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Effect of NPK on plant growth, flower yield, and flower quality of *Jasminum nitidum* cv. CO-1 (Star Jasmine)

Sentirenla Ozukum, VM Prasad and Samir Ebson Topno

Abstract
The present study entitled, "Effect of NPK on plant growth, flower yield, and flower quality of *Jasminum nitidum* cv. CO-1(Star Jasmine)" was conducted in Department of Horticulture, Naini Agriculture Institute, SHUATS, Prayagraj during 2020-21 to evaluate the plant growth, flower yield and flower quality of Star Jasmine with different treatment combinations of NPK and to find out the most suitable treatment under agro climatic conditions of Prayagraj region. The experiment comprised of 12 treatments, T_1 T_2 T_3 T_4 T_5 T_6 T_7 T_8 T_9 T_{10} T_{11} T_{12} and was laid in Randomized Block Design (RBD) and replicated thrice. The results revealed Maximum Plant Height (36.33cm), Maximum Plant Spread (42.33cm^2), Maximum No. of Branches (21.67), Maximum No. of Leaves per Plant (429.67), Days to Opening of 1st Flower (12.00), Maximum No. of Flowers per Plant (254.33), Flower Diameter (39.67mm), Maximum Flowering Yield per Plant (260.67g), Flower Yield/ha (2.23 t/ha), Maximum Gross Return (Rs.46,800), Net Return (-2,84,935) and B: C Ratio (0.85:1).
Based on the above discussion, it is concluded that treatment T_7 N:P:K (110:110:110 g/plant) was found to be the best treatment as compared to others which significantly increased the plant growth and yield of Jasmine (*Jasminum nitidum*) cv. CO-1 (Star Jasmine).

Keywords: Growth, yield, quality, star jasmine, NPK

Introduction
Jasmine belongs to the family Oleaceae and the genus *Jasminum* comprises of about 500 species, which are dispersed in the warmer parts of Europe, Asia, Africa and the Pacific region (Bhattacharjee, 1980) and is known to be the native of subtropical regions (David, 1990) [1]. Jasmine is one of the oldest of fragrant flowers and is specially appreciated in India, where most people have a love for the fragrant flowers.
A critical analysis of these species, however, has revealed the number of true species to be only 89, of which 40 inhabit the Indian sub-continent. More than 80 jasmine species are found in India, of which only three species are used for commercial cultivation. They are *Jasminum sambac* (Gundumalli/ Madurai Malli), *J. auriculatum* (Mullai) and *J. grandiflorum* (Jathimalli / Pitchi). Jasmine require temperature of 27–32°C during day time and 21–27°C at night, is ideal for good flowering. In off season temperature between 15℃ and 17°C during night shuts the flowering for a week (Leonhardt and Teves, 2002).
Jasminum nitidum plants are grown both as shrub and climber. With characteristic dark green foliage, leaves opposite, 3-10 cm long, variable in shape, usually ovate acute or acuminate or obtuse, entire glabrous. Elegant star or pinwheel shaped flowers which are mildly fragrant and are usually in clusters with 9-11 petals. They are highly valued ornamental plants for home gardens and commercial cultivation.
Jasmines are highly valued and the flowers and buds are used for making garlands, for religious offerings and venis used as hair ornament for the women for religious and other ceremonies. In India, Jasmine is cultivated in an area of about 255.02 million hectares with an annual production of 2167 million tonnes. In Tamil Nadu, Jasmine cultivation is done in a total area of 11900 hectare with an annual production of 88,112 tonnes (NHB, 2017). Jasmine flower produced from Tamil Nadu are being exported to foreign countries and also to other parts of India and.
Jasmine flowers are widely used in aromatherapy since jasmine fragrance is effective in treating depression, nervous exhaustion and stress. In China the flowers are used for perfuming tea, while in India they are made into garlands (Heneidy, 2010). The fragrance of jasmine flower cannot be imitated by any of the known synthetic aromatic chemicals (Bhattacharjee, 1980).

Jasmine oil has a wide range of medicinal applications and can be used in perfumery, soaps, flavorings and the cosmetic industry (Lawless, 1995). Jasmine oil is famous for the treatment of dry, greasy, irritated and sensitive skin. Other reported medicinal uses include soothing irritated coughs, alleviating muscular pain and treating sprains (Prabuseenivasan *et al.,* 2006). Therapeutically, jasmine oil is used as an anti depressant, antiseptic, antispasmodic, sedative and uterine tonic (Kang and Kim, 2002).

Most of the ornamental plants need more than two application of fertilizers during the growing season. Thus, fertilization must continue for good vegetative growth to produce a good flower. For plants to grow and thrive they need a number of chemical elements, but the most important are nitrogen, phosphorus and potassium (Wang *et al.,* 2019) [27].

Plant nutrition plays an important role for enhancing yield and quality in Jasmine. Nitrogen is especially important, and every amino acid in plants contains nitrogen as an essential component for plants to manufacture new cells (Marschner, 1997). Phosphorus which has been called the key to life is essential for cell division and for development of meristematic tissues and it is very important for carbohydrate transformation due to multitude of phosphorylation reaction and to energy rich phosphate bond (Lambers *et al.,* 2008). Potassium is important for growth and elongation probably due to its function as an osmoticum and may react synergistically with IAA. Moreover, it promotes CO_2 assimilation and translocation of carbohydrates from the leaves to storage tissues (Mengel and Kirkby, 1987).

Recently, Jasmine cultivation has received a fillip through research findings which indicated the potentiality of South Indian Jasmine. But one of the serious limiting factors which affects both jasmine flower growers and the consumers and which is likely to affect commercial production, is that the flowering of all the Jasminum species is seasonal. There are peak and lean productive seasons with consequent gluts and scarcity which affect the price trends greatly.

Material and Methods

This chapter contains the details of materials and methodology which is used during the experiment. The present investigation entitled, "EFFECT OF NPK ON PLANT GROWTH, FLOWER YIELD, AND FLOWER QUALITY OF *Jasminum nitidum* cv. CO-1 (Star Jasmine)" was carried out in the field of Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh during the year 2020-2021. The area comes under sub-tropical zone of Indo-Gangetic plains and lies at 25^0 24' 42" N latitude, 81^0 50' 56" E longitude and 98 m altitude above the mean sea level. The area is situated on the right side of the Yamuna river and about 12km from the city. It has a sub-tropical and semi-arid climatic condition and faces both the extremes of temperature, winter being too cold with the temperature dropping till 2°C and the summers too hot with the temperatures rising till 48°C.

The soils were characterized as sandy loam in texture. The experiment was laid out in Randomized Block Design. There were a total of 12 treatments and each of them were replicated thrice respectively. The treatments given were as follows: T_1 T_2 T_3 T_4 T_5 T_6 T_7 T_8 T_9 T_{10} T_{11} T_{12}

For growth attributes, the height of the plant was measured from the base of the plant to the highest point of the uppermost leaf and expressed in cm, Plant spread from north to south and east to west were measured and expressed in cm^2. The Number of Branches per Plant was calculated by counting the number of primary branches per plant. In three randomly selected branches, the number of fully opened leaves was counted at 30, 60 and 90 days after application of the NPK treatment. The average value was worked out and recorded as number of leaves per plant. The observations were recorded at 30 days intervals.

For yield attributes, the number of days to opening of 1st flower was recorded by counting the days, Number of flowers per plant was recorded weekly and finally total number of flowers was calculated, The measurement of flower diameter was done with the help of a 'Vernier caliper' and was expressed in mm. Fully opened flowers in each treatment and replication was plucked, the diameter of the flower was measured at the point of maximum breadth at harvest, the yield of flowers per plant is weighted weekly and calculated per year and converted into tonnes/heactare per year.

The data from the experiments were analyzed statistically, wherein the treatment differences were found to be significant and the critical differences were worked out at 5% level of probability (P=0.05).

Results and Discussion

Plant Height (cm)

Plant height was influenced by different levels of NPK at 90 DAP and the result was found to be significant. Significantly higher plant height (36.33cm) was obtained with the treatment T_7 N:P:K (110:110:110 g/plant). The plant height was found to be minimum (26.67cm) was obtained in the treatment T_{12} N:P:K (125:200:200 g/plant).

Significantly maximum may be due to increase in fertilization of macro nutrients from the required level. Although, all the fertilizers used have their importance, higher dose of potassium among the macro nutrients was found to be the most crucial for increase in plant height because potassium enhances the synthesis and translocation of carbohydrate. As the potassium dissolves in the soil water is taken up by the plant roots and the exchangeable K is released into the soil solution to maintain equilibrium between the two forms. Potassium has also been reported to be involved in the synthesis of peptide bond, and protein and carbohydrate metabolism, and also participates in rapid cell division and differentiation **(**Belorkar *et al.,* 1992). Nitrogen is a constituent of protein and nucleic acid, which is helpful in plant growth (Haque, 2001) and also promotes rapid growth. Phosphorus also encourages cell walls and length of the plant resulting in higher plant height in gerbera (Ayemi *et al.,* 2017) [4]. Similar result was reported by Amin *et al.,* (2011). Acharya *et al.,* (2004) also reported highest plant height with the application of nitrogen and phosphorus in marigold.

Plant spread (cm^2)

The plant spread was found to be maximum (42.33cm^2) in the treatment T_7 N:P:K (110:110:110 g/plant). And minimum plant spread (29.00cm^2) was obtained in the treatment T_{12} N:P:K (125:200:200 g/plant).

Significantly maximum plant spread may be due to application of chemical fertilizer which provided sufficient nutrition to support development process. Although, all the fertilizers used have their importance, higher dose of potassium among the macro nutrients was found to be the

most crucial for increase in plant spread. Potassium enhances the synthesis and translocation of carbohydrate. It triggers activation of enzymes and is essential for production of Adenosine Triphosphate (ATP) which is an important source for many chemical processes during plant growth. Nitrogen also promotes rapid vegetative growth and synthesizes amino acids which in turn form protein. Phosphorus also stimulates early growth and encourages cell wall and length of plant resulting in maximum plant spread in gerbera (Ayemi *et al.,* 2017) [4]. Similar result was reported by Barad *et al.,* (2010).
Another reason might be due to the fact that nitrogen is a constituent of protein which is essential for formation of protoplasm thus affecting cell division and cell enlargement and ultimately yielding better vegetative growth.

Number of Branches per Plant
The number of branches per plant at 90 DAP was found to be significant. Significantly higher number of branches per plant (21.67) was obtained in the treatment T_7 N:P:K (110:110:110 g/plant) and the minimum number of branches per plant (10.67) was obtained in the treatment T_{12} N:P:K (125:200:200 g/plant).
Improved growth may be attributed due to application of phosphorus which is an integral part of sugar phosphate (ATP and ADP) and necessary for photosynthetic and respiratory processes. Potassium triggers activation of enzymes and is essential for production of Adenosine Triphosphate (ATP). Moreover, dividing total fertilizer application into two or more splits to enhance nutrient efficiency by the plant as the roots are more developed and able to access more fertilizer. Increased growth and quality due to split application of fertilizers as observed with the present investigation are in close conformity with the findings of Chaudhary *et al.* (2016) [8] in Rose, Krushnaiah *et al.* (2018) [14] in Aster, Lee *et al.* (2018) [15] in Lettuce, Swati *et al.* (2021) [25] in Marigold, Wang *et al.* (2017) [28] in Orchid.

Number of Leaves per Plant
The number of leaves per plant was influenced by different levels of NPK at 90 DAP and the result was found to be significant. Significantly higher number of leaves per plant (1289) was obtained in the treatment T_7 N:P:K (110:110:110 g/plant) and minimum number of leaves per plant (583) was obtained with treatment T_{12} N:P:K (125:200:200 g/plant).
Significantly maximum number of leaves per plant was recorded in T_7 which may be due to increase in fertilization of macro nutrients from the required level. Nitrogen is associated with high photosynthetic activity and vigorous vegetative growth which has the tendency to increase leaf cell number and cell size with an overall increase in leaf production. Phosphorus also plays a role in photosynthesis, respiration, energy storage and transfer resulting in maximum number of leaves. Potassium helps in the synthesis of peptide bond, protein and carbohydrate metabolism resulting in maximum number of leaves.
Another reason could be because of optimum nutrients provided to plants, which might have accelerated rate of photosynthesis thereby enhancing the vegetative growth of plants, as reported by Parya *et al.,* (2010) [6] in golden rod.
It could also be due to the better nutritional status of plant which was favored by the treatments. Similar results were also reported by Bhattacharjee *et al.,* (1983) in *J. grandiflorum*, Prakash *et al.,* (2002) and Gauhane *et al.,* (2004) in Marigold, also observed similar result in their experiments.

Table 1: Effect of NPK on Plant Growth of *Jasminum nitidum*

Treatment No.	Treatment Combination	Plant Growth			
		Plant Height (cm)	Plant spread (cm^2)	Number of Branches per Plant	Number of Leaves per Plant
T_1	60:120:120 (g/plant) (RDF)	33.67	40.00	19.67	1224
T_2	45:60:60(g/plant)	30.67	36.00	16.67	1012
T_3	55:70:70(g/plant)	31.67	36.33	16.00	1070
T_4	60:80:80(g/plant)	32.33	38.00	18.00	1202
T_5	75:90:90(g/plant)	31.00	36.33	16.33	1187
T_6	100:100:100(g/plant)	31.67	36.00	16.67	1075
T_7	110:110:110(g/plant)	36.33	42.33	21.67	1289
T_8	115:120:120(g/plant)	28.67	32.33	13.67	735
T_9	120:130:130(g/plant)	27.67	31.00	13.33	698
T_{10}	125:140:140(g/plant)	27.33	30.67	12.67	690
T_{11}	125:175:175(g/plant)	27.00	29.67	12.00	692
T_{12}	125:200:200(g/plant)	26.67	29.00	10.67	583
	S.Ed (+)	1.10	1.11	0.94	43.66
	C.D.at 0.5%	2.29	2.30	1.94	90.55

Days to Opening of 1st flower
The days to opening of 1st flower (days) was found to be minimum (12.00) in the treatment T_7 N:P:K (110:110:110 g/plant). And maximum days to opening of 1st flower (days) (15.00) was obtained in the treatment T_{12} N:P:K (125:200:200 g/plant).
The probable reason for early flower opening may be contributed by meristematic activity of metabolites from vegetative growth of plants. Potassium is a major osmotically active component in plant cells contributing to cell turgor and enhancing the capacity of plant cell to retain water and nutrients. Nitrogen and Phosphorus also resulted in maximum increase in nutrient uptake and stimulates blooming resulting in early flower opening. Similar result was reported by Mohariya *et al.* (2004) in Gerbera.

Number of Flowers per Plant
The number of flowers per plant at 90 DAP was found to be significant among the treatments. Significantly higher number of flowers per plant (254.33) was obtained with treatments T_7 N:P:K (110:110:110 g/plant) Minimum plant height (93.67) was obtained with treatment T_{12} N:P:K (125:200:200 g/plant).

Significantly maximum number of flowers per plant may be due to the high level of potassium which had pronounced effect on number of flowers among the macro nutrients. Balanced dose of nitrogen, phosphorus and potassium seemed to have increased the vegetative growth favorable for the synthesis of peptide bond, protein and carbohydrate metabolism that are essential for flower development. High potassium with appropriate dose of nitrogen and phosphorus seemed to have increased the number of flowers per plant in gerbera (Ayemi *et al.,* 2017) [4]. Similar result was obtained by Nayak *et al.,* (2005).

Flower diameter (mm)

The flower diameter (mm) was found to be maximum (39.67mm) in the treatment T_7 N:P:K (110:110:110 g/plant). And minimum flower diameter (mm) (32.00mm) was obtained in the treatment T_{12} N:P:K (125:200:200 g/plant).

Split application of nitrogen at different stages which is attributed to the increased meristamatic activity and uptake of nitrogen at relevant time by the plant required to intensify the vegetative growth (Patil *et al.,* 2004) [19]. It clearly indicates that the application of phosphorus in split dose fulfilled the requirement of Jasmine crop more effectively. Luxuriant growth, more dry matter under split application of nitrogen, phosphorus and potassium which ultimately increased the weight and diameter of flower buds **(**Manisha *et al.* 2016) [16]. The results are in close conformity with the findings of with Borah *et al.* (2020) [7] in Marigold, Manisha *et al.* (2016) [16], Mukhopadhyay and Bankar (1985) [17] in Tuberose, Ogujboye *et al.* (2020) [18] in Maize, Patil *et al.* (2004) [19] in Gaillardia, Soares *et al.* (2016) [24] in Soyabean, Rubina Khanam et al. (2017) [22] in Gladiolus.

Nitrogen can stimulate meristematic activity involved in flower bud differentiation through polyamines biosynthesis that further added to increase flower bud diameter and flower bud weight (Chaudhary *et al.* 2016) [8].

Significantly maximum flower diameter might be due to the presence of higher potassium dose among the macro nutrients which is also a major osmotically active component in plant cells contributing to cell turgor and enhancing the capacity of plant cell to retain water and nutrients. Potassium also results in superior quality of flower due to the improved efficiency of photosynthesis. Nitrogen and phosphorus also resulted in maximum increase in nutrient uptake and stimulates blooming resulting in maximum flower diameter in Gerbera. Similar result was reported by Mohariya *et al.,* (2004).

Table 2: Effect of NPK on Flower Quality of *Jasminum nitidum*

Treatment No.	Treatment Combination	Flower Quality		
		Days to Opening of 1st flower	Number of Flowers per Plant	Flower diameter (mm)
T_1	60:120:120 (g/plant) (RDF)	12.67	237.33	38.33
T_2	45:60:60(g/plant)	13.33	215.00	37.00
T_3	55:70:70(g/plant)	12.67	206.67	36.33
T_4	60:80:80(g/plant)	13.00	225.33	37.33
T_5	75:90:90(g/plant)	13.67	197.33	35.67
T_6	100:100:100(g/plant)	13.33	187.33	36.67
T_7	110:110:110(g/plant)	12.00	254.33	39.67
T_8	115:120:120(g/plant)	13.33	141.67	34.00
T_9	120:130:130(g/plant)	13.33	134.67	35.00
T_{10}	125:140:140(g/plant)	13.67	125.00	32.67
T_{11}	125:175:175(g/plant)	14.00	115.00	33.33
T_{12}	125:200:200(g/plant)	15.00	93.67	32.00
	S.Ed (+)	0.43	6.90	1.05
	C.D.at 0.5%	0.90	14.32	2.17

Flower Yield per Plant (g)

The flower yield per plant was found to be maximum (260.67 g) in the treatment T_7 N:P:K (110:110:110 g/plant). The minimum flower yield per plant (127.33g) was found in the treatment T_{12} N:P:K (125:200:200 g/plant).

Significantly maximum flower yield per treatment was due to the chemical fertilizers which provide sufficient nutrition to support vegetative growth and flower formation. There is always a dramatic change in quantity of plant growth when appropriate fertilizers are added. Nitrogen is needed for vegetative growth and is a part of proteins, enzymes, vitamins and chlorophyll and low nitrogen and high potassium level promotes flowering resulting in maximum flower yield. Similar result was obtained by Barad *et al.,* (2010).

Flower Yield/ha (t/ha)

The flower yield per ha was found to be maximum (2.34 t/ha) in the treatment T_7 N:P:K (110:110:110 g/plant). The flower yield per ha was found to be minimum (1.30 t/ha) in the treatment T_{12} N:P:K (125:200:200 g/plant).

The reason for maximum no of flower is due to the fact that the amount of applied nitrogen significantly increased the growth parameter like number of branches, plant height which have synthesized more plant metabolites and ultimately led to increased number of flowers (Chan, 1995). Similar results were found by Chawala *et al*., (2007) in Chrysanthemum.

Table 3: Effect of NPK on Flower Yield of *Jasminum nitidum*

Treatment No.	Treatment Combination	Flower Yield	
		Flower Yield per Plant (g)	Flower Yield/ha (t/ha)
T_1	60:120:120 (g/plant) (RDF)	233.33	2.09
T_2	45:60:60(g/plant)	186.00	1.67
T_3	55:70:70(g/plant)	167.00	1.50
T_4	60:80:80(g/plant)	214.33	1.92
T_5	75:90:90(g/plant)	179.00	1.61

T_6	100:100:100(g/plant)	176.67	1.59
T_7	110:110:110(g/plant)	260.67	2.34
T_8	115:120:120(g/plant)	176.00	1.58
T_9	120:130:130(g/plant)	173.00	1.55
T_{10}	125:140:140(g/plant)	160.00	1.44
T_{11}	125:175:175(g/plant)	145.00	1.30
T_{12}	125:200:200(g/plant)	127.33	1.14
	S.Ed (+)	11.01	9.45
	C.D.at 0.5%	22.84	18.64

Conclusion

On the basis of the results obtained from the present investigation, it is concluded that, the application of the treatment combination T_7 N:P:K (110:110:110 g/plant) was found to be the best as compared to others in terms of plant growth *viz.*, Plant Height (36.33 cm), Plant Spread (42.33 cm^2), Number of branches (21.67), Number of Leaves per plant (429.67), and flower yield *viz.*, Days opening of 1st Flower (12.00 days), Number of Flowers per plant (254.33), Flower Diameter (39.67 mm), Flower Yield per Plant (260.67 g), Flower Yield/ha (2.23 t/ha) of *Jasminum nitidum* and the Benefit Cost Ratio is (0.85:1). Therefore, the application of T_7 N:P:K (110:110:110 g/plant) on *Jasminum nitidum* plants can be recommended for better growth and flowering under Prayagraj agro-climatic conditions.

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