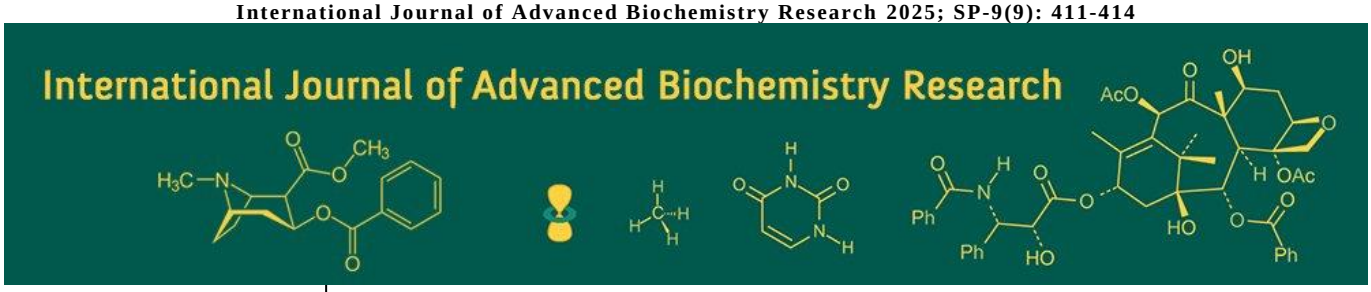

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Studies on canopy management using plant growth retardant in hollyhock (*Alcea rosea*)

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Abstract
The present study entitled "Studies on Canopy Management using Plant Growth Retardant in hollyhock (*Alcea rosea*)*"* was conducted at the Horticultural Research cum Instructional Farm, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G) during the year 2024-2025. The study confirmed that hollyhock plants treated with foliar application of the application of Cycocel @ 1250 ppm (CCC) (T_8) results showed that the Cycocel treatment effectively reduced plant height to 47.65 cm at 60 DAT and 120.10 cm at 90 DAT, a substantial decrease compared to the control plants which reached 80.14 cm and 195.56 cm, respectively. While reducing height, Cycocel @ 1250 ppm (T_8) also promoted a more compact and robust plant structure. It led to a maximum plant spread (E-W: 55.19 cm, N-S: 51.00 cm), an increased number of primary branches (22.86), a higher number of leaves per plant (36.50 at 60 DAT and 42.40 at 90 DAT), and the highest stem diameter (20.52 mm). Conversely, this treatment resulted in a smaller leaf area (170.33 cm^2) and minimum internodal length (7.26 cm). Furthermore, the application of Cycocel @ 1250 ppm (T_8) positively influenced flowering characteristics, leading to the maximum number of flowers per plant (188.66), the largest flower diameter (90.82 cm), and the longest flower withering period (3.50 days). In contrast, Paclobutrazol (PBZ) at 50 ppm accelerated the flowering time. These findings demonstrate that Cycocel @ 1250 ppm is highly effective in controlling plant height and enhancing a number of desirable ornamental traits, suggesting its potential for landscaping use.

Keywords: Hollyhock, paclobutrazol, cycocel, vegetative and flowering

Introduction
The common hollyhock, *Alcea rosea*, has a chromosome number of 2n = 84. This means that each cell in a hollyhock plant contains 84 chromosomes, arranged in 42 pairs. perennial flower known for its tall, stately spikes of showy, cup-shaped blooms. Native to Asia and Europe, Hollyhocks have been cultivated for centuries for their ornamental value, medicinal properties, and culinary uses. With over 60 species and countless hybrids, Hollyhocks offer a diverse range of colors, growth habits, and flowering characteristics. Hollyhocks are a classic and highly valued plant in landscaping for their strong vertical presence and old-fashioned charm. Their towering flower stalks, which can grow from six to nine feet tall, provide a dramatic backdrop for garden beds, especially against fences, walls, or the back of a border. This vertical element adds a sense of structure and visual interest that can break up a flat landscape and make a garden appear more dynamic.

Plant growth retardants have been used to regulate the growth and flowering of annuals. They are used to shorten the length of a plant's shoots in a controlled manner without affecting developmental patterns or being phytotoxic. The application of synthetic growth retardants like paclobutrazol, cycocel and slows down the cell division or inhibits the gibberellin biosynthesis and cell elongation. Their application has reduced plant height, improved stem diameter and leaf number, altered root architecture directly contributed to yield increase and indirectly reduced the event of lodging (Syahputra *et al*. 2016) [18]. These chemicals used in many ornamental crops to produce more compact and aesthetically pleasing plants by reducing shoot length. Though the hollyhock plants are highly attractive and good ornamental value but due to its tall growing nature it leads to bending and make unsuitable for growing in pots. Therefore, keeping in view of foregoing consideration the investigation was carried to study the effect of growth retardants on growth and flowering attributes in hollyhock.

Materials and Methods

The present Studies on Canopy Management using Plant Growth Retardant in hollyhock (*Alcea rosea*) was conducted at the Horticultural Research cum Instructional Farm, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G) during the year 2024-2025. Hollyhock seedlings were procured from horticulture nursery, IGKV. Healthy seedlings were transplanted 30 days after sowing. Field preparation was done with repeated ploughing and incorporated rotavator to obtain fine tilth. Organic manures such as Farm yard manure 50 kg and vermicompost 15 kg mixed together and applied.

The experiment was laid out in Randomized Block Design (RBD) with 3 replications under open field condition. Each replication consists of 9 treatments and treated with the following growth retardants; (T_0) Control (Water), (T_1) PBZ at 20 ppm, (T_2) PBZ at 30 ppm, (T_3) PBZ at 40 ppm, (T_4) PBZ at 50 ppm, (T_5) Cycocel at 500 ppm, (T_6) Cycocel at 750 ppm, (T_7) Cycocel at 1000 ppm and (T_8) Cycocel at 1250 ppm 30 days after transplanting dated January12, 2025. Different concentration of treatment was prepared and all treatments were sprayed on foliage of individual plants. Control plants were sprayed with distilled water. Different vegetative and flowering parameters were recorded at 60 DAT and 90 DAT. The recorded data were statistically analysed by the randomized block design analysis of variance (ANOVA) as suggested by Fischer (1954) in his book "Design of Experiment".

Results and Discussion

Effect of growth retardants on vegetative attributes of Hollyhock

Hollyhock plants treated with different growth retardants showed significant variation among different vegetative and flowering parameters. Table 1 indicating that the application of Cycocel foliar spray at 1200 ppm (T_8) resulted in the minimum plant height, with measurements of 47.65 cm at 60 DAT and 120.10 cm at 90 DAT. Whereas maximum plant height was recorded in (T_0) control 80.14 cm at 60 DAT and 195.56 cm at 90 DAT. These findings are accordance with previous studies, those by Cycocel (chlormequat chloride) is a well-known plant growth retardant that functions by inhibiting the biosynthesis of gibberellins. Gibberellins are a class of plant hormones that are primarily responsible for cell elongation and stem growth. By blocking the synthesis of gibberellins, Cycocel effectively reduces internodal elongation, leading to a more compact and shorter plant. These findings are consistent with previous studies, such as those by Sunayana (2015) in marigold, Kumar *et al*. (2019) in nerium odorum. This resulted in shortened internodes and height.

The maximum plant spread (E-W) 55.19 cm and (N-S) 51.00 cm was observed with the application of Cycocel @ 1250 ppm (CCC) (T_8). On the other hand, plants treated with (T_1) Control (Water) (E-W) 41.75 cm and (N-S) 39.08 cm recorded lowest plant spread. This finding is related with Kumar *et al*. (2022) [8] in cosmos The highest number (22.86) of primary branches per plant was resulted in Cycocel @ 1250 ppm (CCC) (T_8). Conversely, minimum number (14.12) of primary branches per plant was recorded from (T_1) Control (Water). These results are in agreement with the findings of Abdella (2005) [1] in snapdragon, Mishra *et al*. (2005) [9] in china aster, Singh *et al*. (2016) [16] in geranium, Hemlata and Singh (2017) [7] in marigold and Sharaf-Eldien *et al*. (2017) [14] in zinnia. The effect of paclobutrazol soil drenching at 5 ppm on branches, plant spread and number of leaves due to the suppression of GA_3 biosynthesis by paclobutrazol, resulting in hormonal changes that favor bud initiation and branching.

Table 1: Effect of growth retardants on vegetative attributes of hollyhock

Notation	Treatments	Plant height 60 DAT (cm)	Plant height 90 DAT (cm)	Plant spread (E-W) (cm)	Plant spread (N-S) (cm)	Primary branches
T_0	Control (Water)	80.14	195.56	41.75	39.08	14.12
T_1	Paclobutrazol @ 20 ppm (PBZ)	67.66	158.28	42.01	41.70	15.59
T_2	Paclobutrazol @ 30 ppm (PBZ)	64.64	155.02	45.81	42.55	16.73
T_3	Paclobutrazol @ 40 ppm (PBZ)	58.61	148.15	46.33	43.62	17.55
T_4	Paclobutrazol @ 50 ppm (PBZ)	53.79	141.00	47.66	43.81	18.54
T_5	Cycocel @ 500 ppm (CCC)	52.97	135.33	50.17	47.95	19.21
T_6	Cycocel @ 750 ppm (CCC)	50.96	129.73	52.00	49.38	20.21
T_7	Cycocel @ 1000 ppm (CCC)	48.86	126.74	53.69	50.57	20.55
T_8	Cycocel @ 1250 ppm (CCC)	47.65	120.10	55.19	51.00	22.86
C.D at 5%		11.22	25.67	7.56	7.95	3.03

Table 2: Effect of growth retardants on vegetative attributes of hollyhock

Notation	Treatments	Leaf area (cm2)	Number of leaves per plant 60 DAT	Number of leaves per plant 90 DAT	Stem diameter (mm)	Internodal length (cm)
T_0	Control (Water)	317.40	22.00	26.66	13.75	14.5
T_1	Paclobutrazol @ 20 ppm (PBZ)	236.03	23.61	27	14.88	10.56
T_2	Paclobutrazol @ 30 ppm (PBZ)	234.53	24.80	27.33	15.93	10.07
T_3	Paclobutrazol @ 40 ppm (PBZ)	226.17	25.25	28.66	16.40	10.03
T_4	Paclobutrazol @ 50 ppm (PBZ)	215.67	25.80	29.00	16.66	9.86
T_5	Cycocel @ 500 ppm (CCC)	192.50	27.86	33.33	16.92	9.8
T_6	Cycocel @ 750 ppm (CCC)	190.47	31.20	35.13	17.33	9.73
T_7	Cycocel @ 1000 ppm (CCC)	182.47	33.00	40.33	19.08	8.6
T_8	Cycocel @ 1250 ppm (CCC)	170.33	36.50	42.40	20.52	7.26
C.D at 5%		38.59	4.81	5.86	3.18	2.176

Table 2 indicating that the highest stem diameter 20.52 mm and the minimum internodal length 7.26 cm was recorded in Cycocel @ 1250 ppm (CCC) (T_8). These findings are consistent with those of Deshmukh (2005) [13] in gaillardia, Spitzer and Bilovsky (2012) [17] in poppy and Kumar *et al*. (2022) [8] in dahlia. The maximum number of leaves per plant was recorded in plants treated with Cycocel @ 1250 ppm (CCC) (T_8) 36.50 leaves at 60 DAT and 42.40 leaves at 90 DAT. Similar results were reported by El-Sadek (2016) [4] in hibiscus, Hemlata and Singh (2017) [7] in marigold, Asgarian *et al*. (2013) [2], Sharaf-Eldien (2017) [14] in Zinnia and Singh and Bist (2003) [15] in rose. The application of Control (Water) resulted in the largest leaf area (317.40 cm²). In contrast, the smallest leaf area (170.33 cm²) was observed in the Cycocel @ 1250 ppm (CCC) (T_8). This finding is consistent with those of Kumar *et al*. (2022) [8] in cosmos.

Effect of growth retardants on flowering attributes of Hollyhock

Table 3 indicating that the days taken to 50% flowering (70.66 days) and 100% flowering (84.11 days) was recorded early in (T_4) Paclobutrazol @ 50 ppm ppm. These findings align with the results reported by Mishra *et al*. (2005) [9] in china aster, Wei *et al*. (2017) [19] in *Camellia chrysantha* and Sharaf-Eldien *et al*. (2017) [14] in zinnia. Maximum number of flowers per plant was recorded in Cycocel @ 1250 ppm (CCC) (T_8) recorded 188.66 flowers. These findings align with the results reported by El-Sadek (2016) [4] in hibiscus, Hemlata and Singh (2017) [7] in marigold, Asgarian *et al*. (2013) [2], Sharaf-Eldien (2017) [14] in Zinnia, Singh and Bist (2003) [15] in rose. This is likely due to the inhibition of gibberellin (GA_3) biosynthesis by paclobutrazol, when the synthesis of gibberellin is blocked, there is an accumulation of precursors in the terpenoid pathway, which are redirected to enhance the synthesis of abscisic acid (Rademacher, 2000) [12].

The maximum flower diameter (90.82 mm) was observed in plants treated with Cycocel @ 1250 ppm (CCC) (T_8). This observation is in line with the findings of Qureshi *et al*. (2018) in chrysanthemum. Maximum days taken to flower withering (3.50 days) was observed in plants treated with Cycocel @ 1250 ppm (CCC) (T_8). This finding related to Hayashi *et al*. (2001) [6] in herbaceous perennials (Achillea, Echinacea, Leucanthemum, Monarda), Spitzer and Bilovsky (2012) [17] in poppy and Singh and Bala (2017) in chrysanthemum. These effects of cycocel are likely due to cycocel suppressing vegetative growth, which redirects energy from vegetative processes to reproductive growth, thereby promoting flower development.

Table 3: Effect of growth retardants on flowering attributes of hollyhock

Notation	Treatments	Number of days taken to 50% flowering	Number of days taken to 100% flowering	Number of flowers per plant	Flower diameter (mm)	Days taken to flower withering from full blooming
T_0	Control (Water)	75.55	86.67	144.44	81.75	1.36
T_1	Paclobutrazol @ 20 ppm (PBZ)	74.33	86.33	145.89	84.13	1.56
T_2	Paclobutrazol @ 30 ppm (PBZ)	72.66	85.66	151.89	85.46	1.73
T_3	Paclobutrazol @ 40 ppm (PBZ)	72.44	85.55	156.11	85.55	1.80
T_4	Paclobutrazol @ 50 ppm (PBZ)	70.66	84.11	165.00	86.33	2.23
T_5	Cycocel @ 500 ppm (CCC)	77.78	88.33	171.66	87.44	3.10
T_6	Cycocel @ 750 ppm (CCC)	78.33	88.78	176.89	88.82	3.30
T_7	Cycocel @ 1000 ppm (CCC)	79.22	90.44	186.44	89.28	3.36
T_8	Cycocel @ 1250 ppm (CCC)	79.44	90.78	188.66	90.82	3.50
C.D at 5%		14.37	15.24	31.2	15.05	0.46

Conclusion

Based on the findings of the field study, Cycocel (CCC) at 1250 ppm (T_8) is identified as the superior treatment for producing a desirable, compact plant with enhanced flowering characteristics. While it significantly reduced plant height and leaf area, it simultaneously promoted a more robust plant structure, as evidenced by the maximum plant spread, highest number of primary branches, and highest stem diameter. This treatment also resulted in a higher number and larger diameter of flowers, with increased flower longevity, It makes give short hollyhocks offer the classic cottage-garden look in a compact, versatile form, ideal for borders, containers, and windy spots, while still attracting pollinators.

In contrast, Paclobutrazol (PBZ) at 50 ppm (T_4) is considered the best treatment for achieving the earliest flowering. This accelerated flowering time, reaching both 50% and 100% bloom faster than other treatments, which is a key benefit for commercial growers focused on a rapid crop cycle.

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