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Influence of Growing media and NPK on growth and flowering of Alstroemeria cv. Capri

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ABSTRACT
The present studies entitled, "Influence 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 plant height (110.30 cm), maximum shoots per plant at peak flowering (20.45),maximum yield of cut stems per plant (38.44 cut stems)and maximum vase life (19.20 days). Whereas stem thickness (7.32mm) and maximum number of flowers per stem (16.57) was recorded in cocopeat. However maximum plant height (116.90 cm), maximum shoots per plant at peak flowering (27.08),maximum yield of cut stems per plant (38.44)and maximum vase life (19.67 days), stem thickness (8.28 mm) and maximum number of flowers per stem (20.65)was recorded with twice a week fertigation of NPK @ 150:100:150 ppm. Whereas in case of interaction effect the maximum plant height (120.60 cm), maximum shoots per plant at peak flowering (27.08),maximum yield of cut stems per plant (47.83 cut stems)and maximum vase life (20.33 days), stem thickness (9.10 mm) and maximum number of flowers per stem (23.50) was recorded in rhododendron forest soil and fertigation with 150: 100: 150 ppm NPK twice a week. From the present investigation it is concluded that alstroemeria plants grown in the substrate consisting of rhododendron forest soil and fertigated with 150: 100: 150 ppm NPK twice a week can yield most desirable growth, flowering and yield of alstroemeria.
Keywords: Alstroemeria, NPK

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INTRODUCTION

Alstroemeria is a rhizomatous monocot plant and prefers to grow more luxuriantly and flower profusely in the cool and moist climatic conditions. [1]. Though, 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.

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].

In India, alstroemeria has been introduced recently in 2001 by the Ministry of Agriculture, GOI, under FAD programme at three Model Floriculture Centres namely, Ooty (Tamil Nadu), Chail (Himachal Pradesh) and Srinagar (Jammu and Kashmir).

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

Plant height:

Different growing substrates have exhibited varied responses to plant height of alstroemeria and the growing substrate consisting of rhododendron forest soil has recorded maximum height (110.30 cm) (Table-1). Production of tallest plants in rhododendron forest soil may be ascribed to the fact that this medium might have exhibited better physico-chemical properties, besides maintaining a requisite biological balance that could contribute to the better growth and development of plants in comparison to other growing substrates used. These findings get support from the earlier reports of Noguera *et al.* [3] in calendula. However, Singh [4] in geranium and Latpate [5] in hydrangea have observed more plant height in rai forest soil enriched growing substrates which was found to be statically at par with rhododendron forest soil enriched growing substrates.

Similarly, the response of NPK doses on plant height varied with the doses applied and maximum plant height (116.90 cm) has been recorded with the twice a week application of 150: 100: 150 ppm (Table 1). The more plant height in this treatment might be due to the fact that fertigation increases fertilizer use efficiency of applied nutrients i.e. N, P and K thus, increased availability and uptake of nutrient contents might have accelerated the rates of various physiological and metabolic processes in the plant system that had ultimately resulted in better plant growth and development [6 and 7]. Fertigation helped in uniform distribution of applied nutrients besides better timings for application of water and nutrients i.e. N, P and K which ultimately enhanced the plant height [8 and 9].

The treatment combination, $T_3 \times F_5$ i.e. growing of plants in rhododendron forest soil and fertigated with 150 : 100 : 150 ppm NPK twice a week resulted in maximum height of plants (120.60 cm) which may be due to reason that the interactive effects of T_3 and F_5 treatment

combination might have created conductive conditions for the better growth and development of plant. Consequently, plants grew much longer in this treatment combination.

Stem thickness (mm)

The thickness of cut stems was recorded maximum (7.32 mm) in the cocopeat. Which may ascribed to the fact that cocopeat or forest soil enriched substrates might have contributed for production of more bio-mass particularly the production of more leaves per plant which synthesized more food that was translocated down and stored in stem tissues. Consequently, the flowering shoots produced were quite thick and sturdy. These results are in conformity with the work of Dinova *et al.* [10] who observed better stems when alstroemeria plants were grown in the substrate enriched with well de-composed conifer needles.

As regards the influence of NPK application, maximum stem thickness (8.28 mm) was recorded in F_5 i.e. fertigation of 150: 100: 150 ppm NPK twice a week. it was found to be at par with F_4 (7.97 mm) i.e fertigation once a week with 150: 100: 150 ppm NPK. It is well known fact that the optimum quantity of NPK could enhance plant growth mainly due to the reasons that nitrogen is an important content of nucleic acid and protein synthesis where as phosphorus is an essential component of the energy compounds (ATP and ADP) and phosphoproteins [11].

Table 1. Effect of growing substrates and NPK doses on plant height, stem thickness and number of snoot per plant at a time of alstroemeria cv. 'Capri'

Growing substrates / NPK doses	Plant height (cm)					Stem Thickness (mm)					Number of shoots per plant at a time				
	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	92.06	97.73	101.30	103.50	98.63	5.64	5.31	5.81	5.76	5.63	14.00	15.50	14.42	15.67	14.90
F_2	101.00	101.10	102.00	105.60	102.40	5.84	5.66	6.44	5.86	5.95	14.92	17.92	17.58	16.17	16.65
F_3	104.00	103.90	105.20	111.00	106.00	6.63	5.89	6.73	7.63	6.72	17.08	19.50	19.67	19.50	18.94
F_4	110.70	110.10	114.30	113.50	112.20	8.05	7.45	7.82	8.54	7.97	20.92	23.58	23.50	22.67	22.67
F_5	112.30	116.90	120.60	117.70	116.90	7.60	7.63	9.10	8.80	8.28	20.67	25.67	27.08	21.83	23.81
Mean	104.00	105.90	108.70	110.30		6.75	6.39	7.18	7.32		17.52	20.43	20.45	19.17	

$CD_{0.05}$

Growing substrates	=	4.21	NS	1.61
NPK doses	=	2.08	0.53	1.15
Growing substrate x NPK doses	=	7.25	1.04	2.30

Growing substrates	**NPK doses**
T_1 = Sand : Soil : FYM (1:1:1, v/v) T_2 = Rai Forest soil T_3 = Rhododendron Forest soil T_4 = Cocopeat	F_1 = N : P : K @30 : 15 :30 g/m^2 (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 stems, yield per plant and vase life of alstroemeria cv. 'Capri'

Growing substrates / NPK doses	Number of stems (during Peak flowering)					Yield per plant					Vase life (Days)				
	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	11.08	12.00	12.67	12.92	12.17	25.28	32.58	34.97	32.67	31.38	16.33	17.67	18.33	17.75	17.75
F_2	12.92	12.33	12.75	13.00	12.75	32.25	32.67	30.83	29.08	31.21	17.67	17.67	18.67	18.17	18.17
F_3	16.58	15.08	15.25	17.75	16.17	37.92	37.17	36.81	35.75	36.91	17.33	18.00	18.67	18.33	18.33
F_4	16.17	17.50	17.92	17.92	17.37	39.42	36.83	41.75	42.08	40.02	19.67	19.33	20.00	19.67	19.67
F_5	16.92	20.92	23.50	21.25	20.65	40.00	42.50	47.83	42.50	43.21	18.67	19.67	20.33	19.58	19.58
Mean	**14.73**	**15.57**	**16.42**	**16.57**		34.97	36.35	38.44	36.42		17.93	18.47	19.20	19.20	

$CD_{0.05}$

Growing substrates	=	NS	NS	0.36
NPK doses	=	1.44	2.30	0.63
Growing substrate x NPK doses	=	2.88	4.58	1.25

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/m^2 (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

Similarly, potassium is an activator of many enzymes that are essential for photosynthesis and respiration and it also activates enzymes needed for the formation of starch and proteins [12]. The positive influence of nitrogen on stem thickness is due to its role in synthesis and translocation of phytohormones viz. cytokinins which resulted in vigorous shoot growth (13). Our findings are in conformity with the work of Eck *et al.* (14) who observed better plant growth and cut flower quality in carnation with the application of 180 ppm N and 200 ppm K through fertigation.

Verma [15] reported increased percentage of 'A' grade flowers over control in carnation with foliar application of higher doses of nitrogen (1500 ppm).

In case of interaction between growing substrates and NPK doses, the treatment combination $T_3 \times F_5$ i.e. when plants were grown in rhododendron forest soil and fertigated twice a week with 150: 100: 150 ppm NPK recorded maximum stem thickness (9.10 mm) and found to be at par with $T_4 \times F_5$ (8.80 mm) and $T_4 \times F_4$ (8.54 mm). The better stem thickness in the said treatment combination could be attributed to the creation of conducing root zone environment for production of healthy multi-stemmed rhizomes and shoots by the rhododendron forest soil, which got the further impetus with the application balanced and required does of NPK through most précised method.

Number of shoots per plant :

Maximum shoots per plant were recorded in rhododendron forest soil (20.45) and found to be at par with rai forest soil (20.43) and cocopeat (19.17) and it may be attributed to better physico-chemical and biological properties exhibited by this growing substrate which might have contributed for production of more multi-stemmed rhizomes leading to production of more shoots per plant. In addition, this substrate might have supplied more nutrients in available form especially nitrogen which have contributed for better plant growth, hence

production of more bio-mass. 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 plants. Thus, production of more shoots per plant [16]. Our results are in close agreement with the work of Singh [4] and Latpate [5] who reported more shoots per plant in the growing substrates enriched with forest soils of rai and rhododendron.

The NPK doses exhibited significant effects on number of shoots per plant and application of F_5 i.e. twice a week fertigation of NPK @ 150:100:150 ppm produced (23.81) shoots per plant respectively and found to be at par with F_4 i.e. once a week fertigation of 150: 100: 150 ppm NPK (22.67) which may be ascribed to the reason that plant received required amount of NPK. In addition timely and frequent fertigation might have contributed for availability of more nutrients and adequate soil moisture and ultimately increased photosynthetic rate. Thus, production of more bio-mass.

These results are in close conformity with the earlier findings of Ashok *et al.* [17] who reported that fertigation with ammonical nitrate @ 150 ppm resulted in higher yield of shoots in comparison to control in rose.

The interactions between growing substrates and NPK doses were also found to be significant. The treatment combination, $T_3 \times F_5$ i.e. rhododendron forest soil and fertigation with 150: 100: 150 ppm NPK twice a week produced maximum number of shoots per plant (27.08) and found to be at par with $T_2 \times F_5$ (25.67). Which may be ascribed to the fact that rhododendron forest soil contributed for production of more multi-stemmed rhizomes and got further impetus as a consequence of higher dose of NPK twice a week through fertigation. These results are in close agreement with the earlier work of Lisiecka and Szczepanaik [18] and Healy and Wilkins [19].

Number of flowers per stem (During peak flowering):

The data arranged in Table-2 depict that growing substrates have influenced number of flowers per stem non-significantly. However, cocopeat produced maximum number of flowers per stem (16.57) The more number of flowers per stem in this growing substrate might be ascribed to the reason that the said growing substrate could have engineered better growing environment particularly in the root zone that produced good quality flowering shoots and consequently more number of flowers were produced in a shoot. These results are in agreement with the earlier work of Banswal (20) who reported production of more flowers per inflorescence in chincherinchee when grown in rhododendron forest soil enriched growing substrates. Our findings also got support from the work of Dinova *et al* [10] who reported better quality alstroemeria cut flowers when grown in a substrates containing conifer needles.

Number of flowers per stem was significantly highest (20.65) when plants were fertigated with 150:100: 150 ppm dose of NPK twice of week. The increase in number of flowers per stem in the said treatment might be due to higher level of N, P and K. Phosphorus has been called the 'the key to life' because it is directly involved in most of life processes. An adequate supply of phosphorus in the life of a plant is important in laying down the primorida for its reproductive parts [21]. Potassium moves readily with in plants and tends to translocate to the areas of growth [2]. Potassium is also involved in the meristematic growth and is of utmost importance for maintenance of water status of the plant. Uptake of water in the cells and tissues is frequently as a consequence of active K^+ uptake [23]. Therefore, more uptake of P and K resulted into healthy growth and ultimately could produce more number of flowers per stem.

The interactions, growing substrates and NPK doses were found to be significant. Maximum number of flowers per stem (23.50) was obtained in the interaction, $T_3 \times F_5$ i.e. rhododendron forest soil, when fertigated with 150: 100: 150 ppm NPK twice a week and found to be at par with $T_4 \times F_5$ (21.25) and $T_2 \times F_5$ (20.92). It could be attributed to the reason that said treatment combination might have proven to be a critical interactive combination for producing higher number of flower buds in an individual flowering shoots.

Maximum yield per plant:

A perusal of data in Table 2 revealed that growing substrates exhibited non-significant effect on yield per plant. Maximum yield of cut stems per plant (38.44 cut stems) was obtained in rhododendron forest soil and found to be at par with all growing substrates. which might be ascribed to the fact this growing substrate could have assured better growing environment, supplied sufficient nutrients in available form, high level of organic

carbon etc. besides other physico-chemical and biological properties. So, due to availability of more congenial environment and required nutrition, plants produced more shoots in sufficient quantity which later on become reproductive. Thus, more number of stems per plant was produced in rhododendron forest soil. These results are in close agreement with the earlier findings of Singh (4), Latpate (5) and Banswal (20) in Geranium, Hydrangea and Chincherinchee, respectively.

The NPK doses exhibited significant effects on yield of cut flowers per plant. When plants fertigated twice a week with 150: 100: 150 ppm NPK, produced significantly higher yield per plant (43.21 cut stems) than

all other doses of NPK. The increase in number of cut stems per plant with this treatment might be attributed to stimulation of growth and photosynthesis as well as subsequent translocation of assimilates to sustain the growth of developing shoots. Nitrogen an essential component of amino acids and proteins which function as the building blocks for plant tissues, and also essential for synthesis of carbohydrates used with in the plant, besides stimulating root growth and development as well as uptake of other nutrients optimally (24). The nucleus of each plant cell contains phosphorus and as a result, cell division and growth are not possible without adequate phosphorus. Phosphorus in the cell get united with C, H, O, N and other elements to form complex organic molecules (22 and 25). Potash applications are required for the vegetative growth, cell expansion and synthesis of chlorophylls (26 and 27). Ahmed and Tullosh Reid [28] opined that at higher levels of K uptake and utilization, the availability of N and P also got increased. Thus resulting into vigorous growth of the plants and more number of shoots are produced per plant. Hence, the yield per plant was higher in substrates when higher amount of NPK doses were applied particularly in more frequencies.

The interaction between growing substrates and NPK doses were found to be significant. Among the various interactions, the treatment combination, $T_3 \times F_5$ i.e. when plants were grown in rhododendron forest soil and fertigated twice a week with 150:100:150 NPK recorded significantly highest yield per plant (47.83 cut stems). Which could be due to the reason that above cited treatment combination might have proved to be a beneficial factor for the production of more cut stems per plant. It might be as a consequence of the fact that treatment combination, $T_3 \times F_5$, have also produced highest number of vegetative shoots which later on got converted into flowering shoots. Hence, more number of cut stems per plant.

Vase Life (days):

The data presented in Table 2 indicate that there was significant effect of growing substrates and NPK doses on vase life of alstroemeria cut flowers. The vase life of alstroemeria cut flowers was recorded maximum (19.20 days) in rhododendron forest soil and found to be at par with rai forest soil (19.20 days). This could be to ascribed to the fact that rhododendron forest soil might have assured better growing environment, supplied sufficient nutrients as well as ensured better gausses exchange for production of best quality alstroemeria, cut flowers. Hence exhibited more vase life than other growing substrates. These results got the support from the findings of Bhatia *et al.* (29) who found increased vase life of carnation cv. 'Sunrise' cut flowers in growing substrate comprising of soil + FYM + Cocopeat (2:1:1, v/v) supplemented with 100 ppm N and 140 ppm K through soluble fertilizers twice a week.

Maximum vase life (19.67 days) was recorded in F_4 i.e. once a week fertigation with 150: 100: 150 ppm NPK and found to be at par with twice a week fertigation with 150: 100: 150 ppm NPK (19.58 days). This might be due to the reason that NPK supplied with optimum dose of P production of cut stems of better quality hence there was increase in vase life. As it is well documented that P and K generally act as proceed elements and known to reduce the rate of flower senescence. The phosphorous is believed to be participated in the selection of plasma membrane, nucleic acid as well as co-enzymes and subsequently lower down the respiratory activities and degree of dehydration. Potassium is known to increase resistance of plants and flowers to the adverse conditions and also provides mechanical strength to the flower petals and stem tissues, so, helps in increasing vase life [30].

Application of nutrient at suitable and appropriate concentrations increased the vegetative growth required for photosynthetic activities. Higher vase life in this treatment might have

also been due to the increase in the fresh weight of the flowers as a consequence of accumulation of more photosynthetes in the stem tissues and flower petals as well.
These results got support from the findings of Sarkar and Roychoudhary [31] who reported maximum vase life of carnation cv 'Chaubad Yellow' with fertigation of 200 ppm N and P twice a week. Krishnappa and Reddy [32] also recorded maximum vase life of carnation cv. 'Master' with fertigation of 120 % dose of recommended fertilizers.
The treatment combination, $T_3 \times F_5$ i.e. when plants were grown in rhododendron forest soil and fertigated twice a week with 150: 100: 150 ppm NPK, recorded maximum vase life of cut flowers (20.33 days) it was at par with $T_3 \times F_4$ (20.00 days), $T_2 \times F_5$ (19.67 days), $T_1 \times F_4$ (19.67 days), $T_4 \times F_4$ (19.67 days), $T_4 \times F_5$ (19.58 days) and $T_2 \times F_4$ (19.33 days). and may be attributed to the reason that interactive effect of rhododendron forest soil and fertigation with 150 : 100 : 150 ppm NPK twice a week might have resulted in the production of best quality cut flowers.

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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