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# Effect of plant densities and Cycocel on leaf, chlorophyll content, yield and quality 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 leaf, chlorophyll content, yield and quality attributes of okra. Experiment was laid in Factorial Randomized Block Design with three replications during summer season under shadenet house. The observations on leaf, chlorophyll content, yield and quality attributes were recorded during investigation. Results revealed that the significant effect of spacings on leaf area, chlorophyll-b, total chlorophyll, fruit yield per hectare and vitamin-C. Whereas, cycocel levels were found significant for the traits like leaf area, chlorophyll-b, fruit yield and vitamin-C. In case of interaction effects the characters like chlorophyll-b, total chlorophyll and fruit yield found significant performance. Remaining traits were not showned any significant influence under the experiment. The important characters like chlorophyll-b(84.06 $mg^{-100g}$), total chlorophyll (173.17 $mg^{-100g}$) were performed significantely maximum found better in spacing at 60 x 30 cm without the application of cycocel. However, these characters were at par with the spacing at 60 x 30 cm with the application of cycocel at 400 ppm. The highest fruit yield per hectare (16.13Mt) was noticed at spacing at 40 x 25 cm with the application of cycocel at 600 ppm. However, it was at par with the spacing at 40 x 25 cm with the foliar application of cycocel at 800 ppm. It is inferenced that the significantly highest fruit yield with maximum vitamin-C were found with planting density at 40 x 25 cm with the foliar application of cycocel at 600 ppm in okra at 30 and 45 DAS.

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

## Introduction
Okra, (*Abelmoschus esculantus* (L.) Moench) is one of the most important summer vegetable crops grown for its immature fruits which are commonly used in culinary preparation. It is grown mainly for it's tender non-fibrous edible fruit extensively throughout India. Okra is adapted to a wide range of soil. Okra thrives well in most soil types from sandy loam, loam and or clay soils with a pH range of 5.8-8.0 It has good nutritional value. Its tender green fruits are also canned, dehydrated or frozen for off season consumption. Okra fruits also have nutritional and medicinal values as the fruit contain 6.4 g carbohydrates, 2.2 g protein 0.2 g fat, 66 mg calcium, 500 mg phosphorus, 15 mg iron and 13 mg vitamin-C per 100 g edible portion. Similarly, okra fruit is excellent source of iodine which is necessary for the resistance against throat disease like goiter (Chauhan, 1972) [5]. It is good for the people suffering from heart weakness (Yawalkar, 1969) [23]. Industrially, okra mucilage is usually used in glaring certain papers and also useful in confectionaries among other uses (Markose and Peter, 1990) [13]. Okra's medicinal value has also been reported in curing ulcers and relief of haemorrhoids. Okra is useful against chronic dysentery and genito-urinary disorders (Hilou, *et al*., 2006) [8]. Leaves are sometimes used as poultices (Maurya *et al*., 2013) [14]. The immature pods are consumed as boiled vegetable and are also dried and used as soup thickeners or in stews (Yadev and Dhanker. 2002) [22]. Foliage of okra plants are known to provide good sources of fodder for livestoch. Plant spacing is an important factor for okra production both in summer and rainy season crop. (Hossain *et al*., l999) [9]. It has been observed that suitable planting spacing can lead to optimum okra fruit yield. Therefore, this study is aimed at investigating the effects of planting spacing and cycocel on growth, yield and quality of okra,

Growth substances enabled man to control the plant growth and has become the greatest tool in the hands of horticulturists for increasing yield and better quality of vegetables. Spacing determines the available area for a plant to sorce for growth resources, such as water, light and nutrients. To achieve better quality export yield it need to be undertake the research on high density plantation with effect of cycocel.

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.

The ideal plant density to be used in a given crop is that sufficient to achieve the optimum leaf area index to intercept the maximum solar radiation useful for photosynthesis. In this sense, the plant population acts on the penetration of solar radiation and on the balance between growth of the vegetative parts and the fruits. Thus, changes in the plant population or increased availability of solar radiation indirectly affect the distribution of dry matter between plant organs (Kunz *et al*., 2007).The use of adequate spacing is very important because it exerts influence on flowering, number of productive stems, yield per plant and crop productivity, which may exceed 15,000 kg ha-$^{1}$ (Gaion *et al*., 2013) [7].

In recent years, scientists have given attention to the idea of regulating plant growth as third most important factor in improving the growth, yield and quality with the application of plant growth substances in various ways (Cathey, 1964) [4]. It helps in efficient utilization of metabolites in certain physiological process going in plant systems. Generally, increase in planting density results in increased yield per unit area till a certain limit (Weiner, 1990) [21]. 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 application of CCC to plants represses the growth of stems, leaves and stolons, but improves photosynthetic capacity by increasing leaf chlorophyll content. The present investigation was undertaken to produce 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.

## 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 leaf, chlorophyll content, yield and quality 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 after sowing (DAS) at four different concentration levels *i.e.* 0 ppm (distilled water), 400, 600 and 800 ppm. All, recommended practices like nutrient and plant protection measures were given during the experiment. Different commercial characters of okra were recorded during growth of the crop *viz.* leaf area, leaf area index, chlorophyll-a, chlorophyll-b, total chlorophyll, fruit yield per plant, fruit yield per hectare, rind thickness and vitamin-C. Collected information 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) [16].

## Results and Discussion

The data on leaf, chlorophyll content, yield and quality as influenced by plant density and foliar applications of cycocel at is presented in Table 1.

### Effect of plant density

The results revealed that the significant effect of different plant densities were shown for the characters like leaf area, chlorophyll-b, total chlorophyll, fruit yield per hectare and vitamin-C. whereas, other charcters like leaf area index, chlorophyll-a, fruit yield per plant and rind thickness were found to be non significant. The maximum leaf area (60.20 cm$^{2}$), chlorophyll-b content (59.11 mg$^{-100g}$) and total chlorophyll content (141.98 mg$^{-100g}$) was recorded significantely higher at spacing of 60 x 30 cm. However, these characters were at par with the spacing at 60 x 25 cm (56.60 cm$^{2)}$ and total chlorophyll (130.60 mg$^{-100g}$) except chlorophyll-b content. whereas, the highest fruit yield per hectare (13.36 Mt) and vitamin-C (13.92 mg$^{-100g}$) was recorded at spacing of 40 x 25 cm followed by 40 x 30 cm (12.29 Mt and 12.70 mg$^{-100g}$, respectively).Similar results were also reported by Ijoyah *et al*., (2010) [10], Maurya *et al*., (2013) [14], Bhagure and Tambe (2015), Pathithinige *et al*., (2008), Kokare *et al*., (2006) [11].

### Effect of cycocel

Cycocel showed significant effect on different characters of okra like leaf area, chlorophyll-b, fruit yield per hectare and vitamin-C. whereas, other characters like leaf area index, chlorophyll-a content, total chlorophyll content, fruit yield per plant and rind thickness were not shown more difference among the treatments. The maximum leaf area (62.95 cm$^{2}$) and chlorophyll-b (70.28 mg$^{-100g}$) were recorded significantly more without the application of cycocel, which is fallowed by foliar application of cycocel 400 ppm(53.83 cm$^{2}$ and 56.16 mg$^{-100g}$, respectively).whereas, the highest fruit yield per hectare(12.69 Mt) and vitamin-C(13.64 mg$^{-100g}$) was recorded with the foliar application of cycocel at 600 ppm, it is followed by foliar application of cycocel 800 ppm (11.68 Mt) and vitamin-C content was at par 13.44 mg$^{-100g}$. These findings are in agreement with those of Prasad and Srihari (2008) [18], Bhagure and Tambe (2015), Sajjan *et al*., (2003) [19], Munikrishnappa and Shantappa (2009) [15], Arora and Dhankar (1992) [2], Chhonkar *et al*., (1977) [6].

### Effect of interaction

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

Interaction effects revealed that the traits like chlorophyll-b, total chlorophyll and fruit yield per hectare were found significant, while rest of characters like leaf area, leaf area index, chlorophyll-a, fruit yield per plant, rind thickness and vitamin-C were not shown any more differences among the treatments. The maximum chlorophyll-b content (84.06 mg$^{-100g}$) and total chlorophyll content (173.17 mg$^{-100g}$) were determined at $S_1C_1$ *i,e* spacing at 60 x 30 cm without the foliar application of cycocel. However, it was at par with the treatment $S_1C_2$ *i.e* 40 x 30 cm, with the foliar application of cycocel at 400 ppm (72.84 mg$^{-100g}$, 165.32 mg$^{-100g}$, respectively).

Among the treatments, significantly maximum yield (16.13 Mt/ha) by treatment $S_4C_3$ (40 x 25 cm with the foliar application of cycocel at 600 ppm). 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 the foliar application of cycocel at 600 ppm) were also found on 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. Which is followed by $S_3C_4$ *i.e* 40 x 30 cm with the foliar application of cycocel at 800 ppm (14.11 Mt /ha). Whereas, $S_1C_4$ (60 x 30 cm with the foliar application of cycocel at 800 ppm) and $S_1C_1$ (60 x 30 without the foliar application of cycocel) recorded significantly the lowest *i.e.* 10.11 Mt and 10.24 Mt per hectare yield level, respectrively. Similar results were observed by Kokare *et al*., (2006) [11], Bhagure and Tambe (2015), Sajjan *et al*., (2003) [20], Munikrishnappa and Shantappa (2009) [15], Arora and Dhankar (1992) [2].

**Table 1:** Effect of plant densities and cycocel on leaf, chlorophyll content, yield and quality attributes of okra

| Traits/ Treatment details | | Leaf area ($cm^2$) | Leaf area index | Chlorophyll -a content (mg/100g) | Chlorophyll-b content (mg/100g) | Total chlorophyll content (mg/100g) | Fruit yield per plant (g) | Fruit yield per hectare (MT/ha.) | Rind thickness (mm) | Vitamin-C (mg/100g) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Factor S: Spacing levels** | | | | | | | | | | |
| $S_1$ | 60 x 30 cm | 60.20$^{a}$ | 0.71 | 82.87 | 59.11$^{a}$ | 141.98$^{a}$ | 115.11 | 10.15$^{d}$ | 1.08 | 11.90$^{c}$ |
| $S_2$ | 60 x 25 cm | 56.60$^{ab}$ | 0.80 | 78.65 | 51.65$^{b}$ | 130.30$^{ab}$ | 117.20 | 10.86$^{c}$ | 1.09 | 11.82$^{c}$ |
| $S_3$ | 40 x 30 cm | 53.95$^{bc}$ | 0.98 | 75.28 | 51.56$^{b}$ | 126.84$^{ab}$ | 118.31 | 12.29$^{b}$ | 1.10 | 12.71$^{b}$ |
| $S_4$ | 40 x 25 cm | 50.51$^{c}$ | 1.17 | 72.65 | 48.22$^{b}$ | 120.87$^{b}$ | 122.93 | 13.36$^{a}$ | 1.13 | 13.92$^{a}$ |
| C.D @ 5% | | 6.059* | NS | NS | 7.241* | 16.882* | NS | 0.591* | NS | 0.359* |
| $C_1$ | 0 ppm | 62.95$^{a}$ | 1.00 | 88.21 | 70.28$^{a}$ | 158.45 | 113.36 | 10.11$^{d}$ | 1.05 | 11.22$^{c}$ |
| $C_2$ | 400 ppm | 53.83$^{b}$ | 0.97 | 78.68 | 56.16$^{b}$ | 134.80 | 119.15 | 10.73$^{c}$ | 1.07 | 12.03$^{b}$ |
| $C_3$ | 600 ppm | 52.97$^{b}$ | 0.86 | 72.35 | 42.59$^{c}$ | 114.93 | 121.3 | 12.69$^{a}$ | 1.14 | 13.64$^{a}$ |
| $C_4$ | 800 ppm | 51.51$^{b}$ | 0.82 | 70.22 | 41.51$^{c}$ | 111.73 | 120.12 | 11.68$^{b}$ | 1.10 | 13.44$^{a}$ |
| C.D @ 5% | | 6.059* | NS | NS | 7.241* | NS | NS | 0.591* | NS | 0.359* |

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

**Table 2:** Interaction effect of plant densities and cycocel on leaf, chlorophyll content, yield and quality attributes of okra

| Traits/ Treatment details | | Leaf area ($cm^2$) | Leaf area index | Chlorophyll-a content (mg/100g) | Chlorophyll-b content (mg/100g) | Total chlorophyll content (mg/100g) | Fruit yield per plant (g) | Fruit yield per hectare (MT/ha.) | Rind thickness (mm) | Vitamin-C (mg/100g) |
|---|---|---|---|---|---|---|---|---|---|---|
| $T_1$ | $S_1C_1$ | 69.58 | 1.05 | 89.11 | 84.06$^{a}$ | 173.17$^{a}$ | 104.18 | 10.24$^{e}$ | 1.02 | 10.26 |
| $T_2$ | $S_2C_1$ | 64.72 | 1.14 | 74.59 | 63.51$^{bc}$ | 138.10$^{bcd}$ | 106.09 | 10.40$^{e}$ | 1.03 | 9.77 |
| $T_3$ | $S_3C_1$ | 59.40 | 1.27 | 112.91 | 62.39$^{bc}$ | 175.30$^{a}$ | 111.07 | 10.44$^{e}$ | 1.00 | 10.95 |
| $T_4$ | $S_4C_1$ | 58.09 | 1.31 | 76.23 | 71.18$^{ab}$ | 147.41$^{abc}$ | 115.29 | 10.52$^{e}$ | 1.02 | 13.92 |
| $T_5$ | $S_1C_2$ | 57.84 | 0.99 | 92.48 | 72.84$^{ab}$ | 165.32$^{ab}$ | 116.89 | 10.69$^{de}$ | 1.10 | 11.40 |
| $T_6$ | $S_2C_2$ | 57.76 | 0.98 | 75.84 | 62.37$^{b}$ | 138.21$^{bcd}$ | 117.31 | 10.76$^{de}$ | 1.12 | 11.67 |
| $T_7$ | $S_3C_2$ | 55.62 | 1.03 | 72.46 | 46.47$^{d}$ | 118.93$^{cd}$ | 117.48 | 10.85$^{de}$ | 1.10 | 12.40 |
| $T_8$ | $S_4C_2$ | 55.61 | 1.04 | 73.93 | 42.96$^{d}$ | 116.89$^{cd}$ | 118.94 | 11.83$^{cd}$ | 1.13 | 12.67 |
| $T_9$ | $S_1C_3$ | 54.77 | 0.73 | 54.85 | 51.10$^{cd}$ | 105.95$^{d}$ | 119.71 | 12.07$^{c}$ | 1.11 | 12.90 |
| $T_{10}$ | $S_2C_3$ | 53.58 | 0.77 | 71.40 | 40.58$^{d}$ | 111.98$^{d}$ | 121.01 | 12.25$^{c}$ | 1.07 | 13.13 |
| $T_{11}$ | $S_3C_3$ | 53.50 | 0.85 | 75.77 | 42.97$^{d}$ | 118.74$^{cd}$ | 123.69 | 15.53$^{a}$ | 1.15 | 13.90 |
| $T_{12}$ | $S_4C_3$ | 52.56 | 0.93 | 78.86 | 49.23$^{cd}$ | 128.09$^{cd}$ | 132.13 | 16.13$^{a}$ | 1.18 | 14.64 |
| $T_{13}$ | $S_1C_4$ | 49.32 | 0.58 | 78.18 | 46.31$^{d}$ | 124.49$^{cd}$ | 121.27 | 10.11 | 1.16 | 13.03 |
| $T_{14}$ | $S_2C_4$ | 48.07 | 0.63 | 68.78 | 40.13$^{d}$ | 108.91$^{d}$ | 121.34 | 13.74$^{b}$ | 1.05 | 12.70 |
| $T_{15}$ | $S_3C_4$ | 47.89 | 0.62 | 70.34 | 41.04$^{d}$ | 111.38$^{d}$ | 123.37 | 14.11$^{b}$ | 1.14 | 13.60 |
| $T_{16}$ | $S_4C_4$ | 46.72 | 0.66 | 72.10 | 42.88$^{d}$ | 114.98$^{cd}$ | 124.44 | 15.97$^{a}$ | 1.16 | 14.43 |
| **C.D @ 5%** | | **NS** | **NS** | **NS** | **14.482*** | **33.764*** | **NS** | **1.182*** | **NS** | **NS** |

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

## Conclusion

It is concluded that the spacing at 60 x 30 cm was found better for leaf area, chlorophyll-b and total chlorophyll. Whereas, the high test yield was recorded at spacing at 40 x 25 cm with the foliar application of cycocel at 600 ppm. In quality parameters, maximum vitamin-C was found better at 40 x 25 cm as well as with the foliar application of cycocel at 600 ppm at 30 and 45 DAS.

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