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Effect of plant densities and cycocel on growth, flowering and yield attributes of okra (*Abelmoschus esculentus.* (L.) Moench) Cv. Parbhani Kranti

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Abstract
An experiment was conducted at College of Horticulture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, during 2018 to know the effect of different plant densities (60 x 30 cm, 60 x 25 cm, 40 x 30 cm and 40 x 25 cm) and foliar application of cycocel (0, 400, 600 and 800 ppm) on various growth, flowering and yield attributes of okra. Experiment was laid in Factorial Randomized Block Design with three replications during summer season under shadenet house. Application of foliar sprays of cycocel were given at 30 and 45 DAS. The observations on growth, flowering and yield attributes were recorded during the investigation. The results revealed that the significant influence of different plant densities and cycocel was noted for reduction in plant height, maximum increasing in stem girth, internodal length, number of branches per plant and fruit yield per hectare. The interaction effect of plant density and cycocel significantly influenced on stem girth, internodal length and fruit yield per hectare. The siginificantly maximum fruit yield per hectare was noted in S_4C_3(40 x25 cm, cycocel at 600 ppm) which was at par with S_4C_4 (40 x 25 cm, cycocel at 800 ppm).It is revealed that either plant spacing at 40 x 25 cm with the foliar spray of cycocel at 600 ppm or plant spacing at 40 x 30 cm with the foliar spary of cycocel at 800 ppm at 30 and 45 DAS found to be better for increasing fruit bearing and yield in okra.

Keywords: Plant density, cycocel, spacing, okra, yield

Introduction
Okra (*Abelmoschus esculentus* (L.) Moench) is one of the most important vegetable widely cultivated in Maharashtra. Among fruit vegetables, okra has good demand throughout the year. Okra is fast growing herb of family Malvaceae. It is the most profitable summer vegetable. It's adaptability to a wide range of growing condition makes it popular among vegetable growers. It is one of the important fruit vegetable crops of the tropical and subtropical regions of the world as all classes of the people of the world popularly consume it. Okra requires a long, warm and humid growing period. It can be successfully grown in hot, humid areas. It is sensitive to frost and extremely low temperatures. For normal growth and development, a temperature between 24 and 28°C is preferred. It is grown on sandy to clay soils, but due to its well-developed tap root system, relatively light, well drained, rich soils are ideal. As such, loose, friable, well manure loam soils are desirable. Desired pH range is 6.5 to 6.8. The hibiscus like flowers and erect stature gives the okra plant its ornamental value. Flowers form singly at the nodes and flower induction is promoted by regular harvest of the young, immature pods, which are considered to have the highest quality (Iremiren *et al*., 1991) [6]. The role of cycocel has been found to retard the plant height by reducing inter nodal length and simultaneously induce the formation of lateral shoots thereby, plant possess more number of fruit bearing shoots.

Plant spacing is an important factor for okra production, both in summer and rainy season crop (Hossain *et al*., l999) [4]. The use of adequate spacing is very important because it exerts influence on flowering, number of productive stems, yield per plant and crop productivity (Gaion *et al*., 2013) [3]. Generally, increase in planting density results in increased yield per unit area till a certain limit (Weimer, 1990) [16]. Suitable plant spacing can lead to optimum seed yield. Whereas, too high or too low plant spacing could result in relatively low yield and quality (Absar and Siddique, 1982) [1]. The improper plant spacing may cause either too dense or too sparse population resulting in the reduction of okra yield. But optimum plant density ensures the plants to grow uniformly and properly through efficient utilization of moisture, nutrients, light and thus causes to produce maximum yield of okra. Planting with proper spacing increases yield, quality and size of fruit.

Among several growth retardants cycocel is very promising and it is used on large scale in vegetable crops (Zayed *et al*., 1985) [17].

Chlormequat or cycocel is an anti-gibberellin growth retardant that inhibits both cell division and cell elongation. The appropriate spacing coupled with foliar spray of cycocel export quality okra needs specific standards *viz*. tenderness, 3 to 4 cm in length, uniform in size, dark green in colour, disease and pest free with good quality fruits. The growth rate of okra is very high which resulted in to the increasing internodal length and all affects naturally on yield. To achieve better quality export yield it was undertaken the research on high density plantation with effect of cycocel. Hence, the present investigation was undertaken to study the effect of plant densities and cycocel on growth, flowering and yield attributes on okra.

Material and Methods

The investigation was undertaken at Instructional cum Research Farm of College of Horticulture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani to know the effect of plant densities and cycocel on growth, flowering and yield attributes of okra. The experiment was laid out in Factorial Randomized Block Design with three replications during summer season of 2018 under shade net house. Sowing was undertaken at four different spacing levels *i.e* 60 x 30 cm, 60 x 25 cm, 40 x 30 cm and 40 x 25 cm. Whereas, cycocel was applied as foliar spray at 30 and 45 days (DAS) after sowing at four different concentration levels *i.e.* 0 ppm (distilled water), 400, 600 and 800 ppm. The recommended package of practices *viz*. fertilizer management, plant protection measure, irrigation and intercultural operations were undertaken during the investigation. Different commercial characters of okra were recorded during growth of the crop *viz.* plant height, stem girth, internodal length, number of nodes per plant, number of branches per plant, days to first flowering, days to 50 per cent flowering, node at first flowering, fruit yield per plant, and fruit yield per hectare. The data genarated during the investigation was subjected to statistical analysis to test the significance among the treatments on various characters of okra under study was done according to the procedure given by Panse and Sukhatme (1985) [11].

Results and Discussion

The data on growth, flowering and yield attributes as infliuenced by different plant densities and foliar applicatons of cycocel is presented in Table 1.

Table 1: Effect of plant densities and cycocel on growth, flowering and yield attributes in okra

Traits/ Treatment details		Plant height (cm)	Stem girth (mm)	Inter nodal length (cm)	Number of nodes per plant	Number of branches per plant	Days to first flowering	Days to 50 per cent flowering	Node at first flowering	Fruit yield per plant (g)	Fruit yield per hectare (MT/ha.)
Factor S: Spacing levels											
S_1	60 x 30 cm	46.27^{a}	14.18^{a}	4.10^{a}	21.81	1.95^{c}	42.78	43.64	3.52	115.11	10.15^{d}
S_2	60 x 25 cm	36.85^{b}	13.19^{b}	3.97^{ab}	21.90	2.15^{bc}	42.05	42.42	3.42	117.20	10.86^{c}
S_3	40 x 30 cm	32.55^{c}	10.74^{c}	3.95^{ab}	22.10	2.21^{b}	41.8	41.24	3.4	118.31	12.29^{b}
S_4	40 x 25 cm	28.51^{d}	9.92^{d}	3.60^{c}	23.07	2.62^{a}	41.62	41.83	3.15	122.93	13.36^{a}
C.D @ 5%		2.31*	0.644*	0.335*	NS	0.338*	NS	NS	NS	NS	0.591*
Factor C Cycocel levels											
C_1	0 ppm	38.11^{a}	9.92^{d}	4.55^{a}	22.36	1.13^{b}	42.43^{a}	42.72	3.39	113.36	10.11^{d}
C_2	400 ppm	38.00^{a}	10.74^{c}	3.77^{b}	22.40	2.53^{a}	42.19^{a}	42.63	3.38	119.15	10.73^{c}
C_3	600 ppm	34.22^{b}	13.19^{b}	3.67^{bc}	22.13	2.60^{a}	42.12^{a}	42.50	3.35	121.3	12.69^{a}
C_4	800 ppm	32.85^{b}	14.19^{a}	3.63^{bc}	21.98	2.67^{a}	41.52^{b}	42.46	3.33	120.12	11.68^{b}
C.D @ 5%		2.31*	0.644*	0.335*	NS	0.338*	0.819*	NS	NS	NS	0.591*

Within a treatment group, means in a column followed by the same letter(s) are not significantly different using CD at 5% level of probability.
NS = Not Significant, * = Significant, S= Spacing levels C= Cycocel levels

Effect plant density

The effect of plant densities had siginificant influence on plant height, stem girth, internodal length, number of branches per plant, and fruit yield. Whereas, non-significance influence was noted on rest of attributes. The significantly minimum height of plant (28.51 cm) and internodal length (3.60 cm) was recorded in spacing at 40 x25 cm. It was followed by spacing at 40 x 30 cm (32.55 cm, 3.95 cm, respectively) and 60 x 25 cm (36.85 cm, 9.97cm, respectively).The significantly maximum stem girth was found in spacing 60 x 30 cm(14.18 mm) fallowed by spacing at 60 x 25 cm(13.19 mm) and 40 x 30 cm(10.74 mm). These findings are in agreement with those of Zayed *et al*., (1985) [17], Mahorkar *et al*., (2007) [9], Sajjan *et al*., (2003) [14] and Maurya *et al*. (2013) [10].

The significantly highest number of branches per plant (2.62) and fruit yield per hectare (13.36 Mt) was observed in spacing at 40 x 25 cm, it was followed by spacing 40 x 30 cm (2.21,12.29 Mt, respectively).These findings are in agreement with those of Ijoyah *et al*., (2010) [5], Maurya *et al*., (2013) [10] and Pathithinige *et al*., (2008).

Effect of cycocel

The significantly minimum height of plant (32.85 cm) and internodal length (3.63cm) was observed due to foliar application of cycocel at 800 ppm. However, it was at par with the foliar application of cyccocel at 600 ppm (32.22 cm, 3.67 cm, respectively).Whereas, significantly maximum number of branches per plant (2.67 cm) was observed due to foliar application of cycocel at 800 ppm which is followed by application of cycocel at 600 ppm (2.60). The significantly highest fruit yield was obseved due to application of cycocel at 600 ppm (12.69 Mt), which was followed by cycocel at 800 ppm (11.68 Mt).The rest of the attributes number of nodes per plant. Days to 50 percent flowering, node at first flowering and fruit yield per plant had non-significant influence due to application of cycocel in okra. These findings are in agrrement with thise of Kokare *et al*., (2006) [8], Khan *et al*., (1978) [7] and Rajput *et al*., (2011) [13].

Effect of interaction

The data on interaction effect of plant density and application of cycocel has given in Table 2.

The maximum stem girth (13.90 mm) was observed at 60 x 30 cm without the application of cycocel. However, it was at par with the spacing at 60 x 25 cm without the application of cycocel (12.80 mm).Whereas, the significantly minimum intermodal length (3.25 cm) was observed in spacing at 40 x 30 cm with the foliar application of cycocel at 800 ppm. However, it was at par with the spacing at 40 x 25 cm with

cycocel spray at 800 ppm (3.33 cm). Among the treatments, significantly maximum yield potential was reported by S_4C_3 (40 x 25 cm with the foliar application of cycocel at 600 ppm) treatment recorded 16.13 Mt per hectare. whereas, plant density at S_4C_4 (40 x 25 cm with the foliar application of cycocel at 800 ppm) and S_3C_3 (40 x 30 cm with foliar application of cycocel at 600 ppm) were also found at par with S_4C_3 (40 x 25 cm with the foliar application of cycocel at 600 ppm) with yield level of 15.97 Mt and 15.53 Mt per hectare, respectively. The interaction effect of different spacing and cycocel levels was found non-significant for plant height, number of nodes per plant, number of branches per plant, days to first flowering, days to 50 per cent flowering, node at first flowering, fruit yield per plant. These findings are in agreement with those of Vikash Kumar *et al*. (2016) [15], Aliyu. and Ajala (2016) [2].

Table 2: Interaction effect of plant densities and cycocel on growth, flowering and yield attributes in okra

Traits/ Treatment details		Plant height (cm)	Stem girth (mm)	Inter nodal length (cm)	Number of nodes per plant	Number of branches per plant	Days to first flowering	Days to 50 per cent flowering	Node at first flowering	Fruit yield per plant (g)	Fruit yield per hectare (MT/ha.)
T_1	S_1 C_1	51.27	13.90^{a}	5.11^{a}	19.53	1.06	43.73	44.21	3.60	104.18	10.24^{f}
T_2	S_2 C_1	49.19	12.80^{ab}	4.85^{ab}	19.73	1.12	43.47	44.00	3.53	106.09	10.40^{f}
T_3	S_3 C_1	45.11	12.60^{b}	4.28^{bc}	21.00	1.13	42.53	43.67	3.53	111.07	10.44^{f}
T_4	S_4 C_1	39.53	11.70^{b}	4.13^{cd}	21.13	1.21	42.33	43.18	3.53	115.29	10.52^{f}
T_5	S_1 C_2	38.00	10.10^{c}	3.98^{cde}	21.14	2.07	42.27	43.17	3.53	116.89	10.69^{ef}
T_6	S_2 C_2	37.86	9.70^{cd}	3.95^{cde}	21.73	2.13	42.20	43.00	3.44	117.31	10.76^{ef}
T_7	S_3 C_2	36.00	9.52^{cd}	3.93^{cdef}	21.87	2.12	42.14	42.67	3.43	117.48	10.85^{ef}
T_8	S_4 C_2	35.53	9.50^{cd}	3.91^{cdef}	22.13	2.27	42.07	42.67	3.42	118.94	11.83^{de}
T_9	S_1 C_3	34.86	9.12^{cde}	3.76^{cdef}	22.19	2.40	41.93	42.33	3.41	119.71	12.07^{d}
T_{10}	S_2 C_3	33.73	9.10^{cde}	3.73^{cdef}	22.33	2.67	41.87	42.33	3.40	121.01	12.25^{d}
T_{11}	S_3 C_3	32.30	8.92^{cde}	3.69^{cdef}	22.73	2.66	41.22	41.35	3.17	123.69	15.53^{a}
T_{12}	S_4 C_3	31.23	8.90^{cde}	3.66^{cdef}	23.00	2.65	41.18	40.67	3.10	132.13	16.13^{a}
T_{13}	S_1 C_4	30.86	8.60^{de}	3.50^{def}	23.13	2.92	41.73	42.33	3.33	121.27	10.11^{f}
T_{14}	S_2 C_4	30.77	8.50^{de}	3.41^{ef}	23.33	2.93	41.60	42.00	3.27	121.34	13.74^{c}
T_{15}	S_3 C_4	25.60	7.90^{e}	3.25^{f}	23.59	3.06	41.53	41.67	3.20	123.37	14.11^{bc}
T_{16}	S_4 C_4	24.93	7.80^{e}	3.33^{ef}	25.00	3.29	41.20	41.12	3.13	124.44	15.97^{a}
C.D @ 5%		NS	1.288*	0.67*	NS	NS	NS	NS	NS	NS	1.182*

Within a treatment group, means in a column followed by the same letter(s) are not significantly different using CD at 5% level of probability.
NS = Not Significant, * = Significant= Spacing levels C= Cycocel levels

Conclusion

On the basis of different parameters under study it could be concluded that reduction in height of plant and intermodal length and increasing number of branches, induce early flowering and better yield were found in spacing 40 x 25 cm and also observed with sprayings cycocel at 800 ppm. Whereas, the highest fruit yield per hectare was found in spacing 40 x 25 cm with the foliar applications of cycocel at 600 ppm at 30 and 45 DAS.

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