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Impact of Growing Media and NPK on growth and Flowering of Alstroemeria cv. Capri

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ABSRACT
The present studies entitled, "Impact of Growing media and NPK on growth and flowering of Alstroemeria cv. Capri)" were carried out at the Research Farm of Department of Floriculture and Landscaping, Dr. Yashwant Singh Parmar University of Horticulture and Forestry, Nauni, Solan during the year 2010-2012. The experiment was laid out in Split Plot Design having 20 treatment combinations of four growing substrates and five NPK doses, replicated thrice with four plants per plot per treatment. Four growing substrates viz., sand: soil: FYM (1:1:1, v/v), rai forest soil, rhododendron forest soil and cocopeat and five NPK doses viz., NPK @ 30:15:30 g/m² (as soil application), NPK @ 100: 50: 100 ppm once a week, NPK @ 100: 50: 100 ppm twice a week, NPK @ 150: 100: 150 ppm once a week and NPK @ 150: 100: 150 ppm twice a week. The data were recorded on various growth, flowering and yield parameters for three consecutive years. The results revealed that plants grown in rhododendron forest soil recorded maximum values for maximum number of leaves per stem (37.50), early flowering (149.30 days), maximum number of flowers per cyme (4.03), largest inflorescence size (8.75cm), maximum cut stems per plot (159.10). whereas maximum stem length (105.80cm) recorded in cocopeat. Whereas the maximum leaves per stem (43.48), early flowering (149.30 days), maximum number of flowers per cyme (4.75), largest inflorescence size (10.30 cm), maximum cut stems per plot (164.20) and maximum stem length (112.60 cm)was recorded with application of NPK @150:100:150 ppm twice a week through fertigation. However Incase of interaction effect of growing substrate and NPK doses thee maximum leaves per stem (48.75), early flowering (139.70 days), maximum number of flowers per cyme (5.17), largest inflorescence size (12.38 cm), maximum cut stems per plot (172.80 cut stems) and maximum stem length (116.20 cm)was recorded in rhododendron forest soil when NPK @150:100:150 ppm twice a week was applied through fertigation. From the present study, it is concluded that growing substrate comprising of rhododendron forest soil and application of NPK dose @150;100:150 ppm twice a week through fertigation is best for commercial cultivation of alstroemeria.
Keywords: Alstroemeria, *fertigation. Growing Media, NPK*

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INTRODUCTION

Alstroemeria (*Alstroemeria hybrida* L.) is an important bulbous ornamental plant of great commercial value and belongs to family Alstroemeriaceae. It is native to South America [1]. The genus *Alstroemeria* has about 93 species mostly found in Chile and Brazil. A large number of cultivars have been bred through hybridization and mutagenesis and being cultivated for cut flower production and pot plant mainly in the Netherlands, Colombia, U.S.A., England, Kenya, Japan and other countries.

Alstroemeria is a recent introduction in the world floriculture trade but it is gaining popularity in the global perspective mainly due to the reason that it has large number of cultivars in variety of colours, ease in cultivation besides the fact that its cut flowers have long lasting vase life over two to three weeks. Therefore, alstroemeria has attained the status of one of the most important cut flower of the world. Besides cut flowers and pot plants, alstroemeria is also gaining popularity for being growing as an important bedding plant, in containers for the deck, patio as well as in the various landscapes and bulbous gardens particularly in the temperate regions.

All over the world, alstroemeria growers are facing the problem of increasing costs in production, whereas the turnover is not in line with the advanced costs, mainly because of the fact that modern cultivars of alstroemeria are being protected by plant breeder rights, besides higher cost of infrastructure and non availability of advanced production technologies [2].

MATERIAL AND METHODS

The experiment was laid out in Split Plot Design having 20 treatment combinations of four growing substrates and five NPK doses, replicated thrice with four plants per plot per treatment. Four growing substrates viz., sand: soil: FYM (1:1:1, v/v), rai forest soil, rhododendron forest soil and cocopeat and five NPK doses viz., NPK @ 30:15:30 g/m^2 (as soil application), NPK @ 100: 50: 100 ppm once a week, NPK @ 100: 50: 100 ppm twice a week, NPK @ 150: 100: 150 ppm once a week and NPK @ 150: 100: 150 ppm twice a week.

The selected healthy and disease free plants of alstroemeria (*Alstroemeria hybrida*) cv. ' Capri' were planted at a spacing of 50 cm × 50 cm with a density of four plants per plot having a size of 1×1 m, containing a sterilized growing substrates in the poly house on 29th October, 2010. Before planting, the application of F_1 i.e. NPK @ 30: 15: 30 g/m^2 was incorporated in the growing substrate(s) on 28th October, 2010 and mixed thoroughly. However, in 2011 and 2012, the application of F_1 dose i.e. NPK @ 30 : 15 : 30 g/m^2 was also incorporated in the medium when flowering was over and after (29th October in 2011) stripping off all the shoots.

The application of F_2, F_3, F_4 and F_5 through fertigation were applied as per technical programme after the establishment of plants continuously starting w.e.f. November 30th, 2010 up to 20th June, 2012. To maintain the good plant health and obtaining best quality flowering stems, standard plant protection measures were adopted which included fortnightly drenching and spraying with Diathane M-45 @ 2g/l and Bavistin @ 1g/l, alternatively. The standard cultural practices were followed to raise a successful crop which included irrigation, netting, weeding, hoeing and removal of unwanted stems/shoots etc.

RESULTS AND DISCUSSION

STEM LENGTH (cm)

The data contained in Table-1 indicates that there is significant effect of growing substrate and NPK doses on stem length. The maximum stem length (105.80 cm) recorded in cocopeat was found to be at par with rhododendron forest soil (104.40 cm) and rai forest soil (102.10 cm), respectively. The production of longer cut stems in the said substrates could be ascribed to the fact that rhododendron enriched substrate had produced tallest plants hence stem length was recorded more in the said growing substrates.

The production of longest flowering shoots in the above cited substrate might be due to more N and P contents besides other better physico-chemical and biological properties. Nitrogen and phosphorus are known to stimulate and development and growth of multi-stemmed rhizomes, storage and fibrous roots as well as uptake of other nutrients optimally. In addition, increase in nitrogen allows the plants to utilize other nutrients optimally and thus puts up more biomass. It is also evident that rhododendron forest soil also exhibited high value of organic carbon and it is a well known fact that organic matter had to increase the binding capacity of any growing substrate due to which there is more availability of micro and major nutrients available in the said by growing substrate.

These results are in close agreement with the earlier reports of Sattelmacher and Marashner [3] as well as Goodwin and Erwee [4] who observed that availability of nitrogen increased the availability of cytokinins to the shoots which are normally produced in roots. So, resulted in production of more and longer shoots which ultimately become reproductive.

As regards the effect of NPK doses, the maximum stem length (112.60 cm) was obtained with the application of NPK @150:100:150 ppm twice a week through fertigation and found to be significantly higher over all other doses. These findings are in agreement with the earlier results of Raina *et al.*,[5] and Raina, (6).

These results are also in consonance with earlier findings of Sarkar and Roychodhary (7) who reported that split application of N and P (200 ppm) twice a week resulted in highest stem length in carnation cv. 'Chaubad Yellow'. Similarly, Bhatia *et al*. (8) also reported more stem length of carnation cv. 'Sunrise' cut flowers when fertigated with 100 ppm N and 140 ppm K twice a week.

The interaction, $T_3 \times F_5$ produced the longest flowering shoots (116.20 cm) and it was found to be at par with $T_2 \times F_5$ (112.70 cm) and $T_4 \times F_5$ (113.20 cm). It may be as a consequence of attaining more plant height due to the reason that rhododendron enriched substrate assured conducive conditions for better growth and development of multi-stemmed rhizomes which produced longer shoots that become reproductive later on and were further catalyzed by the required and appropriate application of NPK through fertigation. Hence, resulted in the production of longest cut stems.

NUMBER OF LEAVES PER STEM

The maximum number of leaves per stem (37.50) were obtained when plants were grown in rhododendron forest soil and found to me at par with rai forest soil (35.12). The production of more leaves per stem in the rhododendron forest soil may be attributed to the engineering of better physico-chemical and biological properties in this that could contribute for production of more bio-mass and longer shoots. Due to higher level of nitrogen, plant could produce much more longer shoots with more number of nodes and as a consequence, more leaves were produced per plant in the rhododendron forest soil.

The significantly highest number of leaves per stem was optained (43.48) with the application of F_5 dose of NPK and may be ascribed to the fact that, this treatment might have supplied higher amount of NPK in available form to produce long stems. Consequently, these stems had maximum nodes and inter-nodes and accordingly more number of leaves per stem. Nitrogen helps to increase the availability of cytokinines that are known to permote the growth of plant and hence manifested in the production of significantly longer shoots with more number of leaves.

The treatment combination $T_3 \times F_5$ resulted in the production of highest number of leaves per stem (48.75) which could be due to the reason that above mentioned treatment combination might have proved to be a beneficial factor for the production of more leaves per plant.

DAYS TAKEN TO FLOWERING

A perusal of data revealed that growing substrates as well as NPK doses have exhibited significant effects on days taken to flowering. Among various substrates used, T_3 (rhododendron forest soil) recorded significantly earliest flowering (149.30 days). Which may ascribed to the reason that this medium assured better physico-chemical and biological properties and the plants might have utilized them.

More efficiently for putting up requisite vegetative growth and formation of flower buds comparatively in lesser time. Early flowering in rhododendron growing substrate could also be due to availability and utilization of more nutrients particularly K present in it. It is well known fact that K helps in flowering. Similar results have also been reported by Farthing and Ellis (9) in geranium and Anuje *et al*. (10) in gerbera.

As regards the effect of NPK doses, significantly earliest flowering (145.60 days) was recorded in F_5 i.e. twice a week fertigation of 150: 100: 150 ppm NPK. This might be due to the reason that with optimum doses of NPK application, nutrient uptake efficiency of the plants also got increased and consequently, plants could put up requisite vegetative in lesser time due to which the flowering was advanced as compared to the recommended practices and other treatments where lower doses of NPK were applied. In many species, phosphorus and nitrogen interact closely in affecting maturity as excess nitrogen delaying of flowering and abundant phosphorus speeds up maturity. Thus, if excess phosphorus is provided, root growth is often increased to shoot growth. This in contrast affects with excess nitrogen results in causing low shoot to root ratios (11). These results are in conformity with the findings of Kumar (12) who also reported advancement in flowering stages with the increasing doses of N and P in chrysanthemum. Kumar and Rana (13) reported earliest flowering with the increase in nitrogen dose in carnation cv. 'Chaubad Yellow'.

The interaction of growing substrates and NPK doses resulted in earliest flowering (139.70 days) in the treatment combination $T_3 \times F_5$ and found to be at par with $T_3 \times F_4$ (143.20 days). Which may be due to the reason that this treatment combination might be a critical factor for production of flowers in minimum time.

NUMBER OF FLOWERS PER CYME

The effect of growing substrate found to be non-significant. Maximum number of flowers per cyme (4.03) was recorded in rhododendron forest soil. This may be due to the fact that this growing substrate assured congenial growing conditions and consequently more flower buds per cyme. Hence, the production of increased number of flowers per cyme. These results are in line with the earlier worker of Banswal (14) and Wazir *et al*. (2).

The highest number of flowers per cyme (4.75) were produced with the fertigation of 150 : 100 : 150 ppm NPK twice a week and may be due to the reason that increase in NPK doses and its frequency might have led to increase the NPK uptake and utilization as well. Potassium moves readily with in the plant systems and tends to be translocated to the areas of growth (15). Potassium is involved in the meristematic growth and is utmost importance for the water status of the plant. It also increases the uptake of other elements. The increased level of P is also important for the improvement of flowering parameters.

The treatment combination, $T_3 \times F_5$ resulted in the production of highest number of flowers cyme (5.17) and found to be at par with $T_2 \times F_5$ (4.67), $T_4 \times F_5$ (4.58), $T_1 \times F_5$ (4.58) and $T_3 \times F_4$ (4.50). It could be attributed to the better interaction of rhododendron forest soil and higher application of NPK with more frequency that led to production of more flowers buds per cyme.

INFLORESCENCE SIZE (cm)

The plants grown in rhododendron forest soil produced the inflorescences of largest size (8.75 cm) and found to be at par with rai forest soil (8.20 cm) and cocopeat, (8.22 cm). This may be attributed to the fact that the constituents of above growing substrate have engineered better structure and other physico-chemical and biological properties required by the alstroemeria plants. In this substrate, the level of P availability was also higher. It is well known fact that P improves the flowering parameters. Similar findings have been reported by Sekar and Sujata (16) in gerbera. The maximum inflorescence size (10.30 cm) was recorded with fertigation of 150:100:150 ppm NPK twice a week. The increase in inflorescence size may be attributed to the enhanced availability and utilization as well as translocation of metabolites required for better growth. The fertigation might have helped in uniform distribution of NPK besides better timing for application of water and nutrients (5 & 6) which could have ultimately enhanced the inflorescence size.

It is evident that nitrogen is one of the key elements for plant growth and increase in nitrogen supply accelerates the synthesis of chlorophyll and amino acids which enhanced the vegetative growth (17 & 18). Beneficial effects of phosphorus on the growth were probably due to the increased synthesis of metabolites in the presence of directly applied phosphorus to plants. Since phosphorus is important content of nucleic acids and is involved through ATP in the activation of amino acids for synthesis of proteins, thus the importance of this element is well documented. Potassium is essential for photosynthesis and respiration vis-à-vis activates enzymes needed to form starch and protein (19). Talukdar *et al*., (20) reported maximum diameters of flowers of chrysanthemum with fertigation of 75 % recorded dose of fertilizer under green house conditions.

The interaction between growing substrates and NPK doses recorded maximum size of inflorescences (12.38 cm) in the treatment combination, $T_3 \times F_5$. which may be due to the reason that this treatment combination might be a crucial and critical for the production of large size inflorescences in a alstroemeria.

YIELD PER PLOT (cut stems)

The maximum cut stems per plot (159.10) were found when plants were grown in rhododendron forest soil. The production of more cut stems per plant in growing substrate comprising of rhododendron forest soil may be attributed to the better physico-chemical and biological properties exhibited by this growing substrate as well as supplying of more nutrients in available form especially nitrogen which have contributed for better growth and production of more biomass. Since nitrogen is known to stimulate the manufacture of carbohydrates and proteins which in turn enhances cell division and hence improved the vegetative growth of plant and production of more so, more number of shoots per plant. Hence, more stem yield per plot. The production of higher cut stems (164.20) with the NPK dose application of F_5 may be ascribed to the fact that this treatment might have supplied higher amounts of N, P and K in available form and consequently, there was production of more flowering shoots in comparison to other treatments. Nitrogen increases the availability of cytokinins that are known to promote the development of more shoots per plant. The effect is manifested in the production of significantly higher number of shoots by the plants receiving higher levels of NPK which in turn results in an increase in the number of cut flowers per plant and hence per plot too.

Phosphorus does play a role in photosynthesis cherry storage, cell division and enlargement (21) since phosphorus is found in the nucleic acids and involved through ATP in the activation of amino acids for the synthesis of proteins. Potassium is involved in the meristematic growth and is of utmost importance for water status of the plant. The uptake of water in the cells and tissues is frequently the as a consequence of active K^+ uptake. These results are in close conformity with the earlier findings of Kumar and Rana (13) who reported significant increase in the number of flowers with increase in nitrogen dose. Barman *et al*. (22) recorded highest flower yield per meter square per annum in rose cv. 'First Red' with 200 and 300 kg N and K_2O ha^{-1} $year^{-1}$ through water soluble fertilizers. The treatment combination, $T_3 \times F_5$ resulted in the production of highest number of cut stems per plot (172.80 cut stems) which could be due to the reason that above cited treatment combination might have proved to be a beneficial factor of the production for more cut stems per plot. It might be due to the fact that combination, $T_3 \times F_5$ have also produced highest number of vegetative shoots which was responsible for the production of more reproductive shoots too.

Table 1. Effect of growing substrates and NPK doses on stem length, number of leaves per stem and days taken to first flowering of alstroemeria cv. 'Capri' in year 2012

Growing substrates ------------- NPK doses	Stem length (cm)					Number of leaves per stem					Days taken to first flowering				
	4.27	4.27	4.27	4.27	4.27	T_1	T_2	T_3	T_4	Mean	T_1	T_2	T_3	T_4	Mean
F_1	2.08	2.08	2.08	2.08	2.08	25.00	27.00	31.08	25.25	**27.08**	164.30	159.70	158.30	159.20	**160.40**
F_2	4.18	4.18	4.18	4.18	4.18	26.00	30.17	29.25	27.67	**28.27**	159.00	157.20	152.80	156.50	**156.40**
F_3	4.27	4.27	4.27	4.27	4.27	31.92	31.00	35.25	31.33	**32.37**	156.90	153.10	152.20	154.70	**154.20**
F_4	2.08	2.08	2.08	2.08	2.08	38.00	41.50	43.17	35.67	**39.58**	152.00	145.70	143.20	151.90	**148.20**
F_5	4.18	4.18	4.18	4.18	4.18	39.17	45.92	48.75	40.08	**43.48**	148.80	145.00	139.70	148.70	**145.60**
Mean	4.27	4.27	4.27	4.27	4.27	**32.02**	**35.12**	**37.50**	**32.00**		**156.20**	**152.10**	**149.30**	**154.20**	

$CD_{0.05}$

Growing substrates	=	4.27	5.19	3.02
NPK doses	=	2.08	2.96	2.12
Growing substrate x NPK doses	=	4.18	5.90	4.25

Growing substrates

T_1 = Sand : Soil : FYM (1:1:1, v/v)
T_2 = Rai Forest soil
T_3 = Rhododendron Forest soil
T_4 = Cocopeat

NPK doses

F_1 = N : P : K @30 : 15 :30 g/m² (as control)
F_2 = N : P : K @100 : 50 : 100 ppm once a week
F_3 = N : P : K @100 : 50 : 100 ppm twice a week
F_4 = N : P : K @150 : 100 : 150 ppm once a week
F_5 = N : P : K @150 : 100 : 150 ppm twice a week

Table 2. Effect of growing substrates and NPK doses on number of flowers per cyme, Inflorescence size and number of cut stems per plot of alstroemeria cv. 'Capri' in year 2012

Growing substrates NPK doses	Number of flowers per cyme					Inflorescence size(cm)					Number of cut stems per plot				
	T_1	T_2	T_3	T_4	Mean	T_1	T_2	T_3	T_4	Mean	T_1	T_2	T_3	T_4	Mean
F_1	2.75	3.08	3.25	3.00	**3.02**	6.48	6.66	6.48	6.48	**6.53**	109.00	130.33	153.33	130.67	**130.80**
F_2	3.00	3.25	3.42	3.17	**3.21**	6.44	7.06	6.83	6.64	**6.74**	134.33	130.67	123.33	129.67	**129.50**
F_3	3.33	3.50	3.83	3.50	**3.54**	6.99	6.91	7.60	8.32	**7.46**	151.67	148.67	160.67	143.00	**151.00**
F_4	4.25	4.33	4.50	4.17	**4.31**	8.29	9.70	10.46	9.82	**9.57**	157.67	147.33	167.00	168.33	**160.10**
F_5	4.58	4.67	5.17	4.58	**4.75**	8.32	10.67	12.38	9.85	**10.30**	160.00	170.00	191.33	170.00	**172.80**
Mean	**3.58**	**3.77**	**4.03**	**3.68**		**7.30**	**8.20**	**8.75**	**8.22**		**142.50**	**145.40**	**159.10**	**148.30**	

$CD_{0.05}$

Growing substrates	=	NS	0.93	NS
NPK doses	=	0.34	0.50	10.92
Growing substrate x NPK doses	=	0.69	0.10	21.83

Growing substrates

T_1 = Sand : Soil : FYM (1:1:1, v/v)
T_2 = Rai Forest soil
T_3 = Rhododendron Forest soil
T_4 = Cocopeat

NPK doses

F_1 = N : P : K @30 : 15 :30 g/m² (as control)
F_2 = N : P : K @100 : 50 : 100 ppm once a week
F_3 = N : P : K @100 : 50 : 100 ppm twice a week
F_4 = N : P : K @150 : 100 : 150 ppm once a week
F_5 = N : P : K @150 : 100 : 150 ppm twice a week

CONCLUSION

From the present study, it is concluded that growing substrate comprising of rhododendron forest soil and application of NPK dose @150;100:150 ppm twice a week through fertigation is best for commercial cultivation of alstroemeria.

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