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Influence of growth retardant on growth and yield of okra (*Abelmoschus esculentus* L. Moench) Var. Parbhani Kranti in *kharif* season under south Konkan agroclimatic conditions

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Abstract
The investigation was undertaken to study the influence of paclobutrazol and cycocel on growth and yield of okra (Var. Parbhani Kranti) at Mango Research Sub-Centre, Rameshwar, Deogad, Dist. Sindhudurg during the kharif season of the year 2016. The experiment was designed in randomized block design with three replications and seven treatments *viz;* T_1: Control, T_2: CCC (@ 250 ppm), T_3: CCC (@ 500 ppm), T_4: CCC (@ 750 ppm), T_5: PBZ (@ 100 ppm), T_6: PBZ (@ 200 ppm), T_7: PBZ (@ 300 ppm). The growth retardants at respective concentration was sprayed on the plants at 30 days after sowing and second spray was given at 15 days after first foliar spray. At 90 days after sowing, the minimum plant height (89.30 cm) with lowest absolute growth rate (0.9456 cm day^{-1}) was recorded in the treatment CCC @ 750 ppm (T_4). The reduction in plant height was 13.01% over control in CCC @ 750 ppm treatment. The lowest average internodal length (4.63 cm) and highest number of leaves per plant (28.33) were also observed in CCC @ 750 ppm (T_4) treatment. The maximum yield of fresh fruit (239.67 g plant^{-1} and 110.96 q ha^{-1}) was recorded in CCC @ 500 ppm (T_3) and minimum yield (208.00 g plant^{-1} and 96.30 q ha^{-1}) was observed in control (T_1) treatment.

Keywords: Okra, CCC, PBZ, plant height, yield

Introduction
Okra is an annual vegetable crop and considered as one of the important vegetable not only in India but in many countries. It belongs to the family Malvaceae and has medicinal, nutritional value. It's adaptability to a wide range of growing condition made it popular among vegetable growers. Okra crop thrives in all kinds of soils and environmental conditions. However, the long warm growing season with optimum day temperature for its better growth is between 25 to 40ºC. The growth and yield of okra are governed by many factors like seed quality, prevailing geographic and climatic conditions and cultural practices. The south Konkan coastal zone of Maharashtra comprises with Ratnagiri and Sindhudurg districts having lateritic soils with high rainfall area. Under such agroclimatic conditions, the okra crop grows well but such situation favours the intense vegetative growth especially during the *kharif* season.
Chemical substances like plant growth regulators can bring changes in the phenotypes of plants and affect growth either by enhancing or by stimulating the natural growth regulatory systems from seed germination to senescence (Das and Das, 1995) [4]. Among the plant growth regulators, the growth retardants inhibit the cell elongation and cell division and play an important role of anti-gibberellin growth retardant. Paclobutrazol (PBZ) and cycocel (CCC) are the effective and easily available plant growth retardants. While growing the okra crop in *kharif* season of coastal zone, the diminution of the vegetative growth with yield improvement is an aim. Therefore, the present investigation was undertaken to study the influence of paclobutrazol and cycocel on growth and yield of okra (Var. Parbhani Kranti).

Material and Methods
The field experiment was conducted at field of Mango Research Sub-Centre, Rameshwar, Deogad, Dist. Sindhudurg during the kharif season of the year 2016. The experimental site is in hard lateritic rocky area having low soil depth. The experiment was designed in randomized block design with three replications and seven treatments *viz;* T_1: Control, T_2: CCC (@ 250 ppm), T_3: CCC (@ 500 ppm), T_4: CCC (@ 750 ppm), T_5: PBZ (@ 100 ppm), T_6: PBZ (@ 200 ppm), T_7: PBZ (@ 300 ppm). The land was prepared by following preparatory tillage operations and beds of 3.6m X 2.7m were prepared.

The seeds of the okra (Var. Parbhani Kranti) were sown at a spacing of 45cm X 45 cm. The growth retardants at respective concentration was sprayed on the plants at 30 days after sowing and second spray was given at 15 days after first foliar spray. The recommended cultural practices like manuring, weeding, plant protection, etc. were followed to grow the crop. The growth observation on the plant height, number of leaves, internodal length and the yield were recorded. The data were statistically analyzed by the method suggested by Panse and Sukhatme (1985) [7].

Results and Discussion

The data on the growth of okra (Var. Parbhani Kranti) as influenced by the foliar spary of cycocel and paclobutrazol were presented in Table 1 and depicted in Fig. 1.

It is revealed that there was significant reduction in the plant height due to the sparys of cycocel and paclobutrazol growth retardants. At 90 days after sowing, the minimum plant height (89.30 cm) was recorded in the treatment CCC @ 750 ppm (T_4). It was followed by PBZ @ 300 ppm (T_7), CCC @ 500 ppm (T_4) and PBZ @ 200 ppm (T_6). Whereas, the maximum plant height (1.1.63 cm) was in control (T_1). The absolute growth rate of the plant clearly indicated the noteworthy reduced growth rate in the plant growth retardant treatments and the lowest absolute growth rate (0.9456 cm day^{-1}) was observed in the treatment CCC @ 750 ppm (T_4) while it was highest (1.1539 cm day^{-1}) in control (T_1). The notable reduction in the plant growth over control was achieved by CCC and PBZ applications and the highest reduction in plant height (13.01%) was in CCC @ 750 ppm (T_4) treatment, followed by T_7 and T_3 treatments.

The reduction in the plant height might be due to inhibition of cell division by cycocel which produced shorter stem length. It also helps to lower down the levels of diffusible auxin and by this means suppress vegetative growth. Similar findings were also reported by Pateliya *et al.* (2008) [8] and the effect of paclobutrazol on growth was reported by Chutichudet *et al.* (2007) [3]. The internodal length of the okra plant was also significantly reduced due to foliar spary of CCC and PBZ (Table 1). The lowest average internodal length (4.63 cm) was observed in CCC @ 750 ppm (T_4) treatment. It was followed by T_3 which was at par with T_6 treatment. The internode was longest in control (T_1) treatment. The growth of intenodes was short mainly due to cycocel and paclobutrazol where the cell division and elongation in the apical meristem might be restricted. Nawalkar *et al.* (2007) [6], Mandal *et al.* (2012) [5] and Bhagure and Tambe (2013) [2] reported the similar findings with respect to CCC in okra.

In case of the number of leaves, it is perused that the number of leaves was increased with the application of cycocel and paclobutrazol with increasing concentrations. The highest number of leaves per plant (28.33) was counted in the treatment CCC @ 750 ppm (T_4) and was at par with PBZ @ 300 ppm (T_7) and CCC @ 500 ppm (T_3) treatments. The least number of leaves per plant (22.83) was in control (T_1) treatment. The increased number of leaves in the graoth retardant treatments might be due to effectiveness of CCC in suppressing apical dominance, there by promoting the growth of lateral buds in to new shoots (Arora and Dhankhar, 1992) [1]. These results are in conformity with that of Mandal *et al.* (2012) [5] in okra.

The data on fruit yield per plant and per hectare are presented in Table 2 revealed that the foliar spray of CCC and PBZ significantly improved the yield of okra. The maximum yield of fresh fruit (239.67 g plant^{-1} and 110.96 q ha^{-1}) was recorded in CCC @ 500 ppm (T_3) treatment and it was at par with CCC @ 750 ppm (T_4) treatment (Fig. 2). The minimum yield (208.00 g plant^{-1} and 96.30 q ha^{-1}) was observed in control (T_1) treatment. It is cleared from the data that the yield of fruit in CCC @500 pmm treatment was improved by 15.22 per cent over control.

Higher fruit yield in CCC treatemnts was might be due to reduced plant height and increased branching resulting in diversion of food material for the improvement of flowering and fruiting more number of fruits per plant. Similar findings were also reported in okra by Pateliya *et al.* (2008) [8], Rajput *et al.*, (2011) [9] and Sanganagoud *et al.* (2014) [10].

Table 1: The growth of okra influenced by the cycocel and paclobutrazol application

Treatments	Plant height (cm) at 30 days after sowing	Plant height (cm) at 120 days after sowing	Absolute growth rate (cm/day) during 30 to 90 DAS	Reduction in the growth over control (%)	Average internodal length (cm)	Number of leaves plant^{-1}
T_1: Control	32.40	101.63^{a}	1.1539	-	7.23^{a}	22.83^{c}
T_2: CCC (@ 250 ppm)	32.67	98.17^{ab}	1.0917	3.41	6.57^{b}	24.33^{bc}
T_3: CCC (@ 500 ppm)	32.88	94.80^{bc}	1.0319	6.96	5.70^{c}	26.33^{ab}
T_4: CCC (@ 750 ppm)	32.57	89.30^{d}	0.9456	13.01	4.63^{d}	28.33^{a}
T_5: PBZ (@ 100 ppm)	32.50	99.50^{a}	1.1167	2.39	6.57^{b}	23.33^{c}
T_6: PBZ (@ 200 ppm)	33.43	95.80^{bc}	1.0394	5.86	6.10^{bc}	24.67^{bc}
T_7: PBZ (@ 300 ppm)	33.40	93.47^{c}	1.0011	8.52	5.77^{c}	26.83^{ab}
S.Em. ±	0.63	1.13	0.018	-	0.19	0.94
CD (p=0.05)	NS	3.48	0.056	-	0.60	2.90

Table 2: The yield of okra influenced by the cycocel and paclobutrazol application

Treatments	Yield (g plant^{-1})	Yield (q ha^{-1})	Increase in the yield over control (%)
T_1: Control	208.00^{c}	96.30^{c}	-
T_2: CCC (@ 250 ppm)	220.33^{bc}	102.01^{bc}	5.93
T_3: CCC (@ 500 ppm)	239.67^{a}	110.96^{a}	15.22
T_4: CCC (@ 750 ppm)	236.33^{ab}	109.41^{ab}	13.62
T_5: PBZ (@ 100 ppm)	215.00^{c}	99.54^{c}	3.36
T_6: PBZ (@ 200 ppm)	218.00^{c}	100.93^{c}	4.80
T_7: PBZ (@ 300 ppm)	215.33^{c}	99.69^{c}	3.52
S.Em. ±	5.27	2.44	-
CD (p=0.05)	16.22	7.51	-

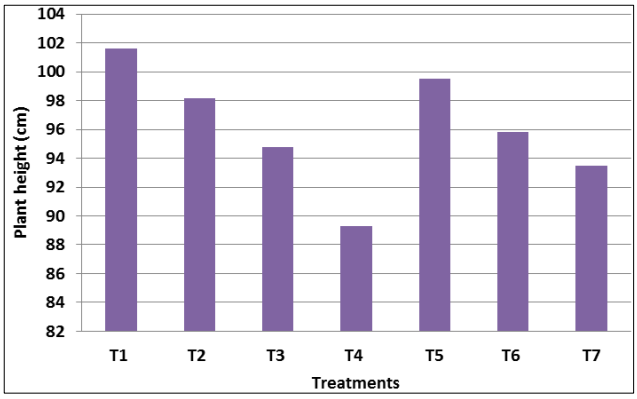

Fig 1: Influence of CCC and PBZ on growth of okra Var. Parbhani Kranti

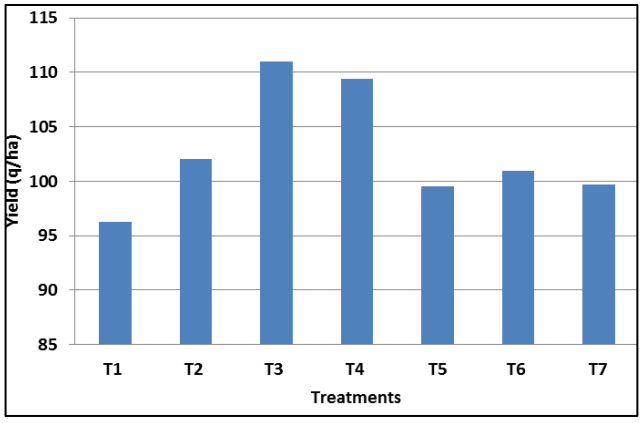

Fig 2: Influence of CCC and PBZ on yield of okra Var. Parbhani Kranti

Conclusion

From the present investigation, it is inferred that the foliar spray of the plant growth retardants significantly reduced the plant growth of okra. The application of CCC @ 750 ppm reduced the plant growth however the yield was improved with CCC @ 500 ppm treatment which is the beneficial for higher production of okra during *kharif* season under south coastal agroclimatic region.

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