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Effect of Humic Acid and Calcium Chloride on the Growth and Flower Production of Snapdragon (*Antirrhinum majus*)

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Abstract A field study was carried out to examine the effect of different concentrations of Humic acid and Calcium chloride on the growth and yield of snapdragon cv. Antirrhinum candy shower yellow F1. The experiment was laid out in a three replicated Randomized Complete Block Design with a sub-plot size of $20ft^2$. The results indicated significant ($P<0.05$) effect of Humic acid and Calcium chloride on the growth and yield of snapdragon cv. Antirrhinum candy shower yellow F1 when applied at different levels. The treatment comprised of 350 g Humic acid + 180 g Calcium chloride produced 30 cm height, 30.78 branches $plant^{-1}$, 33.00 leaves $branch^{-1}$, took 13.22 days to first flower emergence, 21.22 spikes $plant^{-1}$, 25.67 flowers $spike^{-1}$ and 26.00 days blooming period. In control plots, neither where Humic acid nor the Calcium chloride was applied, the snapdragon resulted in 20.89 cm height, 11.33 branches $plant^{-1}$, 15.00 leaves $branch^{-1}$, took 26.11 days to first flower emergence, 7.67 spikes $plant^{-1}$, 13.00 flowers $spike^{-1}$ and 13.00 days blooming period. It was concluded that for growing successful snapdragon, the plants may be fertilized with 350 g Humic acid + 180 g Calcium chloride, and in case of choosing of these, there should be no compromise on Humic acid at higher level.

Keywords: Snapdragon (*Antirrhinum majus*)**,** humic acid, Calcium chloride, flower production

Introduction

At commercial scale, the world flower production has gained much importance in the early 20^{th} century with rapid developments and changes have occurred in the cut flower production, storage, classification and marketing. By means of this change, new techniques and technologies are used in the cut flower industry from production to consumption (Boran, 2008). Therefore, floriculture has become one of the important high value agricultural industries in many countries of the world. International trade in cut flowers has an annual growth rate of 25 percent. The international trade is around 11 billion US dollars and cut flowers contribute 60 percent of the world trade in floriculture. The global exports increased over ten folds from 0.5 billion in 1990 to 5.1

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billion in 2005, which is expected to double in 2025 (Singh *et al*., 2010). In Pakistan, the flower business is mainly concentrated around the big cities like Karachi, Lahore, Islamabad, etc. and is also turning towards a booming business. Therefore, with increasing demand of flowers for number of utilities, flower business is likely to gain expansion. But unluckily in agrarian economy of the country, the floriculture remained a quite neglected segment of agriculture (Manzoor *et al.*, 2001).

Antirrhirum is a genus of plants commonly known as snapdragons of dragon flowers, from the flowers' fancied resemblance to the face of a dragon that opens and closes its mouth when laterally squeezed. They are native to rocky areas of Europe, USA and North Africa (Dorling, 2008). Snapdragon is an herbaceous perennial plant, growing to 0.5–1 m tall, rarely up to 2 m. The leaves are spirally arranged, broadly lanceolate, 1–7 cm long and 2-2.5 cm broad. The flowers are produced on a tall spike, each flower is 3.5-4.5 cm long, zygomorphic, with two lips closing the corolla tube; wild plants have pink to purple flowers, often with yellow lips. The fruit is an ovoid capsule 10–14 mm diameter, containing numerous small seeds. The plants are pollinated by bumblebees, and the flowers close over the insects when they enter and deposit pollen on their bodies (Blamey *et al.* 1989).

Humic acid is an organic fertilizer derived from indigenous lignitic coal and is used in very low concentration, 7 to 20 mg kg^{-1} soil (Nisar and Mir, 1989). It is a naturally occurring polymeric organic compound and is known to perform a wide variety of functions (Schnitzer and Khan, 1972 and Sposito, 1989). Humic acid is produced through the decay/oxidation of organic matter through microbial action and is naturally found in soil, rivers, oceans and in lignitic coals (Lawson and Stewart, 1989). It is a vital constituent of soil organic matter and soils devoid of HA are difficult to be maintained fertile even with large applications of chemical fertilizers. Humic acid serves as a catalyst in promoting the activity of microorganisms and reduces the adverse effects of the chemicals on the environment (Bhardwaj and Gaur, 1970). Because of its ability to form complexes it can convert elements into forms suitable for assimilation by plant (Vaughan and Donald, 1976). Evidences suggest that the effects of HA on soil and plant are longer-lived than other inorganic sources (Sibanda and Young, 1989). Small concentration of HA has been reported to enhance root length, plant growth, moisture and nutrient uptake significantly (Kononova, 1966). However, higher nutrient contents in the soil have been reported to retard the growth promoting properties of humic compounds (Fialova, 1969; Sharif *et al.* 2003). Being promising natural resource Humic acid can be used as an alternative to synthetic fertilizers to increase crop production (Chen and Avaid *et al*., 1990; Alianiello *et al*., 1991; Pan and Dong, 1995). Humic acid is a commercial product contains many elements which improve the soil fertility and increasing the availability of nutrient elements and consequently affect plant growth and yield (Hartwigson and Evans. 2000). In many studies, Humic acid preparations are reported to increase the uptake of mineral elements (Maggioni *et al*. 1987; De Kreij and Basar 1995; Mackowiak *et al.* 2001), to promote the root length (Vaughan and Canellas *et al.* 2002), and to increase the fresh and dry weights of crop plants (Kauser *et al.* 1985; Chen 2004a).

Research shows soluble calcium fertilizer plays vital role in production of high-quality crops. Calcium is essential plant requirement as the cell wall strength and thickness are increased by calcium addition. Calcium is a critical part of the cell wall that produces strong structural rigidity by forming cross-links within the pectin polysaccharide matrix. With rapid plant growth, the structural integrity of stems that hold flowers and fruit, as well as the quality of the fruit produced, is strongly coupled to calcium availability (Easterwood, 2002).

Calcium fertilization of many crops is frequently confused with lime or gypsum soil amendments. Research shows soluble calcium fertilizer plays vital role in production of high-quality crops. Many believe application of these minerals to soils sufficiently supplies the calcium requirement of crops. Unfortunately, the role of calcium in plant nutrition is often eclipsed by interest in macronutrients or specific micronutrients. Many overlooked and is only considered when deficiency disorders influence the economic threshold of produce quality and value. However, calcium is a multifunctional nutrient in the physiology of crop plants and in the soluble form influences availability and uptake. Nitrogen-use efficiency of urea-containing fertilizers is also increased with soluble calcium sources such as calcium nitrate (Easterwood, 2002). Fukai and Uehara (2006) reported positive effects of calcium treatment on vase life of cut snapdragon (*Antirrhinum majus*) flowers; while Carter and Grieve (2008) reported that calcium fertilization improved the growth and germination of *Antirrhinum majus* L. (Snapdragon) when produced under increasingly saline conditions. Friedman *et al.* (2000) reported that calcium fertilization significantly reduced the bending response without affecting the flower quality in (*Antirrhinum majus*). In view of the facts stated above, the experiment was conducted to investigate the effect of Humic acid and Calcium chloride on growth and yield of snapdragon.

Materials and Methods

The experiment was conducted to examine the effect of different concentrations of Humic acid and Calcium chloride on the growth and yield of

Snapdragon cv. Antirrhinum candy shower yellow F1, at the Department of Horticulture, Sindh Agriculture University Tandojam, using a three replicated randomized complete block design (RCBD). For conducting this experiment the whole plot was properly worked and leveled for even distribution of water. Thereafter the main plot was divided into 18 sub-plots measuring 4ft x 5ft ($20ft^2$). All cultural practices were carried out throughout the growing season as recommended.

Each bed was separated by developing 30 cm bund, and these sub-plots/beds were prepared in such a way to be irrigated feasibly and uniformly. The Snapdragon seedlings were transplanted in rows 30 cm apart, keeping plant spacing of 20 cm. The treatments were include: T_1 = Control , T_2 = 180 g Humic acid, T_3 = 350 g Humic acid, T_4 = 180 g Calcium chloride T_5 = 180 g Humic acid + 180 g Calcium chloride, T_6 = 350 g Humic acid + 180 g Calcium chloride. The plants were supplied with humic acid and CaCl as per the treatment plan; while 50g DAP was supplied to each bed as basal dose before sowing and 50 g urea was applied after two weeks of transplanting to improve the soil for nitrogen and phosphorus deficiency. The Humic acid and CaCl were applied at two weeks interval through fertigation. The beds were kept free of weeds throughout the season, so that nutrients and moisture are utilized by the experimental Snapdragon plants optimally; and generally weeds are susceptible to various insect pests and act as their host plants; so it was imperative not to allow weeds in the experimental block as well as in the surroundings with a regular interculturing in all the beds. For recording observations on various growth and flower production parameters, five normal looking Snapdragon plants in each sub-plot/bed were selected at random and labeled to mark the plants for respective treatments. The data of all the parameters individually subjected to the analysis of variance as suggested by Steel *et al.* (1997); while DMRT (Duncan's Multiple Range Test) were employed to compare the treatment means. All the statistical analyses were performed through MSTAT-C computer software package.

Results

Plant height (cm)

The effect of different levels and combinations of Humic acid and Calcium chloride on the Snapdragon was investigated and the results are given in Table-1. It is evident from the results that Snapdragon plants fertilized with 350 g Humic acid + 180 g Calcium chloride resulted maximum height (30.00 cm); while the plants treated with 350 g Humic acid ranked 2nd in height (27.89 cm) and nutrient combination of 180 g Humic acid + 180 g Calcium chloride ranked 3rd producing plants of 25.56 cm height. The plant height in Snapdragon reduced to 23.33 cm and 22.89 cm when supplied with 180 g Humic acid and 180 g Calcium chloride, respectively. However, in control plots, where neither the Snapdragon plants received Humic acid and nor they were supplied with Calcium chloride ranked least in plant height (20.89 cm). The results showed that combined application of Humic acid + Calcium chloride at higher concentrations proved to be highly effective to increase plant height in Snapdragon. However, Humic acid when applied separately showed some promising results for plant height; but separate application of Calcium chloride without Humic acid did not show significant impact on plant height.

Branches plant^{-1}

The number of branches plant^{-1} of Snapdragon under the effect of different levels and combinations of Humic acid and Calcium chloride were monitored and the data are presented in Table-1. It is apparent that Snapdragon plants fertilized with 350 g Humic acid + 180 g Calcium chloride produced maximum branches plant^{-1} (30.78); while the plants receiving 180 g Humic acid + 180 g Calcium chloride ranked 2nd with 25.67 branches plant^{-1}. The application of 380 g Humic acid ranked 3rd producing 15.89 branches plant^{-1}; while 180 g Humic acid resulted in 14.67 branches plant^{-1}. The number of branches plant^{-1} in Snapdragon declined to 12.55 when given with 180 g Calcium chloride, while in control plots, where no Humic acid or Calcium chloride were applied, minimum number of branches plant^{-1} (11.33) were recorded. It was observed that there was remarkable and positive impact of combined application of Humic acid + Calcium chloride on the branches plant^{-1}; and in both the cases either when Humic acid or Calcium chloride were applied separately, the number of branches declined sharply. However, this adverse effect was more severe, when Calcium chloride was applied individually without Humic acid.

Leaves branch^{-1}

The Snapdragon plants was also observed for the number of leaves branch^{-1} as affected by various levels and combinations of Humic acid and Calcium chloride and such results are shown in Table-1. It is obvious from the data that the leaves branch^{-1} were significantly maximum (33.00) when Snapdragon plants were fertilized with 350 g Humic acid + 180 g Calcium chloride, followed by 28.67 and 26.00 average leaves branch^{-1} achieved from the plots fertilized with 180 g Humic acid + 180 g Calcium chloride and 350 g Humic acid, respectively. The number of leaves branch^{-1} in Snapdragon declined considerably to 20.55 and 17.33 when the plants were supplied with 350 g Humic acid and 180 g Calcium chloride, respectively. However, the leaves branch^{-1} decreased to minimum (15.00) when the Snapdragon plants were left untreated. It was observed that leaves branch^{-1} was more influenced by Humic acid application than the Calcium chloride application in regards to their concentration and pattern of application. The combined application of Humic acid and Calcium chloride showed more positive impact on this trait as compared to individual application of these elements. However, Humic acid proved its vitality for leaves branch^{-1} more than the Calcium chloride.

Days taken to first flower emergence

The results in relation to days taken to first flower emergence of Snapdragon as influenced by different levels of Humic acid and Calcium chloride are presented in Table-1. The analysis of variance suggested that the effect of various levels of Humic acid + Calcium chloride and their application patterns on the days taken to first flower emergence of Snapdragon were significant ($P<0.05$). The results indicated that the Snapdragon plants took minimum days to opening of first flower (13.22) when fertilized with 350 g Humic acid + 180 g Calcium chloride, followed by 17.44 and 18.41 days to first flower emergence observed in plots fertilized with 350 g Humic acid and 180 g Humic acid + 180 g Calcium chloride, respectively. The number of days taken to first flower emergence in Snapdragon increased to 19.44 and 20.14 when the plants were supplied with 180 g Humic acid and 180 g Calcium chloride, respectively. However, the days taken to first flower emergence increased to maximum (26.11) when the Snapdragon plants were left untreated of Humic acid and Calcium chloride. It was noted that higher levels Humic acid and Calcium chloride when applied in combination developed earliness in first flower emergence; while the first flower emergence delayed considerably when Humic acid and Calcium chloride were applied separately and at lower levels. Moreover, the impact of Humic acid on this parameter was more pronounced as compared to the application of Calcium chloride.

Table 1. Mean Plant height (cm), Branches plant^{-1} , Leaves branch^{-1}, Days taken to first flower emergence of Snapdragon as affected by different levels of Humic acid, Calcium chloride and their combination

Treatments	Plant height (cm)	Branches plant^{-1}	Leaves branch^{-1}	Days taken to first flower emergence
T1=Control	20.89 f	11.33 d	15.00 f	26.11 f
T2=180 g Humic acid	23.33 d	14.67 c	20.55 d	19.44 d
T3=350 g Humic acid	27.00 b	15.89 c	26.00 c	17.44 b
T4=180 g Calcium chloride	22.89 e	12.55 d	17.33 e	20.14 c
T5=180 g Humic acid + 180g Calcium chloride	25.56 c	25.67 b	28.67 b	18.41 c
T6=350 g Humic acid + 180g Calcium chloride	30.00 a	30.78 a	33.00 a	13.22 a
S.E. ±	0.5486	1.1083	0.8068	0.8948
LSD 0.05	1.2224	2.4694	1.7977	1.9938
LSD 0.01	1.7387	3.5124	2.5570	2.8360

In a column means followed by same letters are not significantly different at P=0.05 as suggested by LSD test.

Spikes plant^{-1}

The observation on the spikes plant^{-1} of Snapdragon as affected by various levels and combinations of Humic acid and Calcium chloride was recorded and such results are shown in Table-2. The results showed that the maximum spikes plant^{-1} (21.22) in Snapdragon were achieved in plots fertilized with 350 g Humic acid + 180 g Calcium chloride, followed by 16.56 and 13.33 average spikes plant^{-1} obtained in plots fertilized with 180 g Humic acid + 180 g Calcium chloride and 350 g Humic acid, respectively. The spikes plant^{-1} reduced to 10.11 and 9.00 when the Snapdragon plants were supplied with 180 g Humic acid and 180 g Calcium chloride, respectively. However, the spikes plant^{-1} decreased to the lowest level (7.67) when the Snapdragon plants were left untreated. The results argued that spikes plant^{-1} was mostly influenced by the application of Humic acid; and with reduction in Humic acid the spikes plant^{-1} decreased considerably. However, in absence of Humic acid, when only Calcium chloride was applied, the spikes plant^{-1} was more adversely affected. However, combined application of Humic acid + Calcium chloride proved to be more effective in increasing the spikes plant^{-1} when compared with their separate applications.

Flowers spike^{-1}

The results in regard to flowers spike^{-1} of Snapdragon as influenced by various levels and combinations of Humic acid and Calcium chloride are presented in Table-2. The results revealed that the maximum flowers spike^{-1} (25.67) in Snapdragon were obtained in plots fertilized with 350 g Humic acid + 180 g Calcium chloride, followed by 23.33 and 22.33 flowers spike^{-1} achieved in plots fertilized with 350 g Humic acid and 180 g Humic acid + 180 g Calcium chloride, respectively. The flowers spike^{-1} reduced to 17.00 and 14.33 when the Snapdragon plants were supplied with 180 g Humic acid and 180 g Calcium chloride, respectively. However, the flowers spike^{-1} reduced to minimum (13.00) when the Snapdragon plants were left untreated (control). It was observed that flowers spike^{-1} was mainly influenced by the application of Humic acid; and decreasing Humic acid, decreased the flowers spike^{-1} considerably. In absence of Humic acid, when only Calcium chloride was applied, the flowers spike^{-1} was more adversely affected. However, application of Humic acid and Calcium chloride in combination resulted in more flowers spike^{-1} as compared to their individual applications.

Blooming period (days)

The data pertaining to blooming period of Snapdragon as affected by different levels and combinations of Humic acid and Calcium chloride are shown in Table-2. The results indicated that the maximum blooming period (26.00 days) was observed in Snapdragon plants fertilized with 350 g Humic acid + 180 g Calcium chloride, followed by average blooming period of 20.39 and 19.22 days observed Snapdragon fertilized with 350 g Humic acid and 180 g Calcium chloride, respectively. The blooming period reduced to 18.33 and 17.33 days when the Snapdragon plants were supplied with 180 g HA + Calcium chloride 180 g and 180 g HA, respectively. However, the blooming period decreased to lowest (13.00 days) when the Snapdragon plants were left untreated (control). It was observed that when the soil enriched with Humic acid and Calcium chloride, the blooming period increased considerably; while blooming period decreased considerably under Humic acid was applied at lower level or when Humic acid and Calcium chloride were applied separately.

Table 2. Mean Spikes plant^{-1}, Flowers spike^{-1}, Blooming period (days) of Snapdragon as affected by different levels of Humic acid, Calcium chloride and their combination

Treatments	Spikes plant^{-1}	Flower spike^{-1}	Blooming period (days)
T1=Control	7.67 e	13.00 e	13.00 d
T2=180 g Humic acid	10.11 d	17.00 c	17.33 c
T3=350 g Humic acid	13.33 c	23.33 b	20.33 b
T4=180 g Calcium chloride	9.00 d	14.33 d	19.22 b
T5=180 g Humic acid + 180 g Calcium chloride	16.56 b	22.33 b	18.33 b
T6=350 g Humic acid + 180 g Calcium chloride	21.22 a	25.67 a	26.22 a
S.E.±	0.5037	0.8342	1.0606
LSD 0.05	1.1224	2.0823	2.3631
LSD 0.01	2.5965	3.2599	3.3613

In a column means followed by same letters are not significantly different at P=0.05 as suggested by LSD test.

Discussion

Humic acid is an organic fertilizer derived from indigenous lignitic coal and is used in very low concentration, 7 to 20 mg kg^{-1} soil (Nisar and Mir, 1989) and it is a vital constituent of soil organic matter and soils devoid of Humic acid are difficult to be maintained fertile even with large applications of chemical fertilizers and Humic acid contains many elements which improve the soil fertility by increasing the availability of nutrient elements and consequently affect plant growth and yield positively (Hartwigson and Evans. 2000). Similarly, Calcium fertilizer plays vital role in quality crop production and it is believed that Calcium is a multifunctional nutrient in the physiology of crop plants and in the soluble form influences availability and uptake (Easterwood, 2002). The experiment was conducted to investigate the effect of Humic acid and Calcium chloride on growth and yield of Snapdragon.

The present study shows that Humic acid and Calcium chloride application affected the growth and yield of Snapdragon. The treatment comprised of 350 g Humic acid + 180 g Calcium chloride sub-plot^{-1} produced 30 cm height, 30.78 branches plant^{-1}, 33.00 leaves branch^{-1}, took 13.22 days to first flower emergence, 21.22 spikes plant^{-1}, 25.67 flowers spike^{-1} and 26.22 days blooming period. Under reduced Humic acid treatment in addition to Calcium chloride (180 g Humic acid + 180 g Calcium chloride), the Snapdragon produced 26.22 cm height, 25.67 branches plant^{-1}, 28.67 leaves branch^{-1}, took 18.41 days to first flower emergence, 16.56 spikes plant^{-1}, 22.33 flowers spike^{-1} and 18.33 days blooming period. In absence of Humic acid and separate application of Calcium chloride (180 g Calcium chloride), the Snapdragon produced 22.89 cm height, 12.55 branches plant^{-1}, 17.33 leaves branch^{-1}, took 20.14 days to first flower emergence, 9.00 spikes plant^{-1}, 14.33 flowers spike^{-1} and 19.22 days blooming period. The higher level of Humic acid without addition of Calcium chloride (350 g Humic acid), resulted in 27.00 cm height, 15.89 branches plant^{-1}, 26.00 leaves branch^{-1}, took 17.44 days to first flower emergence, 13.33 spikes plant^{-1}, 23.33 flowers spike^{-1} and 28.33 days blooming period. The reduced level of Humic acid without Calcium chloride (180 g Humic acid), resulted in 23.33 cm height, 14.67 branches plant^{-1}, 20.55 leaves branch^{-1}, took 19.44 days to first flower emergence, 10.11 spikes plant^{-1}, 17.00 flowers spike^{-1} and 17.33 days blooming period. In control plots, neither where Humic acid nor the Calcium chloride was applied, the Snapdragon resulted in 20.89 cm height, 11.33 branches plant^{-1}, 15.00 leaves branch^{-1}, took 26.11 days to first flower emergence, 7.67 spikes plant^{-1}, 13.00 flowers spike^{-1} and 13.00 days blooming period. These results are in accordance with those of Hood *et al.* (1993) reported significant effect of Ca fertilization on the growth and uptake of snapdragon. Hartwigsen and Evans (1997) reported that application of Humic acid at varied concentrations influenced the growth and flowering in *Tagetes patula* while Jack and Evans (2000) found similar effects on Bonanza marigold. Friedman *et al.* (2000) examined the effect of Calcium salts on the cut flowering stems of snapdragon and found that Calcium salt was effective to improve growth and flowering in snapdragon and suggested that either 20 mM $CaCl_3$, or buffers with a high pH could successfully inhibit the gravitropic response of snapdragon spikes, without reducing flower quality. Atiyeh *et al.* (2002) found that plant growth tended to be increased by treatments of the plants with 50–500 mg kg^{-1} Humic acids, but often decreased significantly when the concentrations of Humic acids derived in the container medium exceeded 500-1000 mg kg^{-1}. These growth responses were most probably due to hormone-like activity of Humic acids from the vermicomposts or could have been due to plant growth hormones adsorbed onto the humates. Dudley *et al.* (2004) determined the effects of humic substances on early stages of *Zinnia elegans* and *Tagetes patula* growth. Fukai and Uehara (2006) investigated the effect of Calcium treatment on the vase life of snapdragon (*Antirrhinum majas* L. cv. Athlete Red) and cut flowers kept in water showed inflorescence bent, while those pretreated with 1% CaCl2 for 16 hours did not show such symptoms. Calcium pretreatment enhanced inflorescence elongation and open florets. Abdel-Mawgoud *et al.* (2007), Singh *et al.* (2008) and Morard *et al*. (2011) reported influence of Humic acid on *Calendula officinalis* and Nikbakht *et al*. (2008) found positive effect of Humic acid on assessed the effect of Humic acid on the growth and flower production of *Gerbera Jamesonii*. Carter and Grieve (2008) investigated the effects of Calcium chloride on the mineral uptake, germination, growth, and quality of two cultivars of *Antirrhinum majus* (Monaco Rose' and Apollo Cinnamon). Overall, quality of stems produced with saline waters ranging from 2.5 to 11 dSm^{-1} was very high ("special"). Irrigation with more saline water (14 dSm^{-1}) resulted in a slight reduction in quality and stems were rated as "fancy" depending on the cultivar. Both cut flower cultivars can be produced for commercial use under saline conditions up to at least 14 dSm^{-1}. Le Chang *et al.* (2012) investigated that the effect of Calcium and Humic acid treatment on the growth and nutrient uptake of Oriental Lily. It was reported that Humic acid (HA) may facilitate plant growth by improving the nutrient uptake as well as through hormonal effects. The effect of a mixture of Calcium and Humic acid indicated that Oriental lily is sensitive to Calcium deficiency. Two levels of Ca (3.5 and 7.0 meq L^{-1}) were combined with 500 mg L^{-1} HA and applied to the nutrient solution of the *Lilium* Oriental hybrid Sorbonne. Arjenaki *et al.* (2012) evaluated the effect of different amounts of special fertilizer for cut flowers and Calcium nitrate on quantitative and qualitative characteristics of hybrid rose cv. High magic in Hydroponic. Calcium nitrate treatment factors also increased the stem length, stem diameter, stem fresh and dry weight, cut flowers fresh weight, bud diameter, number of cut flowers and vase life. Baloch (2014 a) concluded that there was positive and significant impact of Humic acid @ 600g for all the growth and flower yield parameters and increased blooming period in phlox. Baloch (2014 b) concluded that the flower production as well as blooming period was highest in petunia given Humic acid @ 800g; while decreasing Humic acid rate resulted in decreased values for all the traits studied.

Conclusions

It was observed that application of Humic acid was more influential factor and under higher Humic acid level of 350 g in addition to Calcium chloride of 180 g sub-plot^{-1}, maximum flowers spike^{-1} were achieved with minimum blooming period and early emergence of first flower. Calcium chloride when applied alone did not show pronounced effect, but when applied in addition to Humic acid at higher level, the growth and flower production of Snapdragon improved substantially. Hence, it is suggestible that for growing successful Snapdragon, the plants may be fertilized with 350 g Humic acid + 180 g Calcium chloride (20ft^2), and in case of choosing of these, there should be no compromise on Humic acid at higher level.

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