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Effect of biostimulants and biofertilizers on growth and flowering of *Chrysanthemum* cv. Ratlam selection

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Abstract
The present experiment entitled "Effect of biostimulants and biofertilizers on growth and flowering of *Chrysanthemum* cv. Ratlam Selection" was carried out at Jamuvadi Farm, Department of Horticulture, College of Agriculture, Junagadh Agricultural University, Junagadh, during October 2017 to February 2019. The experiment was laid out in Randomized Block Design with Factorial concept (FRBD) consisting two factors with three replications. The treatment comprised with five biostimulants and three treatments of biofertilizers. The results indicated that the foliar application of humic acid @ 0.2% at 60, 90 & 120 DAT with soil drenching of *Azotobacter* @ 3 l/ha + PSB @ 3 l/ha + KSB @ 3 l/ha after transplanting in addition to recommended dose of fertilizers (120:60:60 kg/ha NPK) produced better growth characters viz., the plant height, plant spread (E-W and N-S), number of shoots per plant, fresh weight of plant, dry weight of plant as well as flowering characters viz., initiation of flowering, days to 50% flowering, flowering duration (days), flower stalk length and flower stalk thickness.in *Chrysanthemum* cv. Ratlam Selection.

Keywords: *Chrysanthemum* cv. Ratlam selection, biostimulants and biofertilizers

Introduction
Chrysanthemum (*Chrysanthemum morifolium* Ramat.) is one of the commercially exploited flower crops belongs to the family 'Asteraceae' and referred as "Queen of the East" having diploid chromosome number 2n = 18. The word "*Chrysanthemum*" comes from two Greek words, *Chrysos*-golden and *anthos*-flower which means golden flower. *Chrysanthemum* is native to the northern hemisphere and is widely distributed in Europe and Asia. However, it is believed that, its origin is China (Carter, 1990) [9].

At present, for the increasing flower production, nutrients are supplied through chemical fertilizers. Heavy use of chemicals in agriculture has weakened the ecological base in addition to degradation of soil, water resources and quality. At this juncture, a keen awareness has sprung on the adoption of "organic farming" as a remedy to cure the ills of modern chemical agriculture (Kannaiyan, 2000) [20]. Biostimulants are defined as materials, other than fertilizers, that promote plant growth when applied in small quantities and are also referred to as metabolic enhancers (Zhang and Schmidt, 1997) [41]. While separating fibers from the banana pseudostem, the liquid available is known as sap which contains contained macro elements like, 119 ppm N, 50.4 ppm P, 1289 ppm K and micronutrients like Fe-124 ppm, Mn-6.73 ppm, Cu-4.61 ppm and Zn-0.97 ppm (Gundrashiya, 2013) [17] and also growth promoting substance like, cytokinin- 137.8 mg/l and gibberellic acid- 110.2 mg/l present (Desai, 2018). Seaweed components such as macro and micro element, amino acids, vitamins, cytokinins, auxins, and abscisic acid (ABA)-like growth substances affect cellular metabolism in treated plants leading to enhanced growth and crop yield (Durand *et al*., 2003; Stirk *et al*., 2003) [13, 37]. The liquid contained macronutrients like P- 120 mg/100 g, K- 4170 mg/100 g, Ca- 66.98 mg/100 g and micronutrients like Fe- 147 mg/100 g, Mn- 5.84 mg/100 g, Zn- 9.08 mg/100 g and Cu- 0.36 mg/100 g (Yan *et al.,* 2013) [39]. Panchgavya is a fermented product made from five ingredients obtained from cow, such as milk, urine, dung, curd and clarified butter (Amalraj *et al*., 2013) [2]. Panchgavya contained macro elements like total nitrogen (229 ppm), total phosphorus (209 ppm), total potassium (232 ppm), calcium (25 ppm), IAA (8.5 ppm) and GA (3.5 ppm) (Anon., 2017). Humic acids promote antioxidant production in plants which, in turn, reduces "free radicals".

Free radical molecules result from stress such as drought, heat, ultraviolet light and herbicide use. It suppresses diseases, heat stress and frost damage by promoting antioxidant activity (El-Bassiouny *et al*., 2014; Syedabadi and Armin 2014) [14, 37].

Biofertilizer usually consists of live or latent cells of micro-organisms which include biological nitrogen fixers, P-solubilizing, mineralization of nitrogen and transformation of several elements into available forms. Azotobacter has beneficial effects on crop growth and yield through, biosynthesis of biologically active substances, stimulation of rhizospheric microbes, producing phyopathogenic inhibitors (Chen, 2006; Lenart, 2012) [10, 24]. Phosphates solubilizing activity is determined by the action of several phosphorus solubilizing microorganisms (PSMs) like phosphorus solubilizing bacteria (PSB) and phosphorus solubilizing fungi (PSF) which convert these insoluble phosphates into soluble forms through the process of acidification, chelation, exchange reactions and production of gluconic acid (Rodriguez *et al*., 2006; Chung *et al*., 2005) [32, 11]. Potash is present in several forms in the soil, including mineral K, non-exchangeable K, exchangeable K, and solution K. The KSB are effective in releasing K from inorganic and insoluble pools of total soil K through solubilization (Archana *et al.*, 2013; Gundala *et al.*, 2013; Meena *et al.*, 2014) [3, 16, 25].

To maintain long term soil health and productivity there is a need for integrated nutrient management through manures and biofertilizers apart from costly chemical fertilizers for better yield of the crop (Mondel *et al*., 2003) [27]. Considering the above facts, the present study was planned and undertaken with the objective to assess the response of biostimulants and biofertilizers on yield and quality of *Chrysanthemum* cv. Ratlam Selection.

Materials and methods

The field experiment was carried out twice during October 2017 to February 2019 at the Jamuvadi Farm, Department of Horticulture, Junagadh Agricultural University, Junagadh (Gujarat). The experiment was laid out in Randomized Block Design with Factorial concept (FRBD) consisting two factors with three replications. The treatment comprised of five treatments of biostimulants *viz*., Without spray of biostimulants (B_0), Banana pseudostem Sap @ 1% (B_1), Seaweed extract @ 0.5% (B_2), Panchgavya @ 4% (B_3), Humic acid @ 0.2% (B_4) and three treatments of biofertilizers *i.e*. Without biofertilizers (F_0), *Azotobacter* @ 2 l/ha + PSB @ 2 l/ha + KSB @ 2 l/ha (F_1) and *Azotobacter* @ 3 l/ha + PSB @ 3 l/ha + KSB @ 3 l/ha (F_2). Five plants from each treatment plot were randomly selected, labelled and used for recording observations. For the growth characters, the plant height, plant spread (E-W and N-S), number of shoots per plant 90 and 120 DAT (days after transplanting), fresh weight of plant and dry weight of plant were recorded in centimetres from each treatment plot. To assess performance of biostimulants and biofertilizers on flowering behaviour and flowering characters, the observations were recorded on days to initiation of flowering, days to 50% flowering, flowering duration (days), flower stalk length and flower stalk thickness in *Chrysanthemum* cv. Ratlam Selection.

Table 1: Time of applications

Time of application of biostimulants (Both seasons)	Time of application of biofertilizers (Both seasons)
1st 60 days after transplanting	At the time of transplanting
2nd 90 days after transplanting	
3rd 120 days after transplanting	

Result and discussion

Table 2: Effect of biostimulants

Significantly maximum plant height (48.48 cm) at 120 DAT in pooled, plant spread E-W (29.01 & 28.57 cm, respectively) at 90 DAT & (32.29 & 32.21 cm, respectively) 120 DAT, number of shoots per plant (18.84 & 18.08, respectively) at 90 DAT & (20.20 & 21.04, respectively) at 120 DAT and fresh weight of plant (118.35 & 116.72 g, respectively) during the year 2018-19 and in pooled and dry weight of plant (42.51, 44.75 & 43.63 g, respectively) were registered with an foliar application of humic acid 0.2% (B_4) during both the years and in pooled. Foliar spray of humic acid helps in quick absorption of nutrients, which enhanced the growth of root and shoot effectively resulting in higher uptake of nutrients. The possible reason for this acceleration of growth might be due to the effect of humic acid on cell elongation. Cell elongation is ceased by a rapid increase in wall bound hydroxyl proline by complexing iron within the plant, which removes the iron from a key biochemical reaction involving hydroxyl proline synthesis. Humic acid that enters into plant, mediates in respiration, acts as hydrogen acceptor, alerts the carbohydrate metabolism of plants and thus, promotes the accumulation of sugar. Increased growth of plant in present study are in agreement with the results obtained by Fan *et al*. (2014) [15] in *Chrysanthemum*; Bhagawat (2018) [5, 6] in marigold; Khenizy *et al*. (2013) [22] in gerbera; Aghera (2018) [1] in tuberose; Pansuriya (2018) [30] in gladiolus and Yasser *et al*. (2011) [40] in Roselle plants.

Significantly maximum plant spread N-S (25.18 cm) at 90 DAT in pooled and number of shoots per plant (18.33) at 90 DAT during 2017-18 were registered with an application of banana pseudostem sap 1% (B_1). Banana pseudostem sap contain some biochemical such as gibberellic acid, NAA, cytokinin, chemicals i.e. N, P, K, Ca, Mg, S, micronutrients (Mn, Cu, Zn) and beneficial microbes (PSB, rhizobium, azotobacter and fungus). Also it might be due to increasing auxin level of tissue or enhance the conversion of tryptophan to IAA leading to the enhanced activity of cell division and cell elongation through the effect of gibberellic acid and cytokinin singly or due to combine effect of both. The results of present study are in close conformity with findings of Jadhav *et al*. (2014) [19] and Patel *et al*. (2018) [31] in marigold; Desai (2018) in tuberose and Gundrashiya (2013) [17] in okra, cluster bean and cow pea.

Significantly maximum plant spread N-S (29.18 & 29.55 cm, respectively) at 120 DAT was registered with an application of panchgavya 4% (B_3) during the year 2018-19 and in pooled. It might be due to the nutrient content i.e. macro and micro nutrient level was considerably high which would have been responsible for the increase of the desirable characters. As it is sprayed on the foliage, the absorption of nutrients was on higher side, thus encouraging quick growth and increased plant height as well as other growth attributes like plant spread. Similar results were also obtained by Vetrivel *et al*. (2017) [38] in *Chrysanthemum*; Bellubbi *et al*. (2015) [4] in gerbera; Singh *et al*. (2007) [36] in tuberose; Bhalla *et al.* (2006b) [7] in gladiolus and Sharma *et al.* (2011) [35] in carnation.

Table 2: Effect of biostimulants and biofertilizers on growth parameters in *Chrysanthemum* cv. Ratlam Selection.

Treatments	Plant height at 90 DAT (cm)			Plant height at 120 DAT (cm)			Plant spread (E-W) at 90 DAT (cm)			Plant spread (E-W) at 120 DAT (cm)			Plant spread (N-S) at 90 DAT (cm)		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
Level of biostimulants (B)															
B_0	40.56	41.70	41.13	44.02	44.58	44.30	26.24	25.42	25.83	29.00	28.39	28.70	23.47	22.78	23.12
B_1	42.90	44.04	43.47	45.65	46.21	45.93	28.56	27.26	27.91	31.32	30.86	31.09	25.51	24.85	25.18
B_2	41.37	42.51	41.94	45.19	45.76	45.48	28.15	26.34	27.24	31.29	30.76	31.02	24.71	24.02	24.36
B_3	43.32	44.46	43.89	46.95	47.53	47.24	28.18	27.83	28.00	31.90	32.06	31.98	25.36	24.66	25.01
B_4	43.48	44.62	44.05	48.20	48.76	48.48	28.13	29.01	28.57	32.13	32.29	32.21	25.34	24.65	24.99
S. Em.±	1.102	1.205	0.817	1.220	1.364	0.915	0.976	0.738	0.612	0.976	0.789	0.628	0.612	0.600	0.429
C.D. at 5%	NS	NS	NS	NS	NS	2.59	NS	2.14	1.73	NS	2.29	1.78	NS	NS	1.21
Level of biofertilizers (F)															
F_0	39.93	41.07	40.50	43.55	44.11	43.83	27.38	25.01	26.19	29.73	28.04	28.89	23.68	23.01	23.34
F_1	43.11	44.25	43.68	46.19	46.75	46.47	27.98	27.21	27.60	31.28	31.21	31.24	24.96	24.27	24.62
F_2	43.94	45.08	44.51	48.27	48.84	48.56	28.20	29.29	28.74	32.38	33.36	32.87	25.99	25.30	25.64
S. Em.±	0.854	0.934	0.632	0.945	1.057	0.709	0.756	0.572	0.474	0.756	0.611	0.486	0.474	0.465	0.332
C.D. at 5%	2.47	2.70	1.79	2.74	3.06	2.01	NS	1.66	1.34	NS	1.77	1.38	1.37	1.35	0.94
Interaction (B X F)															
S. Em.±	1.909	2.087	1.414	2.113	2.363	1.585	1.691	1.279	1.060	1.691	1.366	1.087	1.061	1.040	0.743
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV%	7.81	8.32	8.08	7.96	8.79	8.39	10.52	8.15	9.44	9.41	7.67	8.59	7.39	7.44	7.41

Table 2.1: Effect of biostimulants and biofertilizers on growth parameters in *Chrysanthemum* cv. Ratlam Selection.

Treatments	Plant spread (N-S) at 120 DAT (cm)			Number of shoots per plant at 90 DAT			Number of shoots per plant at 120 DAT			Fresh weight of plant (g)			Dry weight of plant (g)		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
Level of biostimulants (B)															
B_0	27.27	26.53	26.90	16.56	15.91	16.23	20.93	17.73	19.33	105.45	108.72	107.08	38.89	41.24	40.06
B_1	28.85	28.11	28.48	18.33	16.89	17.61	21.02	19.40	20.21	112.43	115.70	114.06	40.62	42.98	41.80
B_2	28.15	27.41	27.78	17.02	16.73	16.88	21.24	18.67	19.96	108.65	111.92	110.28	39.21	41.49	40.35
B_3	29.92	29.18	29.55	16.93	17.02	16.98	22.07	19.49	20.78	111.70	114.97	113.34	42.14	44.53	43.34
B_4	29.61	28.87	29.24	17.31	18.84	18.08	21.89	20.20	21.04	115.08	118.35	116.72	42.51	44.75	43.63
S. Em.±	0.682	0.654	0.472	0.406	0.454	0.305	0.512	0.474	0.349	2.663	2.248	1.743	0.966	0.992	0.692
C.D. at 5%	NS	1.90	1.34	1.18	1.32	0.86	NS	1.37	0.99	NS	6.51	4.94	2.80	2.87	1.96
Level of biofertilizers (F)															
F_0	26.38	25.64	26.01	16.39	15.45	15.92	20.93	17.11	19.02	103.39	106.66	105.02	38.70	41.00	39.85
F_1	29.51	28.77	29.14	16.68	17.63	17.15	21.35	19.51	20.43	111.92	115.19	113.55	41.42	43.77	42.60
F_2	30.38	29.64	30.01	18.63	18.16	18.39	22.01	20.68	21.35	116.68	119.95	118.31	41.90	44.22	43.06
S. Em.±	0.528	0.507	0.366	0.314	0.352	0.236	0.397	0.367	0.270	2.063	1.741	1.350	0.748	0.769	0.536
C.D. at 5%	1.53	1.47	1.04	0.91	1.02	0.67	NS	1.06	0.77	5.98	5.04	3.82	2.17	2.23	1.52
Interaction (B X F)															
S. Em.±	1.181	1.133	0.818	0.703	0.787	0.527	0.887	0.821	0.604	4.613	3.894	3.018	1.673	1.719	1.199
C.D. at 5%	NS	NS	NS	2.04	NS	1.49	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV%	7.11	7.01	7.06	7.07	7.98	7.53	7.17	7.45	7.31	7.22	5.92	6.58	7.13	6.92	7.02

Table 2.2: Interaction effect of biostimulants and biofertilizers on growth parameters in *Chrysanthemum* cv. Ratlam Selection.

Treatment combinations	Number of shoots per plant at 90 DAT		
	2017-18	2018-19	Pooled
B_0F_0	18.27	14.47	16.37
B_0F_1	15.87	16.20	16.03
B_0F_2	15.53	17.07	16.30
B_1F_0	18.53	14.93	16.73
B_1F_1	17.53	17.67	17.60
B_1F_2	18.93	18.07	18.50
B_2F_0	15.13	15.00	15.07
B_2F_1	18.00	17.00	17.50
B_2F_2	17.93	18.20	18.07
B_3F_0	15.00	15.60	15.30
B_3F_1	16.07	18.27	17.17
B_3F_2	19.73	17.20	18.47
B_4F_0	15.00	17.27	16.13
B_4F_1	15.93	19.00	17.47
B_4F_2	21.00	20.27	20.63
S. Em. ±	0.703	0.787	0.527
C.D. at 5%	2.04	NS	1.49
CV%	7.07	7.98	7.53

Effect of biofertilizers

Significantly maximum plant height (43.94, 45.08 & 44.51 cm, respectively) at 90 DAT & (48.27, 48.84 & 48.56 cm, respectively) at 120 DAT, plant spread N-S (25.99, 25.30 & 25.64 cm, respectively) at 90 DAT & (30.38, 29.64 & 30.01 cm, respectively) at 120 DAT, number of shoots per plant

(18.63, 18.16 & 18.39 cm, respectively) at 90 DAT, fresh weight of plant (116.68, 119.95 & 118.31 g, respectively) and dry weight of plant (41.90, 44.22 & 43.06 g, respectively) were registered with an application of *Azotobacter* @ 3 l/ha + PSB @ 3 l/ha + KSB @ 3 l/ha (F_2) during both the years and in pooled. Similarly, maximum plant spread E-W (29.29 & 28.74 cm, respectively) at 90 DAT & (33.36 & 32.87 cm, respectively) at 120 DAT and number of shoots per plant (20.68 & 21.35, respectively) at 120 DAT were registered with treatment F_2 during the year 2018-19 and in pooled.

This might be due to positive effect of biofertilizers. *Azotobacter* is free-living non-symbiotic aerobic nitrogen fixing bacteria, found in rhizosphere zone of many plants. This nitrogen-fixing bacterium when applied to the soil undergoes multiplication in billions and fixes atmospheric nitrogen in the soil (plant root region). Nitrogen fixation in the rhizosphere is carried out through the action of nitrogenous enzyme. PSB enhances availability of phosphorus and promote root growth. It also secretes organic acids viz., formic, acetic, propionic, lactic, glycolic, fumaric and succinic acids, vitamins and growth promoting substances like IAA and gibberellins which might helped in better plant growth. KSB enhance availability of potash and promote stem growth. In addition, KSB is also known to produce amino acids, vitamins and growth promoting substance like indol-3-acetic acid (IAA) and gibberellic acid (GA_3) which help in better growth of the plants. Since nitrogen and ferrous are important constituents of chlorophyll, increased availability of these nutrients as a result of biofertilizers activity might have led to higher chlorophyll content. Owing to the direct involvement of chlorophyll in photosynthesis, the corresponding increase in growth rate can be reasoned out. Results are in consonance with the findings of Meshram *et al*. (2008) [26], Palagani *et al*. (2013) [28] and Pandey e*t al*. (2018) [29] in *Chrysanthemum*; Patel *et al.* (2018) [31] and Rolaniya *et al*. (2017) [33] in marigold; Bhor (2010) [8] in rose; Aghera (2018) [1] in tuberose; Pansuriya (2018) [30] in gladiolus and Khan *et al*. (2009) [21] in tulip.

Interaction effect

Significantly maximum number of shoots per plant (21.00 & 20.63, respectively) at 90 DAT was recorded with combined application of humic acid @ 0.2% with *Azotobacter* @ 3 l/ha + PSB @ 3 l/ha + KSB @ 3 l/ha (B_4F_2) during the year 2017-18 and in pooled. Combined application of biofertilizers with foliar spray of humic acid might have helped to enhance the biological activity in the soil, better root development, improved transport of nutritional elements, enhanced chlorophyll content, protein synthesis and photosynthesis, solubilization of nutrients resulting in higher nutrients uptake by *Chrysanthemum* plant. Foliar spray of humic acid helps in quick absorption of nutrients, which enhanced the growth of root and shoot effectively resulting in higher uptake of nutrients. Humic acid acting as a good source of carbon and nitrogen might have improved the efficiency of biofertilizers activity, thus, aiding in photosynthates accumulation. Humic acid and biofertilizers both produce growth promoting hormones such as IAA, cytokinins and gibberellins which boost the plant growth. Plant growth increased due to nitrogen fixing ability of *Azotobacter*, phosphate solubilizing properties of PSB and potash mobilizing properties of KSB. The present findings are in agreement with Fan *et al*. (2014) [15], Palagani *et al*. (2013) [28] and Pandey *et al*. (2018) [29] in *Chrysanthemum*; Bhagawat (2018) [5, 6] and Patel *et al.* (2018) [31] in marigold; Aghera (2018) [1] in tuberose; Pansuriya (2018) [30] in gladiolus.

Table 3: Effect of biostimulants

Significantly maximum duration of flowering (56.59 & 59.13 days, respectively) was registered with an application of banana pseudostem sap 1% (B_1) during the year 2017-18 & in pooled and (62.53 days) with an application of panchgavya @ 4% (B_3) during the year 2018-19. Maximum flower stalk thickness (1.78 mm) was registered with an application of seaweed extract @ 0.5% (B_2) during the year 2017-18 & 1.74 mm with humic acid @ 0.2% (B_4) in pooled.

It can be inferred that the spraying of enriched liquid like sap enhanced the metabolic activities of plants and thus control the vegetative phase of the plant will helpful in converting plant vegetative phase to reproductive phase and increase the flowering duration of *Chrysanthemum*. Panchgavya increased the uptake of nutrients and simultaneous transport of growth promoting substances like cytokinins to the axiallary buds resulting in breakage of apical dominance and also this may be due to the partitioning efficiency *viz*., increased allocation of photosynthates towards the economic part and also hormonal balance in the plant system. Furthermore, these findings are well supported by Jadhav *et al*. (2014) [19] and Patel *et al*. (2018) [31] in marigold; Desai (2018) in tuberose and Gundrashiya (2013) [17] in okra, cluster bean and cow pea.

Table 3: Effect of biostimulants and biofertilizers on flowering parameters in *Chrysanthemum* cv. Ratlam Selection.

Treatments	Days to initiation of flowering (days)			Days to 50% flowering (days)			Duration of flowering (days)			Flower stalk length (cm)			Flower stalk thickness (mm)		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
Level of biostimulants (B)															
B_0	72.13	72.04	72.09	73.44	77.00	75.22	50.87	57.56	54.21	13.90	14.06	13.98	1.66	1.60	1.63
B_1	66.51	69.73	68.12	71.33	75.11	73.22	56.49	61.78	59.13	15.29	14.75	15.02	1.54	1.68	1.61
B_2	67.38	70.98	69.18	72.78	76.11	74.44	55.62	59.00	57.31	15.33	14.16	14.74	1.78	1.64	1.71
B_3	67.80	69.04	68.42	71.00	74.44	72.72	55.20	62.53	58.87	15.23	15.05	15.14	1.61	1.69	1.65
B_4	67.36	68.71	68.03	69.67	73.11	71.39	55.71	62.18	58.94	15.60	15.72	15.66	1.77	1.71	1.74
S. Em.±	1.600	1.706	1.169	1.697	1.907	1.277	1.318	1.325	0.934	0.514	0.583	0.389	0.043	0.045	0.031
C.D. at 5%	NS	NS	NS	NS	NS	NS	3.82	3.84	2.65	NS	NS	NS	0.13	NS	0.09
Level of biofertilizers (F)															
F_0	69.85	72.81	71.33	74.60	78.20	76.40	53.15	56.09	54.62	14.18	13.39	13.79	1.61	1.60	1.60
F_1	68.85	69.60	69.23	70.93	74.40	72.67	54.15	61.55	57.85	14.94	15.00	14.97	1.72	1.69	1.71
F_2	66.00	67.89	66.95	69.40	72.87	71.13	57.04	64.19	60.61	16.08	15.85	15.96	1.68	1.71	1.70
S. Em.±	1.239	1.321	0.906	1.315	1.477	0.989	1.021	1.026	0.724	0.398	0.452	0.301	0.034	0.035	0.024
C.D. at 5%	NS	3.83	2.57	3.81	4.28	2.80	2.96	2.97	2.05	1.15	1.31	0.85	NS	NS	0.07
Interaction (B X F)															
S. Em.±	2.771	2.955	2.025	2.940	3.303	2.211	2.283	2.294	1.619	0.891	1.010	0.673	0.075	0.077	0.054
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV%	7.03	7.30	7.17	7.11	7.61	7.38	7.22	6.56	6.87	10.24	11.86	11.06	7.78	8.06	7.92

Effect of biofertilizers

Significantly minimum days to initiation of flowering (67.89 & 66.95 days, respectively) during the year 2018-19 and in pooled, minimum days to 50% flowering (69.40, 72.87 & 71.13 days, respectively), maximum duration of flowering (57.04, 64.19 & 60.61 days), flower stalk length (16.08, 15.85 & 15.96 cm, respectively) were observed with the application of *Azotobacter* @ 3 l/ha + PSB @ 3 l/ha + KSB @ 3 l/ha (F_2) during both the years & in pooled and flower stalk thickness (1.71 mm) was registered with an application of *Azotobacter* @ 2 l/ha + PSB @ 2 l/ha + KSB @ 2 l/ha (F_1) followed by F_2 in pooled. This might be due to possible role of *Azotobacter*, PSB and KSB. The earliness of flower initiation and 50% flowering in biofertilizer-inoculated plants may be attributed to easy uptake of nutrients and simultaneous transport of growth promoting substances like cytokinins to the auxiliary buds, resulting in breakage of apical dominance. In longer flowering duration might be due to attributed to the better overall food and nutrient status for longer time under these treatment combinations (Verma *et al*., 2011) [25]. Increase in flower stalk length & flower stalk thickness of flowers might be due to the growth promoted by nitrogen and better mobilization and solubilization of phosphate and better uptake of N and P as well as micronutrients like Zn, which is precursor of auxin, which improved flower stalk length as well as thickness. Ultimately, this has resulted in a better sink for faster mobilization of photosynthates and early transformation of plant from vegetative to reproductive phase. Results are in consonance with the findings of Palagani *et al*. (2013) [28] and Pandey *et al*. (2018) [29] in *Chrysanthemum*; Lele *et al*. (2009) [23]; Hadwani *et al.* (2013) [18] and Aghera (2018) [1] in tuberose; Pansuriya (2018) [30] in gladiolus.

Summary and conclusion

From the foregoing discussion it can be concluded that the foliar application of humic acid @ 0.2% at 60, 90 & 120 DAT with soil drenching of *Azotobacter* @ 3 l/ha + PSB @ 3 l/ha + KSB @ 3 l/ha after transplanting in addition to recommended dose of fertilizers (120:60:60 kg/ha NPK) proved to be the best treatment for getting higher vegetative growth and flowering in *Chrysanthemum* cv. Ratlam Selection.

References

1. Aghera SR. Effect of biostimulants and biofertilizers on growth, flower yield, and quality of tuberose (*Polianthes tuberosa* L.) cv. Prajwal. Ph.D. Thesis (unpublished). Junagadh Agricultural University, Junagadh (Gujarat, India), 2018.
2. Amalraj ELD, Praveen KG, Ahmed SKMH, Abdul R, Kishore N. Microbiological analysis of panchgavya, vermicompost, and FYM and their effect on plant growth promotion of pigeon pea (*Cajanus cajan* L.) in Indian. Organic Agriculture. 2013; 3:23-29.
3. Archana D, Nandish M, Savalagi V, Alagawadi A. Characterization of potassium solubilizing bacteria (KSB) from rhizosphere soil. BIOINFOLET-A Quarterly. J Life Sci. 2013; 10:248-257.
4. Bellubbi SB, Kulkarni BS, Patil CP. Effect of integrated nutrient management on growth and flowering of gerbera (*Gerbera jamesonii* L.) var. Rosalin under naturally ventilated polyhouse condition. Int. Agril. Sci. Veteri. Medicine. 2015; 1(1):69-74.
5. Bhagawat P. Effect of bio-fertilizers and bio-stimulant on growth and flower yield of African marigold (*Tagetes erecta* L.). M. Sc. Thesis (unpublished). Indira Gandhi Krishi Vishwavidyalaya Raipur (Chhattisgarh), 2018.
6. Bhagawat P. Effect of bio-fertilizers and bio-stimulant on growth and flower yield of African marigold (*Tagetes erecta* L.). M. Sc. Thesis (unpublished). Indira Gandhi Krishi Vishwavidyalaya Raipur (Chhattisgarh), 2018.
7. Bhalla R, Dharma S, Dhiman SR, Jain R. Effect of biofertilizers and biostimulants on growth and flowering in standard carnation (*Dianthus caryophyllus* Linn.). J Ornamental Hort. 2006b; 9 (4): 282-285.
8. Bhor PB. Effect of integrated nutrient management on rose (*Rosa hybrida* L.) cultivars under protected condition. M.Sc. (Agri.). Thesis (unpublished). Junagadh Agricultural University, Junagadh (Gujarat, India), 2010.
9. Carter GD. In: Introduction to Floriculture (ed. R.A. Larson), Academic Press Inc., 1990.
10. Chen J. The combined use of chemical and organic fertilizers and/or biofertilizer for crop growth and soil fertility. International workshop on Sustained Management of the Soil–Rhizosphere System for Efficient Crop Production and Fertilizer Use, Thailand. 2006, pp. 1–10.
11. Chung H, Park M, Madhaiyan M, Seshadri S, Song J, Cho H *et al*. Isolation and characterization of phosphate solubilizing bacteria from the rhizosphere of crop plants of Korea. Soil Biol. Biochem. 2005; 37:1970-1974.
12. Desai SA. Effect of plant growth enhancers on growth, flowering and yield of tuberose cv. Prajwal. M. Sc. Thesis (unpublished). Navsari agricultural University, Navsari (Gujarat, India), 2018.
13. Durand N, Briand X, Meyer C. The effect of marine bioactive substances (NPRO) and exogenous cytokinins on nitrate reductase inactivity in Arabidopsis thaliana. Physiol Plant. 2003; 119:489-493.
14. El-Bassiouny HSM, Bakry AB, Attia AA, AbdAllah MM. Physiological role of humic acid and nicotinamide on improving plant growth, yield, and mineral nutrient of wheat (*Triticum durum*) grown under newly reclaimed sandy soil. Agric. Sci. 2014; 5(8):687-700.
15. Fan H, Wanga X, Suna X, Li Y, Suna X, Zheng C. Effects of humic acid derived from sediments on growth, photosynthesis and chloroplast ultrastructure in *Chrysanthemum*. Sci. Hortic. 2014; 177:118-123.
16. Gundala PB, Chinthala P, Sreenivasulu B. A new facultative alkaliphilic, potassium solubilizing, *Bacillus* Sp. SVUNM9 isolated from mica cores of Nellore District, Andhra Pradesh, India. Research and Reviews. J Microbiol. Biotech. 2013; 2:1-7.
17. Gundrashiya RR. Effect of spraying of banana pseudostem based enriched sap at different concentration on growth and yield of different crops. M. Sc. Thesis (unpublished). Navsari agricultural University, Navsari (Gujarat, India), 2013.
18. Hadwani MK, Varu DK, Panjiar N, Babariya VJ. Effect of integrated nutrient management on growth, yield and quality of ratoon tuberose (*Polianthes tuberose* L.) cv. Double. Asian J Hort. 2013; 8(2):448-451.
19. Jadhav PB, Singh A, Mangave BD, Patil NB, Patel DJ, Dekhane SS, Kireeti A. Effect of organic and inorganic fertilizers on growth and yield of african marigold (*Tagetes erecta* L.) cv. Pusa Basanti Gainda. Annals Bio. Res. 2014; 5(9):10-14.
20. Kannaiyan K. Bioferitilizers: Key Factors in Organic Farming. The Hind Survey of Indian International

Journal of Modern Plant & Animal Sciences. 2000; 1(2):82-95.
21. Khan FU, Siddique MA, Khan FA, Nazki IT. Effect of biofertilizers on growth, flower quality and bulb yield in tulip (*Tulipa gesneriana*). Indian J Agril. Sci. 2009; 79(4):248-251.
22. Khenizy AM, Zaky AA, Yasser ME. Effect of humic acid on vase life of gerbera flowers after cutting. J Hort. Sci. & Orna. Plants. 2013; 5(2):127-136.
23. Lele AB, Pawar NB, Kolse SV. Studies on *Azotobacter* from rizospheare of gerbera (*Gerbera jamesonii* H.). J Maharastra Agric. Univ. 2009; 34(3):298-300.
24. Lenart A. Occurance Characteristics and Genetic Diversity of *Azotobacter chroococcum* in Various Soils of Southern Poland. Pol. J Environ. Stud. 2012; 21(2):415-424.
25. Meena VS, Maurya BR, Verma JP. Does a rhizospheric microorganism enhance K+ availability in agricultural soils? Microbiol. Res. 2014; 169:337-347.
26. Meshram N, Badge S, Bhongale SA, Khiratkar SD. Effect of bioinoculants with graded doses of NPK on flowering, yield attributes and economics of annual *Chrysanthemum*. J Soils and Crops. 2008; 18(1):147-150.
27. Mondel T, Ghanti P, Mahato B, Mondel AR, Thapa U. Effect of spacing and biofertilizer on yield and yield attributes of direct sown Chilly. Env. Eco. 2003; 21:712-15.
28. Palagani N, Barad AV, Bhosale N, Thumar BV. Influence of integrated plant nutrition on growth and flower yield of *Chrysanthemum* (*Chrysanthemum morifolium* Ramat.) cv. IIHR-6 under Saurashtra condition. Asian J Hort. 2013; 8(2):502-506.
29. Pandey SK, Prasad VM, Singh VK, Kumar M, Saravanan S. Effect of bio-fertilizers and inorganic manures on plant growth and flowering of *Chrysanthemum* (*Chrysanthemum grandiflora*) cv. Haldighati. J Pharmacogn. Phytochem. 2018; SP1:637-642.
30. Pansuriya PB. Effect of biostimulants and biofertilizers on growth, flower yield and quality of gladiolus (*Gladiolus grandiflorus* L.) cv. American Beauty under greenhouse condition. Ph.D. (Horti.). Thesis (unpublished). Junagadh Agricultural University, Junagadh (Gujarat, India), 2018.
31. Patel VD, Patel GD, Desai KD, Patel DJ, Mangave BD. Effect of integrated nutrient management on growth and flower yield of african marigold (*Tagetes erecta* L.). Int. J. Pure App. Biosci. 2018; 6(1):568-572.
32. Rodriguez H, Fraga R, Gonzalez T, Bashan Y. Genetics of phosphate solubilisation and its potential applications for improving plant growth-promoting bacteria. Plant Soil. 2006; 287:15-21.
33. Rolaniya KM, Khandelwal SK, Koodi S, Sepat RS, Choudhary A. Effect of NPK, bio fertilizers and plant spacings on growth and yield of African marigold (*Tagetes erecta* L.). Chem. Sci Rev. Letters. 2017; 6(21):54-58.
34. Seydabadi A, Armin M. Sugar beet (*Beta vulgaris* L.) response to herbicide tank-mixing and humic acid. Int. J Biosci. 2014; 4(12):339-345.
35. Sharma BP, Gautam A, Gupta YC, Dhiman SR, Bhalla R. Effect of foliar sprays of biostimulants on growth and flowering of carnation cv. Sunrise. J Ornamental Hort. 2011; 13(2):101-106.
36. Singh AK. Response of rose plant growth and flowering to nitrogen, *Azotobacter* and farm yard manure. J Ornamental Hort. 2007; 8 (4):296-298.
37. Stirk WA, Novak MS, Van Staden J. Cytokinins in macroalgae. Plant Growth Regul. 2003; 41:13-24.
38. Vetrivel T, Jawaharlal M, Arulmozhiyan R, Kannan M. Effect of bio-stimulants on growth and yield of *Chrysanthemum* (*Dendranthema grandiflora* Tzvelev.) var. Amalfi under protected cultivation. Eco. Environ. Conservat. 2017; 23(4):2297-2301.
39. Yan P, Enyi X, Kai Z, Mangaladoss F, Xianwen Y, Xuefeng Z *et al*. Nutritional and chemical composition and antiviral activity of cultivated seaweed *Sargassum naozhouense* Tseng et Lu. Mar Drugs. 2013; 11(1):20-32.
40. Yasser M, Shalaby EA, Shanan NT. The use of organic and inorganic cultures in improving vegetative growth, yield characters and antioxidant activity of Roselle plants (*Hibiscus sabdariffa* L.) African J Biotech. 2011; 11:1988-1996.
41. Zhang X, Schmidt RE. The impact of growth regulators on the a-tocopherol status in water-stressed *Poa pratensis* L. Int Turfgrass Res. J. 1997; 8:1364-1373.