Research Article

Effect of Pigments, Phenol Content and Postharvest Life on Application of Plant Growth Retardants in *Celosia* Spp.

Aparna Srinivasan[1]*, K.R. Rajadurai[2], S.P. Thamarai Selvi[1] and P. Jeyakumar[3]

[1]Department of Floriculture and Landscaping, Tamil Nadu Agricultural University, Coimbatore -03
[2]Regional Research Station, Kovilangulam, Aruppukottai, 626 107
[3]Department of Crop physiology, Tamil Nadu Agricultural University, Coimbatore -03

Abstract

A field experiment was conducted during November 2014 to May 2015 in *Celosia spp.* to identify the effect of pigments and postharvest life on application of plant growth retardants for enhanced growth and yield in RBD. The treatment comprises of three different growth retardants with concentrations *viz*., chlormequat chloride (500 ppm, 1000 ppm and 1500 ppm), paclobutrazol (40 ppm, 60 ppm and 80 ppm) and daminozide (1000 ppm, 2000 ppm and 3000 ppm). Pigments were extracted to assess the influence of growth retardants. Among the treatments, T_4 (chlormequat chloride @ 1000 ppm) improved in respect of chlorophyll content *viz*., total chlorophyll (1.37 mg g^{-1}), carotenoid content (0.86 mg g^{-1}), betalain pigment (358.65 mg 100^{-1} g), phenol content (34.50 mg g^{-1}), shelf life under ambient condition (4.50 days) and shelf life under cold storage 4°C (10.20 days).

Keywords: *Celosia* spp., foliar spray, CCC, paclobutrazol, daminozide

***Correspondence**
Author: Aparna Srinivasan
Email: aparna3@outlook.com

Introduction

The genus *Celosia* is derived from the Greek word kelos, meaning "burned" and refers to flame-like flower heads and belong to the family Amaranthaceae [1]. Number of plants from this family is known for their vibrant coloured inflorescence and dazzling beauty. There are around 60 species in this genus of which *Celosia cristata*, *C. plumosa*, *C. spicata* are grown and found to be of commercial importance for the development of landscapes in various western countries. Besides developing landscape, plenty of medicinal qualities are derived from the plant with promising activity. Recently pigments find great attention for their usefulness, not only in the food and cosmetic industries but also in nutraceutical and pharmaceutical developments [2]. Since there is a rising demand for natural sources of food colourants with nutraceutical benefits, alternative sources of natural betalains are becoming increasingly important. Demand for loose flowers is increasing day by day due to its presence in religious and social functions. Among the loose flowers, *Celosia* occupies a major place in garland making. Apart from promoting yield attributes, present study aims in studying the effect of plant growth retardants on pigment enhancement and owing to its great demand as a loose flower its effect on shelf life is also studied.

Experimental

An experiment was carried out at the Botanical Garden, Department of Floriculture and landscaping, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore during the period of November 2014 to May 2015 to study the response of different levels of plant growth retardants on enhancement of pigments in *Celosia spp.* The experiment was laid out in Randomized Block Design (RBD) and replicated thrice. The experiment consisted of 11 treatments T_1 - control (no pinching and no chemical spray), T_2 – pinching, T_3 – chlormequat chloride @ 500 ppm T_4 - chlormequat chloride @ 1000 ppm, T_5 - chlormequat chloride @ 1500 ppm, T_6 - paclobutrazol @ 40 ppm, T_7 - paclobutrazol @ 60 ppm, T_8 - paclobutrazol @ 80 ppm, T_9 - daminozide @ 1000 ppm, T_{10} - daminozide @ 2000 ppm, T_{11} - daminozide @ 3000 ppm. Thirty days old seedlings were transplanted to the main field. Foliar spray was given once at 15 days after transplanting as per treatment along with control. The plot size of each treatment was 3.5 x 3.5 m with spacing of 30 x 45 cm. Monocrotophos 36 WSC @ 2ml/litre was sprayed at vegetative stage (35 DAP) as a preventive measure against sucking pests. Observations were recorded for phenol content, chlorophyll, carotenoid and betalain pigment on 30 and 45 days after transplanting. Data were statistically analysed using AGRES and presented in the tables.

Results and Discussion

The physiological parameters directly indicate the efficiency of the plant in terms of yield. Chlorophyll, the pigment responsible for harvesting solar energy and converting into chemical energy, exhibit a differential pattern in its accumulation in plants.

Chlorophyll content (mg g^{-1})

Among the treatments, after 30 days of transplanting chlorophyll 'a' content was found to be maximum (1.11 mg g^{-1}) in the treatment T_4 (chlormequat chloride @ 1000 ppm) while the lowest chlorophyll 'a' content of 0.42 mg g^{-1} was recorded in the control. At 45 days, the maximum chlorophyll 'a' content was found in T_4 and T_8 (paclobutrazol @ 80 ppm) with 1.01 and1.00 mg g^{-1} respectively and were on par with each other (**Table 1**). After 30 days of transplanting, chlorophyll 'b' content was found to be maximum (0.44 mg g^{-1}) in the treatment T_4. Minimum chlorophyll 'b' content was recorded in T_1 (control) with 0.13mg g^{-1}. At 45 days, the maximum chlorophyll 'b' content (0.44 mg g^{-1}) was found in T_4. Treatments T_1(control) and T_2 (pinching) were found to be on par with each other and recorded the lowest chlorophyll 'b' content of 0.13 and 0.16mg g^{-1} respectively (Table 1).

Table 1 Effect of pinching and plant growth retardants on chlorophyll (a) (mg g^{-1}) and chlorophyll (b) (mg g^{-1}) at 30 and 45 DAP in *Celosia* spp.

Treatment Details		Chlorophyll (a)		Chlorophyll (b)	
		30 DAP (mg g^{-1})	45 DAP (mg g^{-1})	30 DAP (mg g^{-1})	45 DAP (mg g^{-1})
T_1	No pinching and no chemical spray (control)	0.42	0.06	0.13	0.13
T_2	Pinching	0.46	0.17	0.16	0.16
T_3	Chlormequat chloride @ 500 ppm	1.04	0.50	0.29	0.29
T_4	Chlormequat chloride @ 1000 ppm	1.11	1.01	0.44	0.44
T_5	Chlormequat chloride @ 1500 ppm	1.06	0.72	0.32	0.32
T_6	Paclobutrazol @ 40 ppm	0.83	0.35	0.27	0.27
T_7	Paclobutrazol @ 60 ppm	0.94	0.43	0.27	0.27
T_8	Paclobutrazol @ 80 ppm	1.00	1.00	0.29	0.29
T_9	Daminozide @ 1000 ppm	0.70	0.20	0.24	0.24
T_{10}	Daminozide @ 2000 ppm	0.74	0.22	0.24	0.24
T_{11}	Daminozide @ 3000 ppm	0.81	0.30	0.25	0.25
Mean		0.83	0.45	0.26	0.64
SEd		0.01	0.01	0.03	0.03
CD @ 0.05 %		0.02*	0.02*	0.07*	0.07*

* Significant @ CD (0.05 %)

In case of total chlorophyll content, after 30 days of transplanting maximum content was found to be (1.50 mg g^{-1}) in the treatment T_4. Minimum total chlorophyll content was recorded in control with 0.54 mg g^{-1}. Similar trend of results were obtained during 45th day.

In the present study, high total chlorophyll content was found in treatment chlormequat chloride @ 1000 ppm. Similarly chlorophyll content increased with the application of chlormequat chloride in faba bean (*Vicia faba* L.)[3]. Results have been reported that cycocel improves the translocation of photosynthates in (*Brassica napus)*[4]. The effect of cycocel in increasing total chlorophyll contents may be due to reduction in cell size resulting in dense cytoplasm in the cells [5]. The total chlorophyll content in leaves of *Celosia* spp. under cycocel treatment was found to be stimulatory with respect to control which may be due to the stimulating effect of cycocel towards intensifying the green colour of foliage [6]. Similar results were obtained in sunflower [7] and [8] have a positive and significant role in increasing the chlorophyll level by using growth retardants. Plant growth retardants increase cytokinin which also enhances chlorophyll content of the leaf [9].

Carotenoid (mg g^{-1})

The treatment T_4 recorded the highest carotenoid content (0.49 mg g^{-1}) during 30 DAP when compared to all other treatments. The treatment T_1 (control) recorded the lowest carotenoid content with 0.18 mg g^{-1}. After 45 days of transplanting, the maximum carotenoid content (0.86 mg g^{-1}) was found in T_4. Control recorded the lowest carotenoid

content 0.18 mg g^{-1}. In the present study, carotenoid content was found maximum in the treatment chlormequat chloride @ 1000 ppm (**Table 2**). CCC had stimulated the vegetative growth and hence has caused an increased accumulation of metabolic components especially carbohydrates such as chlorophyll and carotene. Similar results were coherent in *Solidago canadensis* L.cv. "Tara"[10].

Table 2 Effect of pinching and plant growth retardants on carotenoid content (mg g^{-1}), total phenol content (mg g^{-1}), betalain pigment content (mg 100^{-1} g) and shelf life (days) at different growth stages in *Celosia* spp.

Treatment Details	Carotenoid		Total phenol content (mg g^{-1})	Betalain pigment (mg 100^{-1} g)	Shelf life (days)	
	30 DAP (mg g^{-1})	45 DAP (mg g^{-1})			Ambient condition	Cold storage (4°C)
T_1	0.18	0.18	1.05	182.23	2.05	6.56
T_2	0.19	0.29	2.00	213.03	2.50	7.02
T_3	0.42	0.51	32.50	299.89	4.40	9.02
T_4	0.49	0.86	34.50	358.65	4.50	10.20
T_5	0.43	0.81	33.00	325.55	4.50	9.50
T_6	0.36	0.43	20.50	287.88	3.20	8.20
T_7	0.37	0.44	23.00	289.62	4.01	8.50
T_8	0.39	0.49	25.00	291.50	4.20	8.90
T_9	0.29	0.32	11.50	219.22	3.20	7.20
T_{10}	0.34	0.35	17.00	262.75	3.40	7.50
T_{11}	0.35	0.39	20.00	274.18	3.50	7.90
Mean	0.35	0.46	20.00	272.86	3.59	8.23
SEd	0.003	0.008	0.48	1.83	0.03	0.05
CD @ 0.05 %	0.007*	0.017*	0.99*	3.81*	0.06*	0.10*

* Significant @ CD (0.05 %)

Total phenol content (mg g^{-1})

Among the treatments, the total phenol content was found maximum (34.50 mg g^{-1}) in the treatment T_4 which showed significant difference when compared to all other treatments. Control recorded the lowest total phenol content of 1.05 mg g^{-1} (Table 2). Total phenol content is an indicator of resistance against pest and diseases in crop plants. In the present study, phenol content was recorded maximum in the treatment chlormequat chloride @ 1000 ppm. Antigiberellic nature of growth retardant cycocel might have promoted enhanced level of total phenolics in leaves of *Celosia* spp. Results were in conformity with earlier reports in mustard leaves [11].

Betalain pigment content (mg 100^{-1} g)

The maximum betalain pigment content (358.65 mg 100^{-1} g) was found to be highly significant in the treatment T_4 when compared to all other treatments. This was followed by T_5 (chlormequat chloride @ 1500 ppm) with 325.55 mg 100^{-1} g. Control recorded the lowest betalain pigment of 182.23 mg 100^{-1} g (Table 2). Betalain pigment content showed higher significance by application of plant growth retardants. Betalain pigment was higher in plants treated with chlormequat chloride @ 1000 ppm. In *Calendula officinalis* plants treated with chlormequat chloride increased carotenoid pigment [12]. Plant growth retardants increase cytokinins synthesis and thereby enhance the content of pigments in plants [13].

Shelf life (days)

In Shelf life under ambient condition, the treatments T_4 and T_5 recorded a maximum shelf life of 4.50 days when compared to all other treatments. T_1 (control) recorded the lowest shelf life of 2.05 days (Table 2). Under cold storage at 4°C, the treatment, T_4 recorded a maximum shelf life of 10.20 days when compared to all other treatments. The treatment T_1 (control) recorded the lowest shelf life of 6.56 days (Table 2). Shelf life of *Celosia* flowers both under ambient and cold conditions exhibited marked significance due to pinching and foliar spray of plant growth retardants. Maximum shelf life of flowers under ambient condition was recorded in the treatments with chlormequat chloride @ 1000 ppm. Increased shelf life of flowers may be due to reduced physiological loss in weight (PLW) and more water uptake by CCC treated flowers. Restricted respiration due to inhibitory action of retardant might also have

increased the shelf life. Similar results were obtained in *Tagetes erecta* cv. 'Double orange' [14] and *Tagetes erecta* L. var. Pusa Narangi Gainda [15].

Cycocel increased the duration of flowering and vase life of flowers by maintaining the levels of chlorophyll, protein and RNA content of leaves at higher levels for longer duration and in turn delays senescence [16]. Postharvest quality of *Solidago* inflorescence is improved by using CCC which plays role on maintaining water balance and thereby fresh weight of the flower increases [17]. Further higher accumulation of carbohydrates in stem and leaves might have consequently increased the vase life [18].

Conclusion

The results of the experiment carried out to study the effect of plant growth retardants indicated that, foliar spray of chlormequat chloride @ 1000 ppm enhanced the pigment synthesis, phenol content and shelf life thereby had a profound effect in quality of *Celosia* spp.

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