.26^{b}	9.12^{a}	33.33^{b}
S_4	14.85	27.56^{b}	57.9^{a}	333.6^{b}	149.4^{c}	158.58^{c}	9.20^{a}	37.54d
S_5	14.70	27.80^{b}	54.7^{c}	352.5^{ab}	149.7^{c}	164.40^{ab}	11.66^{b}	38.37^{d}
S_6	15.03	29.87^{a}	56.3^{b}	361.10^{a}	147.4^{c}	166.63^{ab}	12.23^{c}	38.91^{d}
Sub-treatment means								
F_1	15.28	25.32^{b}	50.53^{a}	305.6^{a}	171.79^{b}	185.09^{b}	10.33^{a}	33.25^{a}
F_2	14.85	26.63^{a}	54.00^{b}	317.0^{b}	162.02^{a}	176.35^{a}	10.00^{a}	35.86^{b}
F_3	14.63	26.75^{a}	56.35^{c}	322.1^{b}	161.33^{a}	173.90^{a}	9.98^{a}	35.99^{b}
Main Treatments								
CD 5%	NS	0.67	0.87	5.00	2.80	3.65	0.18	0.46
CV %	4.68	6.73	4.32	4.99	4.84	7.82	5.32	4.97
Sub Treatments								
CD 5%	NS	0.36	0.53	3.90	4.59	2.58	NS	0.39
Main x Sub								
CD 5%	NS	0.798	1.31	9.55	6.09	6.33	0.34	0.74
CV %	6.87	5.43	6.89	5.40	6.57	9.16	6.14	6.78

N was applied as basal dressing while remaining half dose of N was applied after 45 days of sowing as top dressing. Urea, SSP and KCl was applied as N, P and K sources as per their content. For each replication, five plants were randomly tagged for observations on days to seed germination, various growth attributes like internodal length, number of leaves/plant and plant height and various yield attributes like days to flowering, days to flowering to pod formation, number of pods/plant, pod length, pod girth, weight of the pod, yield per plot and etc. The numbers of branches on the tagged plants were counted at the time of last harvest. A LAI 2000 plant canopy analyzer was used to estimate LAI five times at 15 days interval between first flowerings to final harvest. Each data set consisted of one above canopy irradiance reading and four below canopy readings approximately 15 cm above soil along with evenly spaced diagonal transect between the middle rows of each plot. Light intensity was noted using Lux meter (Model TES 1332 at 2,00,000 lux) in between the tagged plants which were in the middle row to know the light interception with different plant density. Statistical analysis was carried out to the know the variance for different parameters, effect of main plot, sub plot and interaction effect of treatments, using AGRES package.

Results and Discussion

It was evident from table 1 that day to germination was not affected significantly among different treatments. Profound increase in plant height was noticed irrespective of spacing. Further the internodal length and plant height were significantly influenced by within row spacing (WRS) of plants. It was evident that the

Table 2. Effect of WRS and fertilizer on growth parameters of okra plant

Treatments	Pod length	Pod girth	Light intensity	Fruit weight (g)	Yield per plot	Yield t/ha
S_1F_1	12.45	1.73	185.4	13.99	6.57	10.95
S_1F_2	13.62	1.76	200.5	14.13	6.84	11.48
S_1F_3	13.73	1.75	194.6	14.86	6.91	11.52
S_2F_1	12.87	1.76	223.7	14.91	7.00	11.66
S_2F_2	13.74	1.79	238.6	15.13	7.28	12.13
S_2F_3	13.82	1.78	244.3	15.87	7.26	12.10
S_3F_1	14.01	1.76	279.4	18.15	7.40	12.37
S_3F_2	15.53	1.78	288.1	18.27	7.53	12.52
S_3F_3	15.89	1.79	291.4	19.14	7.48	12.47
S_4F_1	16.73	1.88	327.8	20.86	8.61	14.35
S_4F_2	17.47	1.88	339.7	21.39	9.15	15.76
S_4F_3	17.02	1.90	342.8	21.02	8.98	14.97
S_5F_1	17.26	1.88	378.9	19.67	8.33	13.88
S_5F_2	17.74	1.95	388.2	20.39	8.42	14.03
S_5F_3	17.93	1.97	393.6	20.15	8.46	14.13
S_6F_1	18.43	2.07	399.8	19.13	7.83	13.05
S_6F_2	19.53	2.13	410.3	20.14	7.29	12.17
S_6F_3	19.26	2.09	413.6	20.06	7.14	11.90
Main treatment means						
S_1	39.73	5.25	580.4	41.64	20.36	33.95
S_2	40.30	5.33	706.6	42.53	21.54	35.90
S_3	45.35	5.36	859.2	47.32	22.43	37.32
S_4	51.17	5.67	1010.7	49.21	26.76	45.09
S_5	52.86	5.78	1160.4	51.37	25.21	42.0
S_6	57.15	6.24	1223.9	55.26	22.27	37.14
Sub-treatment means						
F_1	45.75	5.52	897.52	45.37	22.87	38.11
F_2	48.72	5.65	932.8	47.65	23.28	39.05
F_3	48.74	5.61	940.2	47.28	23.12	38.53
Main Treatments						
CD 5%	0.68	0.07	14.88	0.94	0.28	0.59
CV %	4.04	3.36	4.67	4.25	6.83	4.59
Sub Treatments						
CD 5%	0.61	NS	11.76	0.72	0.25	0.46
Main x Sub						
CD 5%	1.54	0.18	28.85	1.87	0.61	1.13
CV %	5.64	7.82	5.89	5.87	9.57	6.72

plant height increased linearly with the increase in spacing. However, the increase was least observed after 20 cm of within row spacing. S_4 and S_5 were at par on their effect on internodal length and plant height. The increase in internodal length at higher level of nutrients in the present study might be due to higher absorption of nutrients, especially nitrogen which enhanced the cell division, cell elongation with concomitant increase in metabolic activity by which meristmatic activity of tissue increased manifold and led to increase in internodal length. This result was in line with the findings of Pandey *et al.* (1994) on seed yield of okra.

Days taken for initiation of flowering and 50% flowering were also declined with increase in within row spacings. It was, further found that above S_4, the increase in spacing didn't have much effect on flowering and it has detrimental effect on 50 % flowering as the days taken for 50% flowering was recorded lower with S_4 nonetheless which was on par with S_5 and S_6. Fertilizer treatment also has significant effect on flowering as optimum fertilizer application reduce the days to flowering. The best effect of S_4 with F_2 was due to the optimization of spacing and fertilizers which positively influenced the flowering. Flowering was delayed due to high population in S_1 to S_3 as the competition between plants were significantly high for applied fertilizers. Similar result was reported by Gupta (1990) on okra. Days to pod formation get extended if the within row spacing was above than 20 cm. however, increase in fertilizer dose linearly decrease the days to pod formation and increased the number of pods per plant though F_2 and F_3 were at par with each other. The FNP increased linearly with WRS and fertilizer application. Since okra bears a single flower/node, the number of nodes on a plant largely determines the number of fruits it can bear

(Whitehead and Singh, 2000). Close spacing increases competition among adjoining plants for available soil nutrients and water as well as for aerial space for canopy foramation. This prevents profuse branching and production of nodes on those branches for flowering and fruit set. Similar result was reported by Hermannn *et al.* (1990) on Okra.

It was evident that pod length increased with increase in spacing and fertilizer doses. Highest pod length was observed with S_6F_2 which was at par with S_6F_3. Among main treatments, S_4 and S_5 were at par in their influence in pod length while in sub treatments, F_2 and F_3 were at par with each other. Pod girth, though influenced linearly with spacing and fertilizer doses, the increase was least pronounced. The spacing S_1, S_2 and S_3 were at par with each other while the remaining three spacing trials were superior and grouped together statistically. The increase in pod length and girth may be due to less competition between plants for soil nutrients, applied fertilizers, more number of fruit bearing axils and higher light penetration. Similarly, the significant difference in pod length, girth, fresh pod weight with fertilized plots might be due to differences in soil structure and fertility. Whitehead and Singh, 2000). Fresh fruit weight (FFW) increased linearly with the increase in spacing and fertilizer application. Hermann *et al* (1990) observed that okra plants produced heavier pods at wider spacing. Greater fruit weight and fruit number/plant at wider spacing have also been reported in other vegetable crops (Decoteau and Graham, 1994; Kahn *et al.*, 1997). Though the pod length, girth and pod weight was more with S_6 due to lesser population, the final yield per plot was so reduced while in S_1, S_2 and S_3 due to lesser pod length and girth the pod weight got reduced thereby reduce the final yield significantly. The maximum yield was recorded with S_4F_2 treatment which is at par with S_4F_3. At earlier studies on okra plant showed that the optimum population density resulted better yield than high and low population density (Gupta, 1990). Gupta (1990) observed that closest plant spacing of 50x10 cm gave the lowest mean fruit weight and highest yield per hectare (150.8 q/ha) in cv. Pusa sawani. The significant increase in total yields might also be attributed to the increased branching as pod developed in the axil of every branch once flowering has began. Number of nodes per plant also increased with fertilizer application along with optimum spacing of 20 cm with-in row plant spacing. Since every node has a potential to produce flower which directly influence the yield per plot.

The study clearly demonstrated that there was clear relationship between spacing, fertilizer application on final economic yield of okra plant. They have immense effect on physiological and morphological activities and fruiting behaviour of plants. Plant density of S_4 with F_2 level of fertilizer application gave greater yield advantage than other treatments. It was further concluded that S_4 with F_2 treatment was also at least 10 days ahead of other spacing in fruiting at full capacity which will in turn give better return to the grower thus provided the added economic advantage.

सारांश

भिण्डी प्रजाति निर्मल 20 के उपज गुणों पर कतार अंतराल और खाद अनुप्रयोग के अन्तर्गत प्रीााव निर्धारण का अध्ययन करने के लिए आयोजित किया गया। भिण्डी 6 विभिन्न अन्तराल (S_1: 5, S_2: 10, S_3: 15, S_4:20, S_5: 25, S_6:30 cm) और तीन खाद प्रयोग स्तर (F_1:30, 20, 20 किग्रा., NPK F_2: 60, 40 , 40 किग्रा. NPK और F_3: 80, 60, 60 किग्रा. NPK को स्पिल्ट भूखण्ड परिकल्पना में बीज उत्पन्न किया। यह पाया गया कि पौध ऊँचाई ने अन्तराल पुष्पण दिनों के साथ परिक्षण किया। फूल संख्या प्रति पौध, फल लम्बाई, फल घेरा और ताला फल भार की वृद्धि डव्यू आर और खाद अनुप्रयोग में वृद्धि के साथ हुई। यह अन्तराल पर डी.ए.पी. पर पंक्ति रूप पर निर्भर होती है। प्रकाश प्रबलता W R S के साथ भी वृद्धि की। फल उपज प्रति भूखण्ड और प्रति हेक्टेयर S_4 F_2 के साथ अधिक था। सह सम्बन्ध अध्ययन ने जो बढोत्तरी और उपज का बहुस से सम्बन्ध आरोपित करके फल उपज पर सकारात्मक और महत्वपूर्ण प्रभाव को दिख्या गया।

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