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Research Article

Effect of Inoculation of Microbial Consortia at Graded Levels of N, P_2O_5 and K_2O on Flowering and Quality of Cut Flowers of Asiatic Lily to Under NVPH

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Abstract

The present investigation was carried out in the experimental block of the Department of Horticulture, College of Agriculture, Shivamogga, Karnataka during 2018-19 to know the response of microbial consortia at graded levels of N, P, K on flowering, yield and quality of Asiatic lily cut flowers under naturally ventilated poly house (NVPH). The flowering parameters like days taken for flower bud emergence and 50 flowering were found maximum in 75% RDF + *Azotobacter croococcum + Aspergillus awamori + Bacillus musilogenesis* (23.08 and 47.08 days), whereas days to senescence of flowers in standing plant was found maximum in T14 (14.88 days). Flower quality parameters like length of flower stalk, bud diameter, bud length, petal length, petal breadth, flower diameter (N-S), flower diameter (E-W), no. of florets/spike, no. of florets/m2 were found maximum in 75% RDF + *Azotobacter croococcum + Aspergillus awamori + Bacillus musilogenesis* (35.69 cm, 23.75 mm, 7.40 cm, 10.27 cm, 5.20 cm, 17.45 cm, 17.09 cm, 5.00 and 46.33, respectively). However, minimum values were observed in the treatment combination of *Azotobacter croococcum + Aspergillus awamori + Bacillus musilogenesis* without fertilizer application.

Keywords: *Azotobacter croococcum; Aspergillus awamori; Bacillus musilogenesis*

Introduction

Among various flowers grown in India, *Lilium* is one of the most important Genera being used for cut flower, pot plant production and landscaping. The genus *Lilium* belongs to the family Liliaceae comprises more than 80 species and these are divided into seven sections [1]. It is one of the six major genera of flower bulbs produced worldwide [2]. The cultivars of genus *Lilium* are highly appreciated by the horticulturists for their bewitching colours, fragrance and wide adaptability to several environmental conditions [3]. Due to its size, beauty and longevity the *Lilium* is regarded as one of the top ten cut flowers in the world flower trade [4].

Materials and Methods

The present investigation was carried out in the experimental block of the department of Horticulture, College of Agriculture, Shivamogga, Karnataka to study response of microbial consortia at graded levels of N, P, K on flowering and quality parameters of Asiatic lily under protected cultivation. Indian summerset varieties of Asiatic lily were procured from M/S Florence Flora, Bengaluru. The experiment was laid out in complete randomized design (CRD) with seventeen treatments replicated thrice. The treatment details are presented in table 1. The size of the experimental plot was 1m x 1m ($1m^2$). The healthy, uniform sized (12.14 cm diameter) bulbs of Asiatic lily Cv. Indian Summerset were planted at a depth of 5 - 7

T_1	100% Recommended dose of fertilizer (200:50:100 kg NPK/ha)
T_2	75% RD'N' + *Azotobacter croococcum* + 100% RD'P' and 'K'
T_3	50% RD'N' + *Azotobacter croococcum* + 100% RD'P' and 'K'
T_4	75% RD'P' + *Aspergillus awamori* + 100% RD'N' and 'K'
T_5	50% RD'P' + *Aspergillus awamori* + 100% RD'N' and 'K'
T_6	75% RD'K' + *Bacillus musilogenesis* + 100% RD'N' and 'P'
T_7	50% RD'K' + *Bacillus musilogenesis* + 100% RD'N' and 'P'
T_8	75% RD'P' and 'K' + *Aspergillus awamori* + *Bacillus musilogenesis* + 100% RD'N'
T_9	50% RD'P' and 'K' + *Aspergillus awamori* + *Bacillus musilogenesis* + 100% RD'N'
T_{10}	75% RD'N' and 'P' + *Azotobacter croococcum* + *Aspergillus awamori* + 100% RD'K'
T_{11}	50% RD'N' and 'P' + *Azotobacter croococcum* + *Aspergillus awamori* + 100% RD'K'
T_{12}	75% RD'N' and 'K' + *Azotobactercroococcum* + *Bacillus musilogenesis* + 100% RDP
T_{13}	50% RD'N' and 'K' + *Azotobactercroococcum* + *Bacillus musilogenesis* + 100% RD'P'
T_{14}	75% RDF + *Azotobacter croococcum* + *Aspergillus awamori* + *Bacillus musilogenesis*
T_{15}	50% RDF + *Azotobactercroococcum* + *Aspergillus awamori* + *Bacillus musilogenesis*
T_{16}	100% RDF + *Azotobacter croococcum* + *Aspergillus awamori* + *Bacillus musilogenesis*
T_{17}	*Azotobacter croococcum* + *Aspergillus awamori* + *Bacillus musilogenesis*

Table 1: Treatment details.

cm in each plot with 30 x 20 cm spacing. The nutrients like N, P and K was applied in the form of urea (46.4% N), single super phosphate (16% P_2O_5) and muriate of potash (60.0% K_2O), respectively. N, P_2O_5 and K_2O were applied in two split doses i.e. 15 days after planting (50%) and 30 days after planting (50%). Fertilizers were applied separately to individual plots as per the treatments. These fertilizers were applied in ring method five to six centimeter away from the plant.

Results and Discussion

Data presented in table 2 showed that, the response of microbial consortia and graded levels of N, P, K significantly affected the flowering parameters during the course of investigation.

Among the different treatments the soil application of 75% RDF + *Azotobacter croococcum* + *Aspergillus awamori* + *Bacillus musilogenesis* (23.08 days) recorded significantly least number of days to first flower bud emergence compared to the rest of the treatments and it was on par with 50% RDN and P + *Azotobacter croococcum* + *Aspergillus awamori* + 100% RDK (23.16 days). Whereas, the treatment combination of *Azotobacter croococcum* + *Aspergillus awamori* + *Bacillus musilogenesis* took a maximum number of days for flower bud emergence (32.81 days). The reason might be due to the earliness of flower bud emergence may be attributed to the presence of biofertilizers especially inoculation with nitrogen fixing and phosphorous solubilizing biofertilizers which consequently lead to early flower bud emergence. These results are in accordance with the findings of Ali., *et al* [5].

Treatment No.	Days taken for flower bud emergence	Days taken for 50% flowering	Days to senescence of flowers in standing plant
T_1	32.12	51.96	10.19
T_2	29.70	53.13	10.48
T_3	29.21	52.30	10.54
T_4	29.47	52.07	11.30
T_5	28.27	51.28	11.22
T_6	28.95	50.82	12.26
T_7	27.95	50.75	12.41
T_8	26.93	51.13	13.30
T_9	24.77	49.09	14.18
T_{10}	24.14	48.56	13.24
T_{11}	23.16	47.97	14.42
T_{12}	23.40	47.81	14.48
T_{13}	24.22	48.74	13.99
T_{14}	23.08	47.05	14.88
T_{15}	24.37	49.69	12.69
T_{16}	26.47	50.03	11.49
T_{17}	32.82	52.03	10.12
S. Em ±	0.25	0.30	0.12
C.D. (1%)	0.97	1.17	0.48

Table 2: Effect of different graded levels of N, P, K and biofertilizers on flowering parameters of Asiatic lily Cv. Indian Summerset

The same treatment T_{14} took a minimum number of days to 50 per cent flowering and was statistically on par with 50% RD'N' and 'P' + *Azotobacter croococcum* + *Aspergillus awamori* + 100% RD'K' (47.97 days) and 75% RD'N' and 'K' + *Azotobacter croococcum* + *Bacillus musilogenesis* + 100% RD'P' (47.81 days) was significantly more effective over rest of the treatments. However, the treatment combination of *Azotobacter croococcum* + *Aspergillus awamori* + *Bacillus musilogenesis* (52.03 days) took a maximum number of days to 50 per cent flowering.

The reason might be due to, early flowering dependant on food material prepared as a result of photosynthesis in leaves. This was

also due to induced cytokinin synthesis and rapid assimilation of photosynthates resulting in early transformation of the auxiliary bud from vegetative to reproductive phase. Same results were quoted by Ali., *et al*. [5] in gladiolus.

T_{14} (14.88 days) recorded the significantly maximum duration of flowering in comparison with other treatments and found to be on par with 50% RD'N' and 'P' + *Azotobacter croococcum* + *Aspergillus awamori* + 100% RD'K' (14.42 days) and 75% RD'N' and 'K' + *Azotobacter croococcum* + *Bacillus musilogenesis* + 100% RD'P' (14.48 days). While the minimum duration of flowering was registered in *Azotobacter croococcum* + *Aspergillus awamori* + *Bacillus musilogenesis* (10.12 days). This might be due to easy uptake of nutrients and simultaneous transport of growth promoting substances like cytokinin to the auxiliary buds resulting in breakage of apical dominance. Ultimately, they resulted in better sink for faster mobilization of photosynthates and early transformation of plant parts from vegetative to reproductive phase. Similar findings were corroborated by Dalve., *et al*. [6] in gladiolus.

Treatment No.	Length of the flower stalk (cm)	Bud diameter (mm)	Bud length (cm)	Petal length (cm)	Petal breadth (cm)
T_1	28.53	15.89	5.71	7.29	4.12
T_2	26.49	16.81	6.24	7.73	4.18
T_3	28.72	19.41	6.30	8.02	4.16
T_4	28.44	20.46	6.67	8.18	4.31
T_5	26.97	17.81	6.78	8.51	4.44
T_6	28.79	20.90	6.78	8.64	4.15
T_7	27.99	20.88	6.83	8.67	4.39
T_8	29.67	17.65	6.84	8.81	4.35
T_9	29.55	18.50	6.78	7.89	4.32
T_{10}	30.28	16.53	6.80	8.16	4.53
T_{11}	32.98	22.98	7.05	9.74	5.18
T_{12}	33.82	20.65	7.12	9.65	4.86
T_{13}	32.65	22.47	7.33	8.74	4.47
T_{14}	35.69	23.75	7.40	10.27	5.20
T_{15}	33.18	18.95	7.14	9.34	4.30
T_{16}	34.28	16.23	5.15	9.55	5.04
T_{17}	25.91	15.44	5.02	7.1	4.10
S. Em ±	1.30	0.45	0.13	0.15	0.12
C.D. (1%)	5.02	1.76	0.51	0.59	0.47

Table 3: Effect of different graded levels on N, P, K and biofertilizers on flower quality parameters of Asiatic lily Cv. Indian Summerset.

The flower stalk length was highest in the treatment combination of 75% RDF + *Azotobacter croococcum* + *Aspergillus awamori* + *Bacillus musilogenesis* (35.69 cm). Which was on par with T_{16} (34.28 cm.). T_{12} (33.82 cm.), T_{15} (33.18 cm.), T_{11} (32.98 cm.), T_{13} (32.65 cm.). However, found the minimum in *Azotobacter croococcum* + *Aspergillus awamori* + *Bacillus musilogenesis* (25.91 cm.). The stalk length is very important parameter in Asiatic lily cut flowers. It is one of the characters which decide the quality of cut flowers. This difference among the treatments of Asiatic lily Cv. Indian Summerset might be due to easy uptake of nutrients and simultaneous transport of growth promoting substances like cytokinin to the auxiliary buds resulting in breakage of apical dominance. The increase in flower size, weight, number might be due to the effect of balance nutrition supplied through combined application, and the same reports has been reported by Dubey and Mishra [7] and Pansuriya and Chauhan [8].

The maximum diameter of bud was recorded in the treatment of 75% RDF + *Azotobacter croococcum* + *Aspergillus awamori* + *Bacillus musilogenesis* (23.75 mm.). Which was on par with 50% RD'N' and 'P' + *Azotobacter croococcum* + *Aspergillus awamori* + 100% RD'K' (22.98 mm) and 50% RD'N' and 'K' + *Azotobacter croococcum* + *Bacillus musilogenesis* + 100% RD'P' (22.47 mm.). The minimum mean bud diameter (15.44 cm.) was recorded *Azotobacter croococcum* + *Aspergillus awamori* + *Bacillus musilogenesis*. Bud length was maximum in 75% RDF + *Azotobacter croococcum* + *Aspergillus awamori* + *Bacillus musilogenesis* (7.40 cm.) and was found on par with 50% RDF + *Azotobacter croococcum* + *Aspergillus awamori* + *Bacillus musilogenesis* (7.14 cm.), 75% RD'N' and 'K' + *Azotobacter croococcum* + *Bacillus musilogenesis* + 100% RD'P' (7.12 cm) and 50% RD'N' and 'P' + *Azotobacter croococcum* + *Aspergillus awamori* + 100% RD'K' (7.05 cm.). Whereas, *Azotobacter croococcum* + *Aspergillus awamori* + *Bacillus musilogenesis,* recorded the minimum (5.02 cm.). Petal length was maximum in 75% RDF + *Azotobacter croococcum* + *Aspergillus awamori* + *Bacillus musilogenesis* (10.27 cm.) and was found on par with 50% RD'N' and 'P' + *Azotobacter croococcum* + *Aspergillus awamori* + 100% RD'K' (9.74 cm.). Whereas, *Azotobacter croococcum* + *Aspergillus awamori* + *Bacillus musilogenesis* recorded the minimum (7.10 cm.). There was significant difference among the treatments with respect to petal breadth. It was maximum in 75% RDF + *Azotobactercroococcum* + *Aspergillus awamori* + *Bacillus musilogenesis* (5.20 cm.) and was found on par with T_{11}, T_{12}, T_{16}, (5.18, 4.86, 5.04 cm.). Whereas, *Azotobacter croococcum* + *Aspergillus awamori* + *Bacillus musilogenesis* recorded the minimum (4.10 cm.).

Best results in the bud diameter, bud length, petal length, petal breadth were also found in the same treatment. Increase in floret

length due to application of inorganic fertilizer along with biofertilizer might have enabled the plants to produce more photosynthates which was subsequently supplied to flowers for their better reproductive development. The similar results were reported by Padanagur., *et al*. [9] and Baskaran [10]. Significant differences were observed among the treatments with respect to flower diameter. However, the maximum flower diameter (N-S) (17.45 cm.) was recorded in treatment 75% RDF + *Azotobacter croococcum* + *Aspergillus awamori* + *Bacillus musilogenesis* which was on par with T_{12} (16.64) and T_{11} (16.53 cm.) and minimum floret diameter (14.99 cm.) was recorded in treatment T_{17} (*Azotobacter croococcum* + *Aspergillus awamori* + *Bacillus musilogenesis*). However, the maximum flower diameter (E-W) (17.09 cm.) was recorded in treatment 75% RDF + *Azotobacter croococcum* + *Aspergillus awamori* + *Bacillus musilogenesis* which was on par with T_{11} (16.17 cm.) minimum flower diameter (14.79 cm.) was recorded in treatment T_{17} (*Azotobacter croococcum* + *Aspergillus awamori* + *Bacillus musilogenesis*). Number of florets opened at a time is important parameter which is directly related to quality to Asiatic lily, because market price is depend this parameter. Number of florets opened at a time was recorded. It was maximum in 75% RDF + *Azotobacter croococcum* + *Aspergillus awamori* + *Bacillus musilogenesis* (5.00) and which was statistically on par with T_{15}, T_{13}, T_{12} and T_{11} (4.94, 4.86, 4.64, 4.46). Whereas, minimum was observed in T_{17} (2.20). It was found maximum in 75% RDF + *Azotobacter croococcum* + *Aspergillus awamori* + *Bacillus musilogenesis* (46.33). It was statistically on par with T_{15} and T_{13} (44.00 and 43.33). Whereas, minimum was found in T_{17} (32.00)

The increase in flower size, weight, number might be due to the effect of balance nutrition supplied through combined application. Combined application of biofertilizer and chemical fertilizer might have attributed to the translocation of nutrients from soil and enhanced supply of macro and micronutrients during entire growing season and microbial decomposition which might have favored the stimulation and production of auxiliary buds and the carbohydrates when translocated to reproductive organs undergo hydrolysis and get converted into reproductive sugars, which ultimately help in increasing flower size and weight of flowers [11].

Vase life is an important criterion to assess the post harvest quality of cut flowers. The harvested spikes were given a slanting cut at the basal end and were put in tap water which was changed daily and the numbers of days taken for withering of all the florets from all the five spikes were recorded and mean value was expressed.

Treatment No.	Flower diameter(N-S) in (mm.)	Flower diameter (E-W) (mm.)	Number of florets/spike	Number of florets/m^2
T_1	15.01	14.79	2.25	32.33
T_2	15.53	15.41	2.30	35.33
T_3	15.69	15.32	2.30	36.67
T_4	15.60	15.44	2.27	35.67
T_5	16.08	15.43	2.30	35.33
T_6	16.01	15.85	2.27	35.00
T_7	15.31	14.63	3.24	34.00
T_8	15.11	14.13	3.25	35.00
T_9	15.89	15.26	3.29	35.67
T_{10}	16.10	15.69	3.56	36.67
T_{11}	16.53	16.17	4.47	40.33
T_{12}	16.64	15.85	4.64	40.67
T_{13}	15.56	15.37	4.87	43.33
T_{14}	17.45	17.09	5.00	46.33
T_{15}	15.64	15.44	4.94	44.00
T_{16}	14.62	14.36	2.33	40.00
T_{17}	14.99	15.00	2.20	32.00
S. Em ±	0.40	0.34	0.14	0.84
C.D. (1%)	1.56	1.34	0.54	3.27

Table 4: Effect of different graded levels of N, P, K and biofertilizers on other flower quality parameters of Asiatic lily Cv. Indian Summerset.

Treatment No.	Vase life with anthers (days)	Vase life without anthers (days)
T_1	7.21	9.41
T_2	7.61	9.65
T_3	7.85	9.58
T_4	8.15	10.19
T_5	7.97	9.51
T_6	8.12	10.34
T_7	8.25	10.43
T_8	8.48	10.19
T_9	8.64	10.57
T_{10}	10.33	11.56
T_{11}	10.95	12.08
T_{12}	10.69	11.62
T_{13}	10.74	11.71
T_{14}	11.15	12.37
T_{15}	11.05	11.84
T_{16}	10.49	11.27
T_{17}	7.14	9.31
S. Em ±	0.09	0.14
C.D. (1%)	0.36	0.57

Table 5: Effect of different graded levels of N, P, K and biofertilizers on vase life of Asiatic lily Cv. Indian Summerset.

Vase life with anthers was highest in treatment T_{14} (11.15 days) which was on par with T_{15} treatment i.e. 50% RDF + *Azotobacter croococcum* + *Aspergillus awamori* + *Bacillus musilogenesis* (11.05 days) and T_{11} treatment i.e. 50% RD'N' and 'P' + *Azotobacter croococcum* + *Aspergillus awamori* + 100% RD'K' (10.95 days). Whereas (7.14 days) the minimum vase life was recorded in treatment T_{17} (*Azotobacter croococcum* + *Aspergillus awamori* + *Bacillus musilogenesis*).

Vase life without anthers was highest in treatment T_{14} (12.37 days), which was on par with T_{15} treatment i.e. 50% RDF + *Azotobacter croococcum* + *Aspergillus awamori* + *Bacillus musilogenesis* (11.84 days). Whereas (9.31 days) the minimum vase life was recorded in treatment T_{17} (*Azotobacter croococcum* + *Aspergillus awamori* + *Bacillus musilogenesis*).

Increment in vase life might be due to reduction in ethylene synthesis which has a harmful effect for flower life. Biofertilizers regulate nutrient uptake process and prolonged vase phenomenon. Same findings are harmony with Khan., *et al*. [12] who reported that *Azotobacter* + *Azospirillum* inhibit the action of ethylene and extend the vase life of tulip for 10 - 12 days.

Conclusion

From present investigation it can be concluded that, application of 75% RDF + *Azotobacter croococcum* + *Aspergillus awamori* + *Bacillus musilogenesis* recorded higher flower yield and quality of Asiatic lily Cv. Indian Summerset. The use of bio-fertilizers have a lot of benefits apart from the increased yield and returns but also improves the soil structure and texture, as well as there is possibility of reducing the application of chemical fertilizers by 25 per cent with the use of biofertilizers, thus being down the cost of input resulting in a higher cost benefit ratio. Application of 75% RDF + *Azotobacter croococcum* + *Aspergillus awamori* + *Bacillus musilogenesis* proved to be the economically best for cultivation of Asiatic lily under Shivamogga condition.

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