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Nutrient management strategies through split application for optimizing growth, quality, yield and nutrient use efficiency in Jasmine

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Abstract
In a nutrient management, split fertilization play an important role to increase fertilizer use efficiency. Application of fertilizer at time of requirement leads to optimizing the yield and quality of lean season flowers. The experiment was conducted in tropical condition with five different treatments of split application of N, P and K at different growth stage of plant with Randomized Block Design and replicated five times. Application of 25%N+25%P+25%K in last week of December + 25%N+25%P+25%K in last week of March + 25%N+25%P+25%K in last week of June (T_3) to jasmine plants resulted maximum plant height (187.84 cm), length of secondary shoot (90.10 cm) and plant spread in N-S (135.15 cm) and in E-W (132.63 cm) directions at 360 days after pruning. Plants treated with (T_3) noted highest flower bud diameter (8.04 mm) and weight of hundred flower bud (34.20 g). Flower bud yield (7.51 t/ha) were obtained at 240 days after pruning and observed that lean season flowering yield as compared to recommended practices of application of fertilizer. Maximum available nitrogen in soil (231.53 kg/ha) are recorded in (T_3) and phosphorus (69.03 kg/ha) 50%N+50%P+50%K in last week of December + 25%N+50%P+50%K in last week of March + 25%N in last week of June (T_5) before 3rd split of application. It is concluded that T_3 was found proper nutrient schedule to get better growth, yield and quality in *Jasminum sambac*.

Keywords: *Jasminum sambac*, nutrient management, lean season flower, split fertilization, nutrient schedule, yield and quality

1. Introduction
Jasmine belongs to the family Oleaceae, order Oleales and genus *Jasminum*. 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 natural 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]. The splitting of these fertilizers reduces nutrient losses and improved the availability of these elements to root zone. The split application of NPK to increase the inorganic sources improved the cation exchange capacity of soil. The increase of soil CEC may be due to available higher amount of NPK in soil solution and root zone. (Tiwari *et al*., 2016) [26].
Abou-El- Ghait *et al.* (2020) [1] found that to produce good quality *Jasminum sambac* plants with more flowers, it is preferable to apply nutrients with split application. comparison to the basal application, the split N application used N more efficiently, showing consistently higher levels of agronomic use efficiency, recovery efficiency, physiological efficiency and partial factor productivity. Therefore, optimized N management is imperative to improve NUE and reduce the negative impacts on the environment. Du *et al.* (2019) reported that N fertilizer could be reduced by approximately 12%–50% of the conventionally applied rates without sacrificing grain yield in rice.
Sandy textured soils are more fragile and loose, which facilitates the growth of the tubers, while the clayey soils are less fragile and present high capacity of P adsorption, which has a positive correlation with the clay content. Thus, in clayey soils, P adsorption is higher, whereas, in sandy soils, the available P concentrations remain higher after the application of the P fertilization. P is more available in the sandy soil, where P adsorption by soil colloids is lower. (Jessyca Dellinhares *et al.*, 2018) [12]. Research has shown that fertilizer input contributes about 40- 50% of total yield increase for most crops (Dass and Mandal, 2016) [9].

In fact 50% of the total increase in crop production comes from the use of fertilizers and rest from all other factors combined together. Good flower production requires optimal fertilizer management to attain a high ornamental value and to reduce production cost of a plant.

Optimum rate of fertilizer application to a crop is that rate which produces the maximum economic returns at the minimum cost and can be derived from a nutrient response curve. (Ahmed *et al*., 2017) [2, 3]. So, Research objective was optimization growth, yield, quality, economics and nutrient use efficiency by proper nutrient management with split application of fertilizers.

2. Materials and Methods

The present investigation was carried out at 'Floriculture Research Farm, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari (20°57' North latitude and 72°54' East longitude at an altitude of about 11.83 meters above the mean sea level) during December 2018 to December 2019. The experimental site is placed under Agricultural Ecological Situation- III and experimental soil is placed under the group of *Vertic Ustochrets,* sub order Iceptisols.

The experiment was laid out in Randomized Blocked Design with five replication and five treatments *viz.* T_1 - application of 50%N+100%P+100%K at last week of December and 50%N in last week of June, T_2 - application of 50%N+75%P+75%K in last week of December + 25%N+25%K in last week of March + 25%N+25%P in last week of June, T_3 - application of 50%N+50%P+50%K in last week of December + 25%N+25%P+25%K in last week of March + 25%N+25%P+25%K in last week of June, T_4 - application of 50%N+50%P+50%K in last week of December + 25%N in last week of March + 25%N+50%K+50%P in last week of June, T_5 - Application of 50%N+50%P+50%K in last week of December + 25%N+50%P+50%K in last week of March + 25%N in last week of June.

The gross plot size of experiment was 4.8 m x 4.8 m and net plot size was 2.4 m x 2.4 m. The spacing was 1.2 x 1.2 m. Five year old *Jasminum sambac* plants were selected for experiment and planted at 1.2 m x 1.2 m. Pruning was done at 50 cm height from the ground level in December, 2018 to get uniform height.

Vegetative parameters were recorded at 90, 180 and 360 days after pruning and Flowering and parameters were recorded at 90, 180 and 240 days after pruning while yield parameters recorded during picking of the flower buds and cumulative yield was noted per year. Soil analysis was carried out before experiment and after experiment as well as before 3rd split application of fertilizers and estimation of pH, EC, organic carbon, available nitrogen (%), available phosphorus (kg/ha) and available potassium (kg/ha) was done.

3. Result and Discussion

3.1 Vegetative and Flower Quality Parameters

At 90 days after pruning

Application of 50%N + 100%P + 100%K at last week of December and 50%N in last week of June (T_1) to jasmine plants resulted maximum length of secondary shoot (29.87 cm), plant spread in N-S (83.58 cm) and in E-W (72.43 cm) directions, weight of hundred flower buds (33.0 g) at 90 days after pruning. No significant difference was found in plant height, flower bud diameter and shelf life of flower buds (Table 1).

The improved growth observed because of sufficient amount of fertilizers in which nitrogen is an essential part of nucleic acid, which plays vital role in promoting plant growth. Phosphorus might have improved the growth as it is one of the major element and being a constituent of nucleoprotein, known to play a leading role in photosynthesis, cell division and tissue formation (Arnon, 1959) [4]. Potassium would have enhanced the synthesis and translocation of carbohydrates resulting in improved vegetative growth and dry matter accumulation.

Nitrogen resulted increased carbohydrate assimilation leading to increase vegetative growth and got converted into reducing sugar and phosphorus application stimulation in root growth which helped in better root development resulting in more absorption of water and mineral nutrients from soil and ultimately increasing weight of flower buds (Beniwal *et al*. 2005) [5]. The results are in accordance with earlier findings of Ahmed *et al*. (2017) [2, 3] in Chrysanthemum, Bi and Evans (2010) [6] in marigold, Rayham *et al*. (2010) in gerbera, Rolaniya *et al*. (2017) [21] in marigold and Saeed *et al*. (2019) [23] in rose.

Table 1: The effect of split application of nutrients on growth and quality criteria at 90 days after pruning.

Treatments	Plant Height (cm)	Length of secondary shoot (cm)	Plant spread (cm) N-S direction	Plant Spread (cm) E-W direction	Flower bud diameter (mm)	Weight of hundred flower buds (g)	Shelf life of flower buds (hrs.)
T_1	131.15	29.87	83.58	72.43	9.66	33.00	55.42
T_2	127.85	27.37	77.75	65.23	8.91	29.73	54.93
T_3	121.56#	22.90#	70.48#	59.58#	8.60#	24.14#	52.22#
T_4	#	#	#	#	#	#	#
T_5	#	#	#	#	#	#	#
S. Em.±	3.31	1.19	3.01	2.93	0.35	1.51	1.48
C. D. at 5%	NS	3.89	9.83	9.56	NS	4.94	NS
C. V.%	5.84	9.98	8.72	9.97	8.66	11.69	6.11

#:As the treatment plots having similar symbol have received the same treatments, so instead of considering them as different treatments they are averaged and considered as a single treatment. DAPr- Days after pruning

At 180 days after pruning

Plants receiving application of 50%N+50%P+50%K in last week of December + 25%N+50%P+50%K in last week of March + 25%N in last week of June (T_5) showed maximum plant height (172.70 cm), length of secondary shoot (67.49 cm), plant spread in N-S (114.99 cm) and in E-W (104.33 cm) directions, flower bud diameter (9.02 mm) and weight of hundred flower buds (36.11 g) at 180 days after pruning (Table 2). This might be due to more availability of nitrogen for fast multiplication and enlargement of cells leading to quick and better vegetative growth of jasmine plant.

Improved growth may also 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. 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]. 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.

Table 2: The effect of split application of nutrients on growth and quality criteria at 180 days after pruning.

Treatments	Plant height (cm)	Length of secondary shoot (cm)	Plant Spread (cm) N-S direction	Plant Spread (cm) E-W direction	Flower bud diameter (mm)	Weight of hundred flower buds (g)	Shelf life of flower buds (hrs.)
T_1	149.96	54.86	97.38	88.25	7.56	25.33	50.33
T_2	150.34	58.44	98.58	92.84	7.80	27.36	50.53
T_3	161.86	62.92	109.15	97.94	8.85	32.03	54.14
T_4	152.15	57.24	100.86	90.57	7.74	29.12	53.83
T_5	172.70	67.29	114.99	104.33	9.02	36.11	55.31
S. Em.±	5.64	2.29	3.75	3.66	0.36	1.52	1.89
C. D. at 5%	16.91	6.86	11.24	10.96	1.08	4.57	NS
C. V.%	8.01	8.50	8.05	8.62	9.79	11.35	8.02

At 240 and 360 days after pruning

Maximum flower bud diameter (8.04 mm), weight of hundred flower buds (34.20 g) at 240 days after pruning and at 360 days after pruning (Maximum plant height (187.84 cm), length of secondary shoot (90.10 cm), plant spread (135.15 cm) in N-S and (132.63 cm) in E-W directions) were recorded when plants treated with application of 50%N+50%P+50%K in last week of December + 25%N+25%P+25%K in last week of March + 25%N+25%P+25%K in last week of June (T_3) at 360 and 240 days after pruning, respectively (Table 3).

This might be due to fact that application of NPK together at proper time and growth stage of plant and also due to supply of sufficient quantity of these essential nutrients seems to be helpful for improving photosynthesis, cell division, root growth and ultimately. 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 indicated that 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.

Table 3: The effect of split application of nutrients on growth at 360 Days after pruning and quality criteria at 240 days after pruning.

	At 360 days after pruning				At 240 days after pruning		
Treatments	Plant Height (cm)	Length of secondary shoot (cm)	Plant spread (cm) N-S direction	Plant Spread (cm) E-W direction	Flower bud diameter (mm)	Weight of hundred flower buds (g)	Shelf life of flower buds (hrs.)
T_1	164.48	75.07	117.16	111.32	6.40	21.78	52.86
T_2	167.22	77.92	120.13	117.97	5.92	25.87	53.18
T_3	187.84	90.10	135.15	132.63	8.04	34.20	57.48
T_4	167.88	78.87	118.76	118.80	6.73	27.43	54.49
T_5	185.56	83.41	131.13	125.02	7.31	30.82	56.21
S. Em.±	6.03	3.19	4.58	4.48	0.26	1.34	1.75
C. D. at 5%	18.08	9.56	13.73	13.42	0.77	4.02	NS

3.2 Yield Parameters

Split application of fertilizers showed significant results with respect to the essential attribute *viz.*, flower bud yield per plot (kg) and total flower bud yield per ha (t). Highest flower bud yield (4.33 kg/plot) and (7.51 t/ha) were obtained from the plants treated with application of 50%N+50%P+50%K in last week of December + 25%N+25%P+25%K in last week of March + 25%N+25%P+25%K in last week of June (T_3) (Table 4).

In case of nutrient application, when to apply is the prime requirement to obtain the target yield and quality of crop (Kolota and Osinka, 2001) [13]. There is also great role of split application of fertilizer might be resulted the fertilizer use efficiency through fulfilling the need base requirement of nutrients to at proper stage which convert energy to reproductive growth and finally the flower yield. Moreover, to split fertilizer application during the whole growing season rather than providing a single fertilization prior to or at planting, plants can able to take up all nutrients efficiently and reduce the chances of denitrification or leaching.

These findings are in agreement with the findings of Manisha *et al.* (2016) [16] and Parthiban and Khadar (1991) in tuberose, Patil *et al.* (2004) [19] in gaillardia, Soares *et al.* (2016) [24] in soyabean, Rubina Khanam *et al.* (2017) [22] in gladiolus.

Table 4: Effect of split application of fertilizers on flower bud yield per hectare per year

Treatments	Yield (t/ha)
T_1	6.42
T_2	6.57
T_3	7.51
T_4	6.62
T_5	7.26
S. Em.±	0.24
C. D. at 5%	0.71
C. V.%	7.71

3.3 Soil analysis

Soil health with respect to soil pH, EC, organic carbon and available potassium was found non-significant as affected by split application of fertilizers before 3rd split of application and at the end of the experiment. Plants receiving application of 50%N+50%P+50%K in last week of December + 25%N+25%P+25%K in last week of March + 25%N+25%P+25%K in last week of June (T_3) resulted maximum available nitrogen in soil (231.53 kg/ha) while highest available phosphorus in soil (69.03 kg/ha) with the application of 50%N+50%P+50%K in last week of December + 25%N+50%P+50%K in last week of March + 25%N in last week of June (T_5) before 3rd split application of fertilizer (Table 5). This might be due to continuous availability of nitrogen owing to split application of nitrogen which helps in reduction of denitrification and leaching of nitrogen. The application of phosphorus at the vegetative growth stage of the plants maintained a higher value of available P2O5 in soil. Beneficial effect of phosphorus application at this stage of growth of plant attributed to the greater content of available phosphorus in soil during this period. The results are in accordance with the finding of Soares *et al*. (2016) [24] in soyabean, Rubina Khanam *et al*. (2017) in gladiolus.

Table 5: The effect of split application of nutrients before 3rd split application on soil parameters.

Treatments	Soil pH	Soil EC (dSm^{-1})	Organic Carbon (%)	Available Nitrogen ($kg\ ha^{-1}$)	Available Phosphorus ($kg\ ha^{-1}$)	Available Potassium ($kg\ ha^{-1}$)
T_1	7.57	0.33	0.65	192.00	68.69	546.80
T_2	7.65	0.35	0.68	200.00	56.40	544.61
T_3	7.74	0.38	0.71	231.53	59.51	534.66
T_4	7.72	0.37	0.67	207.20	49.44	500.05
T_5	7.77	0.40	0.72	228.60	69.03	542.40
S. Em.±	0.23	0.02	0.02	8.72	3.78	16.74
C. D. at 5%	NS	NS	NS	26.14	11.33	NS
C. V.%	6.71	11.29	7.91	9.20	13.95	7.01

Table 6: The effect of split application of nutrients on soil parameters at the end of experiment

Treatments	Soil pH	Soil EC (dSm^{-1})	Organic Carbon (%)	Available Nitrogen ($kg\ ha^{-1}$)	Available Phosphorus ($kg\ ha^{-1}$)	Available Potassium ($kg\ ha^{-1}$)
T_1	7.55	0.32	0.59	244.17	46.94	477.32
T_2	7.57	0.34	0.64	245.20	51.33	484.50
T_3	7.92	0.39	0.67	242.80	55.96	518.98
T_4	7.61	0.35	0.63	240.80	56.57	524.62
T_5	7.66	0.36	0.66	243.17	52.20	501.09
S. Em.±	0.23	0.01	0.03	13.03	4.84	16.32
C. D. at 5%	NS	NS	NS	NS	NS	NS
C. V.%	6.80	8.75	8.86	11.98	20.58	7.28

4. Conclusion

From the result of the present experiment, it can be concluded that the application of RDF (120:240:120 kg/ha) in three splits (application of 50%N+50%P+50%K in last week of December + 25%N+25%P+25%K in last week of March + 25%N+25%K+25%P in last week of June) enhanced vegetative growth, improved quality of flower buds, maximum fertilizer use efficiency with increased yield with lean season flowering ctherefore, was economically deduced best for production of *Jasminum sambac* under clay/black soil.

5. References

1. Abou el-ghait E, Youssef ASM, Mohammed YF, Noor el-deen TM, Mohammed HI. Effect of benzyladenine and chemical fertilization on growth, flowering and chemical composition of *Jasminum sambac* plant. Scientific Journal of flower and Ornamental Plants 2020;7(4):379-391.
2. Ahmed R, Hussain MJ, Karim MR, Siddiky MA. Effect of N, P and K fertilizer on the flower yield of chrysanthemum. The Agriculturists 2017;15(1):58-67.
3. Ahmed R, Hussain MJ, Karim MR, Siddiky MA. Effect of nitrogen, phosphorus and potassium fertilizers on yield and yield attributes of Marigold. The Agriculturists 2017;15(1):101-109.
4. Arnon DI. Choloroplast and photosynthesis in the photochemical apparatus, its structure and functions. Brookhaven Symposia in Biology 1959;11:181.
5. Beniwal BS, Ahlawat VP, Singh S. Effect of nitrogen and phosphorus levels on flowering and yield of chrysanthemum (*Chrysanthemum morifolium*) cv. Flirt. Crop Research- IIHR 2005;30(2):177-180.
6. BI G, Evans WB. Effect of organic and inorganic fertilizers on Marigold growth and flowering. Hort Science 2010;45:1373-1377.
7. Borah N, Deka J, Deka NC, Barua IC, Saud BK, Das K, *et al.* Soil fertility status, nutrient uptake and productivity of Marigold (*Tagetes erecta* Linn.) as influenced by fertilizer doses and plant growth regulators. Current Journal of Applied Science and Technology 2020;39(24):53-65.
8. Chaudhary UC, Alka Singh, Ahlawat TR, Neelima Palagani. Influence of nitrogen on growth parameters and leaf nutrient composition of Rose cv. Samurai under protected conditions. The Bioscan 2016;11(3):1377-1380.
9. Das DK, Mandal M. Advance technology of fertilizer uses for crop production. In Book: Fertilizer Technology-I Synthesis, (1 st ed.), Studium Press, LLC, USA 2016, 101-150.
10. Du X, Xi M, Kong L. Split application of reduced nitrogen rate improves nitrogen uptake and use efficiency in sweet potato. Scientific Reports 2016;9:14058.
11. Hina Malhotra, Vandana, Sharma S, Renu Pandey. Plant nutrients and abiotic stress tolerance. Springer Nature Singapore 2018.
12. Jessyca LM, Rogerio PS, Adalton MF, Pedro HM. Phosphorus fertilization and soil texture affect Potato yield. Revista Caatinga 2018;31(3):541-550.
13. Kolota E, Osinka M. Efficiency of foliar nutrition of field vegetables grown at different nitrogen rates. Acta Horticulture 2001;563:87-91.
14. Krushnaiah R, Nayak MH, Prasanth, P, Saidanaik D. Studies on the effect of integrated nutrient management on growth, flowering and yield of Italian Aster (*Aster amellus* L.) cv. 'Purple Multipetal'. International Journal

of Current Microbiology and Applied Science 2018;7:1-13.
15. Lee SB, Kim YM, Sung JK, Bae-Lee D. Characteristics of growth stage based nutrient uptake of lettuce grown by fertigation supply in a greenhouse. Korean Journal of Soil and Fertilizer 2018;51:626-635.
16. Manisha Deshmukh, Gupta NS, Deshmukh SD, Priya Gawande, Raut VU. Eminent flowering gained via split application of NPK in Tuberose. International Journal of Current Microbiology and Applied Science 2016;1(6):2144-2150.
17. Mukhopadhyay A, Bankar GJ. Effect of split application of nitrogen on growth and yield of Polianthes tuberosa L. cv. 'Single'. South Indian Horticulture 1985;33(1):60-62.
18. Ogunboye OI, Adekiya AO, Ewulo BS, Olayanju A. Effect of split application of urea fertilizer on soil chemical properties, Maize performance and profitability in Southwest Nigeria. The Open Agriculture Journal 2020;14(36):36-42.
19. Patil BC, Naik HB, Kulkarni BS, Jagdeesh SL, Nalawadi UG. Comparison of effect of split application of nitrogen at different stages on growth and flower yield of gaillardia on red and black soils. Journal of Ornamental Horticulture 2004;7(3&4):138-143.
20. Rayhan MR, Rashid MHA. Effect of varieties and inorganic fertilizers on growth and flowering of gerbera (*Gerbera jamesonii*). Journal of Agriculture, Food and Environment 2020;1(4):6-12.
21. Rolaniya M, Khandelwal SK, Sunita Koodi, Sepat SR, Choudhary A. Effect of NPK, biofertilizers and plant spacings on growth and yield of African Marigold. Chemical Science Review and Letters 2017;6(21):54-58.
22. Rubina Khanam, Dipa Kundu, Patra SK. Integrated nutrient management on growth, quality, yield and soil fertility of Gladiolus in lower Gangetic Plain of India. International Journal of Current Microbiology and Applied Science 2017;6(4):453-459.
23. Saeed A, Noor-Ul-Amin. Effect of Phosphorus and potassium on the production quality of cut Rose cultivars. Sarhad Journal of Agriculture 2019;35(3):798-805.
24. Soares MM, Sediyama T, Lima Neves JS. Nodulation, growth and soyabean yield in response to seed coating and split application of phosphorus. Journal of Seed Science 2019;38(1):30-40.
25. Swati Walia, Kumar R. Nitrogen and sulfur fertilization modulates the yield, essential oil and quality traits of wild Marigold (*Tagetes minuta*). Frontiers in Plant Science 2021;11:1-17.
26. Tiwari NK, Zaidi SFA, Chandan Kumar S, Rahul Kumar. Effect of split application if NPK fertility on nutrient uptake by hybrid rice and soil health. Agriculture Update 2016;2(1):75-78.
27. Wang C, Min Q, Ali Abid A, Sardans J, Wu H., Yok-Fo-Lai D, Penuelas J, Wang W. Optimal coupling of straw and synthetic fertilizers incorporation on soil properties, active Fe dynamics, and greenhouse gas emission in *Jasminum sambac* (L.) field in southern China. Sustainability 2019;11(4):1092-1112.
28. Wang YT, YC Alex Chang. Effect of nitrogen and the various forms of nitrogen on phalaenopsis Orchid. Hort Technology 2017;27(2):144-149.