Differential effect of different methods of applying Paclobutrazol on Calendula(*Calendula officinalis L.*) in Prayagraj climatic condition

ABSTRACT

A field experiment was carried out to investigate the effect of different method of applying Paclobutrazol on plant growth and flower yield of Calendula (*Calendula officinalis L.*) cv. Bon Bon, during November 2022 to February 2023 at Floriculture Research Field, Department of Horticulture, Sam Higginbottom University of Agriculture Technology and Sciences, Pryagraj (U.P.). Different methods of applying Paclobutrazol viz., T0 No Treatment, T1 Paclobutrazol@ 50 ppm as Foliar application, T2 Paclobutrazol@ 100 ppm as Foliar application, T3 Paclobutrazol@ 150 ppm as Foliar application, T4 Paclobutrazol@ 200 ppm as Foliar application, T5 Paclobutrazol@ 50 ppm as Soil drenching, T6 Paclobutrazol@ 100 ppm as Soil drenching, T7 Paclobutrazol@ 150 ppm as Soil drenching and T8 Paclobutrazol@ 200 ppm as Soil drenching was applied to assess the vegetative, floral and yield characteristics of Calendula . The experiment was laid out in complete randomised block design with nine treatments and three replications. The result for growth and flower yield of Calendula (*Calendula officinalis L.*) showed significant difference for the various treatment applied as soil application as a paclobutrazol as well as foliar application. In general paclobutrazol@ 200

ppm as Soil drenching and foliar application improved the different growth and flower yield parameters suggest its efficacy of application. in comparison to plants that had other treatments applied, the plant's height is reduced, making it smaller and more dwarflike, and the number of lateral branches is increased, increasing the flower yield. When compared to foliar application, the soil drenching method of application was found to be more effective because plant roots absorb more of the substance. This is because plants are less capable of absorbing the substance because of higher rates of evapotranspiration in foliar application.

Key words:- Paclobutrazol, Calendula, soil application, Foliar application, growth, yield.

1. INTRODUCTION

Calendula (Calendula officinalis L.) is one of the most popular seasonal flowers. It belongs to the Asteraceae family and is also known as “English Marigold” “Pot Marigold” or orange pot marigold, Ox-eye it's widely planted across the country. Calendula officinalis is a common garden plant associated with Virgin Mary and Queen Mary in old English, hence the name marigold. Calendula grows up 60 cm in height and produces large yellow and orange flowers. Flowers are harvested continuously and new flowers are formed after the harvest. In other words, continuous harvesting of flowers is possible as long as climate conditions are available. In India the important calendula growing states are Tamil Nadu, Karnataka, Andhra Pradesh in south, Maharashtra in west, west Bengal and north Sikkim in the east and Himachal Pradesh, Jammu Kashmir in the north. In India it is estimated that its productivity is about 328.6 kg ha1 fresh weight and 56.68 kg ha-1 dry weight of flower (Omer and Kurt; 2018).

Calendula (Calendula officinalis L.) is an annual with bright yellow or orange daisy-like flowers. The flowers are harvested while in full bloom and dried for use as a medicinal or culinary herb. The entire flower heads or the petals alone are used. An Industrial oil may be expressed from the seeds and an absolute oil is obtained from the flowers. Laying chickens may be fed orange calendula flowers to give the egg yolks a deep yellow color. Calendula is a fast-growing annual that is easy to cultivate. It may be direct-seeded in the field and begins to flower in about two months. Harvest of calendula is time-consuming because the flowers form over a long period of time and individual flowers mature quickly. Over-mature flowers are undesirable in a herbal product. Frequent hand harvest is necessary to obtain the highest quality

product, but some mechanization of harvest may be possible for a lower-grade product or for seed for industrial use Singh et al., (2019) It's also been utilized for therapeutic purposes. Its cultivation is aided not just by the pharmaceutical industry, but also by the rapidly expanding cosmetics industry. The pharmaceutical industry either employs ligulate florets (Flores Calendulae) or entire composite calendula flowers (Flores Calandulae con Calycibus), which are rich orange in colour and have a distinct aroma and bitter in taste. Calendula plant material contains a wide range of active substances, including essential oil, triterpene saponins (calendulosides), flavonoids, carotenoids, saponins, polyacetylenes, sterols, carbohydrates, vitamin C, mucilages and minerals, such as manganese, making it a valuable source of pharmaceutical and medical preparations. In India, China, Europe and the United States, it is one of the most widely utilised medicinal plants. It is widely grown as an ornamental in the world (particularly in southern and eastern Europe) as well as in India.

Calendula is a winter season crop which is grown extensively in beds, baskets, and boxes. The word “calendula” has been derived from Latin word kalendae, meaning first day of the month. Calendula has long flowering period. Bearing large yellow or orange flowers with many petals, this herb is also grown as a common garden plant. The fruit is a thorny curved achene. Calendula is used to treat a variety of skin diseases and is seen effective in treatment of skin ulcerations and eczema. Taken internally through tea, it is used for treatment of stomach ulcers. Calendula is effective in treating juvenile acne and dry psoriasis .

2. MATERIALS AND METHODS

The present investigation ‘Differential effect of different methods of applying Paclobutrazol on Calendula in Prayagraj climatic condition” was conducted at Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Sciences, during the year 20222023. The details of materials used and techniques employed during the course of studies are being described in this.

Table 1- Treatment details

Treatments No.	Treatment
T_0	No Treatment
T_1	Paclobutrazol@ 50 ppm as Foliar application
T_2	Paclobutrazol@ 100 ppm as Foliar application
T_3	Paclobutrazol@ 150 ppm as Foliar application
T_4	Paclobutrazol@ 200 ppm as Foliar application
T_5	Paclobutrazol@ 50 ppm as Soil drenching
T_6	Paclobutrazol@ 100 ppm as Soil drenching
T_7	Paclobutrazol@ 150 ppm as Soil drenching
T_8	Paclobutrazol@ 200 ppm as Soil drenching

3. RESULTS AND DISCUSSION

The result of the experiment has been presented under the following heading –

A. Vegetative Growth Parameters: The vegetative growth parameters of Calendula (Calendula officinalis L.) were assessed to evaluate the effect of different methods of applying

paclobutrazol. The treatments included soil application and foliar application of paclobutrazol, and the experiment followed a complete randomized block design with three replications. Plant height was significantly influenced by the treatments of paclobutrazol applied through soil and foliar application. Soil drenching with paclobutrazol at a concentration of 200 ppm resulted in the minimum increase in plant height, measuring 22.74 cm at 60 days after transplanting (DAT). The treatment methods of paclobutrazol application also had a significant impact on plant spread (N-S to E-W). The foliar application of paclobutrazol at a concentration of 200 ppm led to the minimum increase in plant spread, measuring 19.51 cm at 60 DAT. The number of branches per plant showed a significant difference among the various treatments of paclobutrazol application. Soil drenching with paclobutrazol at a concentration of 200 ppm resulted in the maximum increase in the number of branches per plant, reaching 28.21 at 60 DAT. Similarly, the number of leaves per plant exhibited a significant difference among the treatment methods of paclobutrazol application. The foliar application of paclobutrazol at a concentration of 150 ppm resulted in the maximum increase in the number of leaves per plant, reaching 195.57 at 60 DAT. Overall, these results demonstrate that the different methods of applying paclobutrazol have a significant influence on the vegetative growth parameters of Calendula. The findings suggest that paclobutrazol, especially when applied through soil drenching at a concentration of 200 ppm and foliar application at 150 ppm, can effectively enhance plant height, plant spread, number of branches per plant, and number of leaves per plant. These findings provide valuable insights into the cultivation and management practices of Calendula to optimize its vegetative growth.

B. Flowering parameters: The flowering parameters of Calendula (Calendula officinalis L.) were assessed to examine the impact of different methods of applying paclobutrazol. The treatments included soil application and foliar application of paclobutrazol, and the experiment followed a complete randomized block design with three replications. The days to first bud emergence and days to first flowering showed significant differences among the treatment methods of paclobutrazol application. Soil drenching with paclobutrazol at a concentration of 200 ppm resulted in the minimum number of days to first bud emergence (40.33) and first flowering (46.11). Furthermore, the days to 50% flowering exhibited significant differences among the various treatments of paclobutrazol application. Soil drenching with paclobutrazol at a concentration of 200 ppm exhibited the minimum number of days to 50% flowering, which was recorded as 52.35. The flower weight, flower diameter, number of flowers per plant, and flower yield also displayed significant differences among the treatments of paclobutrazol

application. Soil drenching with paclobutrazol at a concentration of 200 ppm resulted in the minimum flower weight (3.84 g), flower diameter (6.44 cm), number of flowers per plant (101.78), and flower yield (655.85 g). These findings indicate that the different methods of applying paclobutrazol have a notable influence on the flowering parameters of Calendula. Specifically, soil drenching with paclobutrazol at a concentration of 200 ppm demonstrated favourable effects on the timing and quality of flowering. It resulted in early bud emergence and flowering, as well as smaller but higher-yielding flowers. These outcomes provide valuable insights for the cultivation and management practices of Calendula, emphasizing the potential of paclobutrazol application to enhance flowering performance.

C. Yield Parameters: Calendula (Calendula officinalis L.) were assessed to evaluate the impact of different methods of applying paclobutrazol. The treatments included soil application and foliar application of paclobutrazol, and the experiment followed a complete randomized block design with three replications. The flower yield showed significant differences among the treatments of paclobutrazol application. Soil drenching with paclobutrazol at a concentration of 200 ppm resulted in the minimum flower yield, measuring 655.85 grams. Additionally, the number of flowers per plant displayed significant differences among the various treatments of paclobutrazol application. Soil drenching with paclobutrazol at a concentration of 200 ppm resulted in the minimum number of flowers per plant, totalling 101.78. These findings highlight the influence of different methods of paclobutrazol application on the yield parameters of Calendula. Specifically, soil drenching with paclobutrazol at a concentration of 200 ppm resulted in lower flower yield and a reduced number of flowers per plant. These results suggest that paclobutrazol application may have an inhibitory effect on the yield potential of Calendula, particularly when applied through soil drenching. Further research and optimization of paclobutrazol application methods are necessary to determine the most effective approach for maximizing flower yield in Calendula cultivation.

D. Economics of Cultivation: The economic aspects of cultivating Calendula (Calendula officinalis L.) were evaluated to understand the cost-effectiveness of different methods of applying paclobutrazol. The treatments included soil application and foliar application of paclobutrazol, and the experiment followed a complete randomized block design with three replications. The benefit-cost ratio was calculated to assess the economic viability of the different treatments. The treatment of paclobutrazol at a concentration of 200 ppm applied through soil drenching exhibited the maximum benefit-cost ratio, with a value of 1:1.87. This

indicates that for every unit of cost incurred in implementing this treatment, a return of 1.87 units of benefit was obtained. These findings suggest that the application of paclobutrazol, specifically at a concentration of 200 ppm through soil drenching, can be economically advantageous for Calendula cultivation. The higher benefit-cost ratio indicates a favourable return on investment, implying that the potential benefits outweigh the costs associated with implementing this treatment. Considering the economic factors in Calendula cultivation is crucial for growers and stakeholders. The results of this study highlight the potential economic benefits of using paclobutrazol, particularly through soil drenching at the specified concentration. However, it is important to note that economic evaluations may vary depending on factors such as market prices, production costs, and local conditions. Further research and field trials are recommended to validate and optimize the economic feasibility of paclobutrazol application in Calendula cultivation.

Table 2 – Effect of different Level of Paclobutrazol on Vegetative Growth Parameters Of Calendula (Calendula Officinalis L.)

Treatment **Plant Height (Cm)** ***Plant spread (Cm) No. of Branches /Plant No. of Leaves/Plants symbol***

	30DAT	**45DAT**	**60DAT**	**30DAT**	**45DAT**	**60DAT**	**30DAT**	**45DAT**	**60DAT**	**30DAT**	**45DAT**	**60DAT**
T0	23.75	26.32	30.4	10.24	15.78	19.51	1.02	5.76	19.8	29.65	165.34	195.6
T1	22.75	23.85	25.11	10.66	17.99	20.56	1.13	6.14	21.1	34.27	196.73	216.8
T2	22.51	23.26	24.88	12.1	18.44	21.77	1.64	6.87	21.7	32.97	194.41	213.3
T3	21.47	22.27	23.61	12.21	20.18	24.16	1.93	7.3	24.2	32.83	184.31	196.4
T4	21.21	21.82	23.14	12.64	20.68	27.31	2.18	7.47	27.1	39.85	216.32	232.4
T5	22.66	23.77	24.97	12.75	20.42	25.88	1.28	6.35	21.8	30.2	178.59	202.9
T6	22.19	23.48	24.28	12.34	18.95	23.36	1.75	7.13	23.3	34.75	201.89	222.8
T7	21.44	22.18	23.44	13.22	20.68	27.31	2.06	7.58	25.9	37.22	209.44	226.7
T8	20.55	21.54	22.74	13.54	21.07	28.36	2.45	7.79	28.2	44.06	218.12	235.7
	S	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**

F-test	**0.116**	**0.478**	**0.248**	**0.115**	**0.514**	**0.595**	**0.071**	**0.225**	**0.42**	**0.919**	**1.801**	**2.449**
S.Ed. (±)												
C.D. at 0.5	**0.247**	**1.013**	**0.526**	**0.244**	**1.09**	**1.262**	**0.151**	**0.477**	**0.89**	**1.948**	**3.817**	**5.191**

Table 3 – Effect of different Level of Paclobutrazol on earliness of flowering, flower yield and Benefit cost ratio of Calendula (Calendula officinalis L.)

Treatment	*Days to first emergence*	*Days to first flower bud*	*Days to 50% flowering*	*Flower diameter (g)*	*Flower weight*	*Number of flower/Plant*	*Net return*	*Cost yield (g)*	*Symbol*	*Benefit Ratio*
T0	46.78	56.41	56.41	60.57	2.24	4.66	75.68	352.86	162.72	1.16
T1	44.88	52.21	52.21	58.14	2.81	5.22	86.31	450.26	203.14	1.43
T2	43.08	49.5	49.5	56.42	3.11	5.54	93.55	518.6	232.1	1.63
T3	43.57	48.95	48.95	54.58	3.43	6.02	95.91	577.68	241.54	1.7
T4	41.66	47.18	47.18	53.17	3.74	6.23	97.86	609.98	249.34	1.75
T5	44.5	50.1	50.1	57.31	3.05	5.39	91.71	493.98	224.74	1.58
T6	43.8	49.12	49.12	56.3	3.22	5.79	95.13	550.82	238.42	1.68
T7	41.98	48.57	48.57	54.09	3.55	6.09	96.35	587.1	243.3	1.71
T8	40.33	46.11	46.11	52.35	3.84	6.44	101.78	655.85	265.02	1.87
F-Test	**S**	**S**	**S**	S	S	S	S	S		
S.Ed. (±)	**0.665**	**0.333**	**0.333**	0.502	0.045	0.149	1.851	19.423		
C.D. at 0.5	**1.409**	**0.706**	**0.706**	0.237	0.095	0.07	0.873	9.162		

4.CONCLUSION

The result for growth and flower yield of Calendula (*Calendula officinalis* L.) showed significant difference for the various treatment applied as soil application as a paclobutrazol as well as foliar application. In general paclobutrazol@ 200 ppm as Soil drenching and foliar application improved the different growth and flower yield parameters suggest its efficacy of application. Where as the maximum benefit cost ratio (1:1.87) was found in treatment Paclobutrazol@ 200 ppm as Soil drenching.

REFERENCE

Chaney WR (2005). Growth retardants: A promising tool for managing urban trees. Purdue Extension document FNR-252-W; 2005.

Carey, D., B. Whipker, I. McCall, and W. Buhler. (2008). Cytokinin based PGR affects growth of vegetative petunia. *PGRSA.* 94-98.

Sibel Mansuroglu, Osman Karaguzel, Veli Ortacesme And M. Selcuk sayan (2009) Effect of paclobutrazol on flowering, leaf and flower colour of consolida orientalis. Pak. j. bot., 41(5): 2323-2332

Baloch, J.U.D., M. Munir, N.U. Khan, and S. Gul. (2013). Plant growth regulators and noninductive plant environment effect on growth and plant height of facultative long day ornamental annuals. *Sarhad J. Agr.* 29:351-357.

Singh Joginder, Nigam Rashmi, Singh Rajendra, Kumar Anant and Kumar Ashwani (2018). Effect of gibberellic acid and cycocel on growth, flowering and yield of chrysanthemum (Dendranthema grandiflora ramat) cv. birbal sahni. Journal of Pharmacognosy and Phytochemistry SP1: 2753-2758

Jasmina BALIJAGIĆ, Jovan CRNOBARAC, Miodrag JOVANČEVIĆ, Irfan MUJANOVIĆ, (2018).THE EFFECT OF VARIETY AND PLANT DENSITY ON POTMARIGOLD FLOWER YIELD(Calendula officinalis L.) IN AGRO-ECOLOGICAL CONDITIONS OF BIJELO POLJE. Agriculture& Forestry, Vol. 64 Issue 1: 113-120. DOI: https://doi.org/10.17707/AgricultForest.64.1.14

Singh Sanjay, Deepanshu and Urfi Fatmi (2019). Effect of micro-nutrients on plant growth and flower yield of calendula (Calendula officinalis L.) cv. Doppiounder Prayagraj agro-climatic condition. The Pharma Innovation Journal 8(7): 137-140

Ulfa F, Haring F, Kanisa M, Amin A R, Kasim N and Farid M BDR (2020). Flowering of Chrysanthemum sp. in pot at various concentrations of corn extract and paclobutrazol. IOP Conf. Series: Earth and Environmental Science 486 (2020) 012138 Varun Chauhan, Mamta Bohra, Rohan Tomar and Neha Dobhal. (2021). Effect of Paclobutrazol and Daminozide on Floral Attributes of Chrysanthemum (Dendranthema grandiflora Tzvelve). Int.J.Curr.Microbiol.App.Sci. 10(02): 2754-2759

Deogade A. S., Ningot E. P., Thakare A. A., Ingole A. R. and Dahale M. H. (2020). Effect of potting mixture and pot size on growth and flowering of calendula. *Journal of Pharmacognosy and Phytochemistry* 9(6): 1147-1151

Chauhan Varun, Bohra Mamta, Tomar Rohan and Dobhal Neha (2021). Effect of paclobutrazol and daminozide on vegetative attributes of chrysanthemum (*Dendranthema grandiflora* Tzvelve). *Journal of Pharmacognosy and Phytochemistry* 10(1): 2325-2327

Chauhan Varun, Bohra Mamta, Tomar Rohan and Dobhal Neha. (2021). Effect of Paclobutrazol and Daminozide on Floral Attributes of Chrysanthemum (*Dendranthema grandiflora* Tzvelve). *Int.J.Curr.Microbiol.App.Sci.* 10(02): 2754-2759.

Malik K.M., Wani A.H.and Nazki I.T. (2021). Effect of growth retardants on growth, flowering and bulb yield of Asiatic Lilium. International Journal of Scientific and Research Publications, Volume 11, Issue 4, April 2021

Maretha Widhya Aulyaa Gusmawan, Sitawati, Anna Satyana Karyawati, (2022). The Effect of Paclobutrazol Concentrations in Different Shade Levels on Coleus Plant Leaves Color. Jurnal Teknik Pertanian Lampung Vol 11, No. 4 (2022) : 647-657. DOI : http://dx.doi.org/10.23960/jtep-l.v11i4.647-657

Yanqing Wu, Jiao Liu, Daqiu Zhao and Jun Tao. (2022). Effect of Paclobutrazol Application on Plant Growth and Flower Quality in Herbaceous Peony. Phyton-International Journal of Experimental Botany.

UNDER PEER REVIEW