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EFFICACY OF BIOSTIMULANTS ON PHYSIOLOGY OF CHRYSANTHEMUM (*DENDRANTHEMA GRANDIFLORA* TZVELEV.) CV. KOLAR LOCAL UNDER NATURALLY VENTILATED POLYHOUSE

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ABSTRACT

Studies on efficacy of biostimulants on physiology of chrysanthemum under naturally ventilated polyhouse were carried out at department of Floriculture and Landscape Architecture, College of Horticulture, Mudigere during 2015-16. Rooted terminal cuttings of chrysanthem cv. Kolar Local were taken for the study. 12 biostimulant formulations in 2 different concentrations were taken as a foliar spray at 60, 90 and 120 days after planting along with RDF. The treatment receiving only RDF was taken as control. The results revealed that among the biostimulants treatment receiving Biovita (Brown sea weed extract) @ 0.5 per cent proved the best as compared to other treatments.

INTRODUCTION

Chrysanthemum (*Dendranthema grandiflora* Tzvelev.) is one of the most interesting and oldest flower crops which belong to the family, Asteraceae, one of the largest families of flowering plants and ranks next to rose and carnation in demand and popularity in the world. The diploid chromosome number is 2n = 36. With respect to the photoperiodism chrysanthemum is a short day plant. There are very few such garden flowers, which provide diverse and beautiful variations in colour, shape, size and configuration. All these make the chrysanthemum flower suitable for various purposes like bedding plant, vase decorations, garland making and for garden display. At present, wide spread requirement for environment friendly agriculture for the production of quality flowers is in high demand. Efforts are underway for the sustainable way of crop production with organic fertilizers and biostimulants from natural resources to enhance the production of commercially important flower crops. The use of biostimulants, which has the capacity to beneficially modify plant growth, has grown dramatically over the past decade.

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Bio stimulants are the materials other than the fertilizers that promote the plant growth when applied in minute quantities and are also referred as 'metabolic enhancers'. They promote the plant growth besides improving yield and quality. There are hundreds of biostimulant products available in market for agriculture and horticulture crops, but in chrysanthemum, being a valuable flower crop in the international market, there are little, unnoticed works on biostimulants. So, it is the major area to be concerned in order to improve the yield and quality of the flowers without any impacts on environment.

MATERIALS AND METHODS

An experiment was undertaken under naturally ventilated polyhouse condition during 2015-16 at College of Horticulture, Mudigere, Chikkamagaluru, Karnataka. The soil was prepared to fine tilth and raised beds of 3m X 1m were prepared under polyhouse condition. Rooted terminal cuttings of chrysanthemum Cv. Kolar Local (yellow) were planted at a spacing of 30 cm X 30 cm. The experiment was laid out in Randomized complete block design with 25 treatments and two replications. Treatments included T_1 – Control, T_2 – Humigrow (Humic acid) @ 0.3% , T_3 – Humigrow @ 0.5% , T_4 – Fulvic acid @ 0.3%, T_5 – Fulvic acid @ 0.5%, T_6 –

Panchagavya @ 0.3%, T_7 – Panchagavya @ 0.5%, T_8 – Jeevamruta @ 0.3%, T_9 – Jeevamruta @ 0.5%, T_{10} – Amruta Sanjeevini (lipoprotein + Humic acid)@ 0.3%, T_{11} – Amruta sanjeevini @ 0.5%, T_{12} – Zoom flower (Nitro benzene) @ 0.3 % ,T_{13} – Zoom flower @ 0.5%, T_{14} – Biovita (Sea Weed Extract) @ 0.3 %, T_{15} – Biovita @ 0.5%, T_{16} – Spicmex (Amino acid + Humic acid) @ 0.3%, T_{17} – Spicmex @ 0.5%, T_{18} – Neozyme @ 0.3%, T_{19} – Neozyme (Sea Weed Extract+ Amino Acid)@ 0.5%, T_{20} – Swara (Amino Acid, Nicotinic acid, Vit $B_1B_6B_7$) @ 0.3%, T_{21}- Swara @ 0.5%, T_{22} – Humicel plus (Humic Acid + Fulvic Acid+ Sea Weed Extract) @ 0.3%, T_{23} – Humicel plus @ 0.5%, T_{24} – Formula 15 (Humic Acid + Fulvic Acid + Amino acid) @ 0.3%, T_{25} – Formula 15 @ 0.5%. These biostimulants were sprayed on the foliage at 3 intervals *i.e* @ 60, 90 and 120 days after planting (DAP). Following physiological parameters were recorded and they were statistically analysed.

a. Leaf area

The leaf area was computed by using leaf area meter and expressed in square centimeters.

b. Leaf area index (LAI)

Leaf area index is the leaf area occupied per unit land area. It was computed using the formula suggested by Sestak *et al.* (1971).

$$LAI = A/P$$

Where, A = Leaf area
P = Ground area covered by plant or spacing provided

c. Leaf area duration (LAD)

Leaf area duration is the integration of Leaf area index over a period of time or a growing season expressed in days.

$$\text{Leaf area duration} = \frac{L_i + (L_{(i+1)})}{2} \times (t_2 - t_1)$$

Where, Li = Leaf area index at first stage
$L_{(i+1)}$ = Leaf area index at second stage
$t_2 - t_1$ = Time interval between i^{th} and $(i+1)^{th}$ stage (day)

d. Crop growth rate (CGR)

Crop growth rate is the rate of dry matter production per unit ground area per unit time (Watson, 1952). It was calculated using the formula,

$$CGR = \frac{(W_2 - W_1)}{(t_2 - t_1)} \times \frac{1}{A} \quad mg/m^2/day$$

Where,
W_1 = Dry weight of the plant at time t_1
W_2 = Dry weight of the plant at time t_2
A = Land area (Spacing)

e. Relative growth rate (RGR)

Relative growth rate is the measure of the ability of the plant to produce newer plant materials and it is also called Efficiency Index. It was calculated as,

$$RGR = \frac{(\log_e W2 - \log_e W1)}{(t_2 - t_1)} \quad mg/g/day$$

Where,
W_1 = Dry weight of the plant at time t_1
W_2 = Dry weight of the plant at time t_2

f. Net assimilation rate (NAR)

Net assimilation rate is the rate of dry matter production per unit leaf area per unit time. It was calculated by the formula outlined by Gregory (1926)

$$NAR = \frac{(W_2 - W_1)}{(t_2 - t_1)} \times \frac{(\log_e L_2 - \log_e L_1)}{(L_2 - L_1)} \quad mg/dm^2/day$$

Where L_1 and W_1 = Leaf area (m^2) and dry weight of the plant (g) respectively at time t_1
L_2 and W_2 = Leaf area (m^2) and dry weight of the plant (g) respectively at time t_2

RESULTS AND DISCUSSION

The data pertaining to physiological parameters are presented in Table 1-2. All the parameters varied significantly by the foliar application of biostimulants. Dry matter production is a function of two parameters the leaf area or quantum of the photosynthetic system and its activity. Among different treatments Biovita @ 0.5 per cent registered maximum Total dry matter accumulation per plant (53.45 g) which was statistically on par with Humicel plus @ 0.5 per cent and Formula 15 @ 0.5 per cent. While, minimum was recorded by control. An increase in total dry matter accumulation in Biovita sprayed plants might be due to the increased nutrient uptake by the sea weed extract sprayed plants and also due to the presence of macro and micro nutrients and also growth promoting substances which leads to vigorous growth of roots, shoots, leaves and flowers. This is in conformity with the report that stronger root system and efficient absorption of nutrients have been implicated to increase the food reserves in plant resulting in higher dry matter production and accumulation in different plant parts (Neil Mattson, 2015). Regarding the leaf area per plant, Biovita applied @ 0.5 per cent registered maximum (5269.91 cm^2) and was followed by Humicel plus @ 0.5 per cent and Formula 15 @ 0.5 per cent. This is because; the foliar application of sea weed extracts might have enhanced the cytokinin level and thereby cause manifold increase in cell division resulting in enhanced leaf area. It is also due to improved nutrient absorption capacity and increased the photosynthetic activity of the plants. These are in line with the results of research work done by Dhutiraj *et al*. (2003) in gaillardia and Khan *et al*. (2009). The magnitude of photosynthetic ability of the crop is more meaningfully interpreted in terms of leaf area index and leaf area duration.

Table 1. Efficacy of biostimulants on total dry matter accumulation, leaf area, leaf area index and leaf area duration of chrysanthemum under naturally ventilated polyhouse

Treatment	Concentration (%)	Total dry matter accumulation (g/ plant)	Leaf area (cm^2)	Leaf area index (LAI)	Leaf area duration (days)
T_1 - Control (RDF)	-	36.05	471.04	2.74	56.48
T_2 - Humigrow	0.3	44.35	3503.36	3.89	82.43
T_3 - Humigrow	0.5	48.05	4077.78	4.53	97.35
T_4 - Fulvic acid	0.3	42.50	3162.63	3.51	74.25
T_5 - Fulvic acid	0.5	46.95	3914.29	4.35	92.55
T_6 - Panchagavya	0.3	36.60	2627.87	2.92	60.68
T_7 - Panchagavya	0.5	40.10	2968.11	3.29	69.00
T_8 - Jeevamruta	0.3	38.50	2726.67	3.03	65.10
T_9 - Jeevamruta	0.5	42.65	2752.01	3.05	63.68
T_{10} - Amruta sanjeevini	0.3	37.60	3057.17	3.39	74.03
T_{11} - Amruta sanjeevini	0.5	40.48	3083.01	3.42	73.20
T_{12} - Zoom flower	0.3	40.35	2887.10	3.20	67.88
T_{13} - Zoom flower	0.5	43.95	3244.66	3.61	77.93
T_{14} - Biovita	0.3	48.00	4460.65	4.95	106.13
T_{15} - Biovita	0.5	54.37	5269.91	5.27	123.08
T_{16} - Spicmex	0.3	37.42	2698.20	2.97	62.70
T_{17} - Spicmex	0.5	41.25	3123.42	3.47	73.20
T_{18} - Neozyme	0.3	40.65	3191.00	3.54	74.25
T_{19} - Neozyme	0.5	43.65	3519.50	3.91	82.58
T_{20} - Swara	0.3	42.95	3279.78	3.64	76.48
T_{21} - Swara	0.5	44.45	3695.29	4.10	87.68
T_{22} - Humicel plus	0.3	45.90	4251.05	4.72	97.65
T_{23} - Humicel plus	0.5	52.70	5143.99	5.17	122.00
T_{24} - Formula15	0.3	45.85	4188.85	4.65	95.85
T_{25} - Formula 15	0.5	50.95	5029.64	5.13	114.02
S E			1.39	0.14	3.10
CD (5%)			4.05	0.42	9.04

*Note: RDF as a constant for all the treatments

Table 2. Efficacy of biostimulants on crop growth rate (CGR), relative growth rate (RGR) and net assimilation rate (NAR) between 90 and 120days after planting under naturally ventilated polyhouse

Treatment	Concentration (%)	CGR (mg/ m^2/ day)	RGR (mg/ g/ day)	NAR (mg/ dm^2/ day)
T_1 - Control (RDF)	-	71.00	10.50	6.00
T_2 - Humigrow	0.3	89.50	11.85	8.30
T_3 - Humigrow	0.5	97.00	12.25	8.80
T_4 - Fulvic acid	0.3	85.50	11.80	7.80
T_5 - Fulvic acid	0.5	95.00	12.20	8.35
T_6 - Panchagavya	0.3	71.50	11.10	7.60
T_7 - Panchagavya	0.5	82.50	11.25	7.95
T_8 - Jeevamruta	0.3	79.00	11.45	7.80
T_9 - Jeevamruta	0.5	88.00	11.80	8.35
T_{10} - Amruta sanjeevini	0.3	74.50	11.30	7.60
T_{11} - Amruta sanjeevini	0.5	81.00	11.65	8.10
T_{12} - Zoom flower	0.3	79.00	11.50	8.10
T_{13} - Zoom flower	0.5	83.50	11.90	8.20
T_{14} - Biovita	0.3	96.50	12.30	8.70
T_{15} - Biovita	0.5	107.00	13.65	9.40
T_{16} - Spicmex	0.3	73.50	11.40	6.65
T_{17} - Spicmex	0.5	81.00	11.60	7.68
T_{18} - Neozyme	0.3	80.20	11.60	7.65
T_{19} - Neozyme	0.5	84.00	11.90	7.80
T_{20} - Swara	0.3	83.50	11.80	8.40
T_{21} - Swara	0.5	89.00	12.05	8.55
T_{22} - Humicel plus	0.3	87.00	12.15	8.90
T_{23} - Humicel plus	0.5	100.50	12.55	9.3
T_{24} - Formula15	0.3	86.00	11.90	8.30
T_{25} - Formula 15	0.5	99.00	12.45	8.70
SE		4.06	0.40	0.39
CD (5%)		11.86	1.16	1.13

*Note: RDF as a constant for all the treatments

LAI alone is not important but its persistence also governs the productivity which is represented by LAD. Both the parameters were found to be maximum in foliar application of Biovita @ 0.5 per cent (5.27 and 123.08 days, respectively). It might be attributed to the presence of macro and micronutrients and some growth promoting substances in the seaweed extracts which in turn increased photosynthates and growth that could be responsible for the increased leaf area and ultimately leaf area index and duration. These parameters are directly responsible for metabolites required for plant growth and development. The findings are in accordance with the results obtained by Russo *et al.* (1994) in marigold. The crop growth rate (CGR) gives an estimate of productivity of a crop stand per unit land area and the relative growth rate (RGR) is the growth of the plant per day. Among the different biostimulant treatments, plants receiving foliar spray of Biovita @ 0.5 per cent had greater growth rate per unit land area as well as per day (107.00 mg/ m^2/ day and 13.65 g/ g/ day, respectively). The photosynthetic efficiency is measured by net assimilation rate (NAR) which is considered to express a plant's capacity to produce dry weight in terms of its assimilatory surface area. The above growth parameter was also same in the treatment *i.e* Biovita @ 0.5 per cent (9.4 mg/ dm^2 / day). The increased CGR, RGR and NAR may be due to the fact that, sea weed extract mainly contains amino acids like betaines and sterols which enhance the photosynthetic activity, N metabolism and protein synthesis, and also growth regulators especially Auxin and Cytokinin which are responsible for internodal elongation and cell enlargement and there by increases the growth Khan *et al*. (2009).

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