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Effect of different levels of nitrogen in combination with nano urea on growth and yield of crossandra (*crossandra infundibuliformis* l.) cv. lakshmi

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ABSTRACT

An experiment was carried out during the year 2022-2024 in the Department of Horticulture, Faculty of Agriculture, Annamalai University Tamil Nadu to find out the suitable level of nitrogen to be used in combination with nano urea to increase the growth and yield of crossandra (Crossandra infundibuliformis L.) cv. Lakshmi. The experiment was laid out in Randomized Block Design with 14 treatments and 3 replications. Among the different treatments, the treatment T_5 (100% PK + 75% N through urea + 0.4% Nano urea (3 sprays)) resulted in increased growth attributes such as plant height (85.21 cm), stem girth (7.95 cm), number of branches plant^{-1} (24.51), number of leaves plant^{-1} (99.29), plant spread in North-South and East-West direction (53.52 cm and 62.43 cm respectively), leaf area (95.41cm^2), chlorophyll content (0.840 mg g^{-1}) and dry matter production (91.53 g plant^{-1}). But, the treatment T_8 (100% PK + 50% N through urea + 0.4% Nano urea (3 sprays)) resulted in increased yield attributes like maximum number of spikes plant^{-1} (36.27),number of flowers spike^{-1} (39.21), flower yield plant $^{-1}$(51.03 g),flower yield plot^{-1} (974.76 g plot^{-1}), estimated flower yield hectare^{-1} (32.49 q ha^{-1}) The treatment control (T_1) had the lowest value for all the growth and yield attributing characters. Overall, it is concluded that the application of 100% PK + 50% N through urea + 0.4% Nano urea (3 sprays) (T_8) was found to be the best combination for improving the growth and yield of crossandra.

Key words: Crossandra, nitrogen, urea, nano urea, growth and yield.

INTRODUCTION

Crossandra is a popular and important commercial flower crop belonging to the "Acanthaceae" family. It is an important evergreen perennial blooming plant native to South India and Sri Lanka (Vadivel and Panwal, 2016). It's a tall evergreen semi-shrub with glossy, wavy-margined leaves and fan-shaped flowers that bloom at any time of the year. Flowers are irregularly shaped with 3 to 5 asymmetrical petals. They grow from four sided stalked spikes and have a tube-like 2 cm stalk. The colour of the flowers varies from common orange to salmon orange or apricot, coral to red, yellow and even green. It is also popularly known as, "Firecracker flower". The crop management practices like pinching, mulching, earthing up, weed management and nutrient management had been already well researched in this crop and standardized practices are already recommended for farmer's practice. However, the modern techniques like application of nano fertilizers are not researched enough to recommend for farmer's practice. Nano urea contains nanoscale nitrogen particles (30-50 nm) which have more surface area (10,000 times over 1mm urea prill) and number of particles (55,000 nitrogen particles over 1mm urea prill) (Kumar *et al.,* 2021). Nano urea has manifold benefits over conventional urea, reduces the requirement of conventional urea by 50 % or more, required less and produces more: efficacy of one bottle of nano urea (500 ml) is equivalent to one bag of urea, environment friendly produce, improve soil, air and water quality and it is cheaper than conventional urea and reduce input cost to farmers, leads to increase in farmer's income .This experiment aims to study the effect of different levels of nitrogen in combination with nano urea on growth and yield of crossandra (*Crossandra infundibuliformis* L.) cv. Lakshmi.

MATERIALS AND METHODS

This study was carried out in the Floriculture unit, Department of Horticulture, Faculty of Agriculture, Annamalai University, Annamalai Nagar, Tamil Nadu during the year 2022-2024. The experiment was laid out in Randomized Block Design with 14 treatments

and 3 replications. The treatments were T_1 (Control), T_2 (100% NPK), T_3 (100% PK + 75% N through urea + 0.2% Nano urea (3 sprays)), T_4 (100% PK + 75% N through urea + 0.3% Nano urea (3 sprays)), T_5 (100% PK + 75% N through urea +0.4% Nano urea (3 sprays)), T_6 (100% PK +50% N through urea + 0.2% Nano urea (3 sprays)),T_7 (100% PK +50% Nthrough urea + 0.3% Nano urea (3 sprays)), T_8 (100% PK + 50% N through urea + 0.4% Nano urea (3 sprays)), T_9 (100% PK + 25% N through urea + 0.2% Nano urea (3 sprays)),T_{10} (100% PK + 25% N through urea + 0.3% Nano urea (3 sprays)),T_{11} (100% PK + 25% N through urea + 0.4% Nano urea (3 sprays)),T_{12} (100% PK + 0.2% Nano urea (3 sprays)), T_{13} (100% PK + 0.3% Nano urea (3 sprays)) andT_{14} (100% PK + 0.4% Nano urea (3 sprays)). The experimental field (4 cents) was laid out into plots of size of 2 m x 1.5 m. Each treatment plots were formed with 9 pits of spacing of 60 x 40 cm.Healthy, uniform sized rooted cuttings were planted in the pits. FYM 400 kg along with Gypsum 1.5 kg and SSP (2 kg) and MOP (1.5 kg) applied as basal dose. Top dressing was done 30 days after planting with neem cake 4 kg and 26 g of urea. Recommended dose of fertilizers (N P K @ 40:20:60 kg ha^{-1}) i.e., for an area of 3 m^2, 100 % NPK (26 g of urea, 37 g of SSP and 30 g of MOP) at 90 DAP was applied and this dose was repeated at quarterly intervals throughout the cropping period. Similarly, 75 % N = 20 g of urea, 50 % of N = 13 g of urea and 25 % of N = 6.5 g of urea were applied. First irrigation was given immediately after planting. Subsequent irrigations were given at 7 days interval. Application of nano urea were done by foliar application. The required amounts of nano urea as spray solution were dissolved in water as per the doses prescribed in treatment schedule. The prepared solution was sprayed three times in the field on 45^{th}, 60^{th} and 75^{th} DAP. Uniform cultural practices were maintained for all the treatments. The biometric observations on growth attributes like plant height, stem girth, number of branches $plant^{-1}$, number of leaves $plant^{-1}$, plant spread, leaf area, chlorophyll content, dry matter production and yield attributes like number of spikes $plant^{-1}$, number of flowers $spike^{-1}$, flower yield $plant^{-1}$, flower yield $plot^{-1,}$ estimated flower yield $hectare^{-1}$ were recorded at 180 DAPon five randomly selected tagged plants from each treatment in each replication. The data on various parameters were analysed statistically as per the procedure suggested by Panse and Sukhatme (1978).

RESULTS AND DISCUSSION

Growth Attributes

The data pertaining to the effect of different levels of nitrogen in combination with nano urea on growth attributes of crossandra are presented in Table 1. The plant height (85.21 cm) and stem girth (7.95 cm) were observed the maximum in the treatment T_5 (100% PK + 75% N through urea + 0.4% Nano urea (3 sprays)), followed by the treatment T_4 (100% PK + 75% N through urea + 0.3% Nano urea (3 sprays)) with the values of plant height (82.64 cm) and stem girth (7.65 cm). The minimum plant height (51.64 cm) and stem girth (4.68 cm) were observed the minimum in the treatment (T_1) which is control. It might be due to the fact that nitrogen being essential part in the biosynthesis of nucleic acids which when applied through the soil as well as foliar application of nano urea that finally involved in the process of cell division, cell elongation and protein synthesis leading to enhanced plantheight and stem girth. The results are in conformity with the findings of Manisha *et al*. (2014) in African marigold and Vinayaka *et al*. (2022) in jamun. The maximum number of branches in a plant (24.51) and number of leaves in a plant (99.29) were recorded in T_5 (100% PK + 75% N through urea + 0.4% Nano urea (3 sprays)), followed by the treatment T_4 (100% PK + 75% N through urea + 0.3% Nano urea (3 sprays)) with number of branches in plant (23.81) and number of leaves in a plant (96.52). The minimum number of branches in a plant (15.69) and number of leaves in a plant (60.54) were recorded in T_1 (control). The fact that the nano fertilizers have large surface area with particle size less than the pore size of leaves thereby increasing the penetration into the plant and also stimulates the effect of nitrogen on auxin and export of cytokinin to the shoots might encourages cell division and cell elongation of the plant resulting in more number of branches and leaves in a plant. Similar findings were reported by Jadhav *et al*. (2014) in African marigold, Teja *et al*. (2017) in annual chrysanthemum, Rajiv *et al*. (2018) in jasmine.

Table 1: Effect of different levels of nitrogen in combination with nano urea on growth attributes of crossandra (*Crossandra infundibuliformis* L.) cv. Lakshmi

Treatments	Plant height (cm)	Stem girth (cm)	No. of branches plant^{-1}	No. of leaves plant^{-1}	Leaf area (cm^2)	Chlorophyll content (mg g^{-1})	Dry matter production (gplant^{-1})
T_1	51.64	4.68	15.69	60.54	64.27	0.391	47.34
T_2	69.91	6.30	20.61	82.37	66.51	0.593	70.13
T_3	78.97	7.22	22.63	91.58	89.77	0.746	81.98
T_4	82.64	7.65	23.81	96.52	93.37	0.792	87.16
T_5	85.21	7.95	24.51	99.29	95.41	0.840	91.53
T_6	72.61	6.55	21.28	85.31	84.06	0.652	74.97
T_7	76.48	6.91	21.98	88.01	87.21	0.707	79.46
T_8	80.55	7.37	23.14	93.65	90.89	0.781	84.01
T_9	62.93	5.67	18.85	73.84	75.72	0.485	59.99
T_{10}	64.41	5.76	19.32	75.91	78.46	0.493	62.18
T_{11}	66.90	6.01	19.95	78.74	81.83	0.549	67.19
T_{12}	55.21	4.93	16.88	63.52	69.84	0.418	50.67
T_{13}	57.66	5.18	17.58	66.47	72.16	0.431	53.91
T_{14}	60.12	5.42	18.21	69.52	74.59	0.457	56.45
S. Ed	0.95	0.11	0.31	1.25	0.85	0.014	1.22
CD(p=0.05)	1.92	0.21	0.63	2.51	1.71	0.029	2.47

The results on the effect of various treatments on plant spread are presented in Figure 1. The plant spread along North-South (53.52 cm) and East-West (62.43 cm) direction after 180 DAP was found to be the maximum in the treatment (T_5) combination of 100% PK + 75% N through urea + 0.4% Nano urea (3 sprays), followed by T_4 (100% PK + 75% N through urea + 0.3% Nano urea (3 sprays)) with the values of 52.03 cm and 60.42 cm at N-S and E-W direction respectively. The minimum plant spread along N-S (32.38 cm) and E-W (35.72 cm) direction was found in control (T_1). The variation in different treatments might be due to nitrogen has a positive role in increasing the activity of meristematic cells, cell division and its importance in building amino acids such as tryptophan, the basis for building auxins contributing to cell expansion and cell enlargement resulted in increased plant spread of the plant. The findings were comparable with Priyadharshini *et al*. (2018) in African marigold and Vinayaka *et al*. (2022) in jamun.

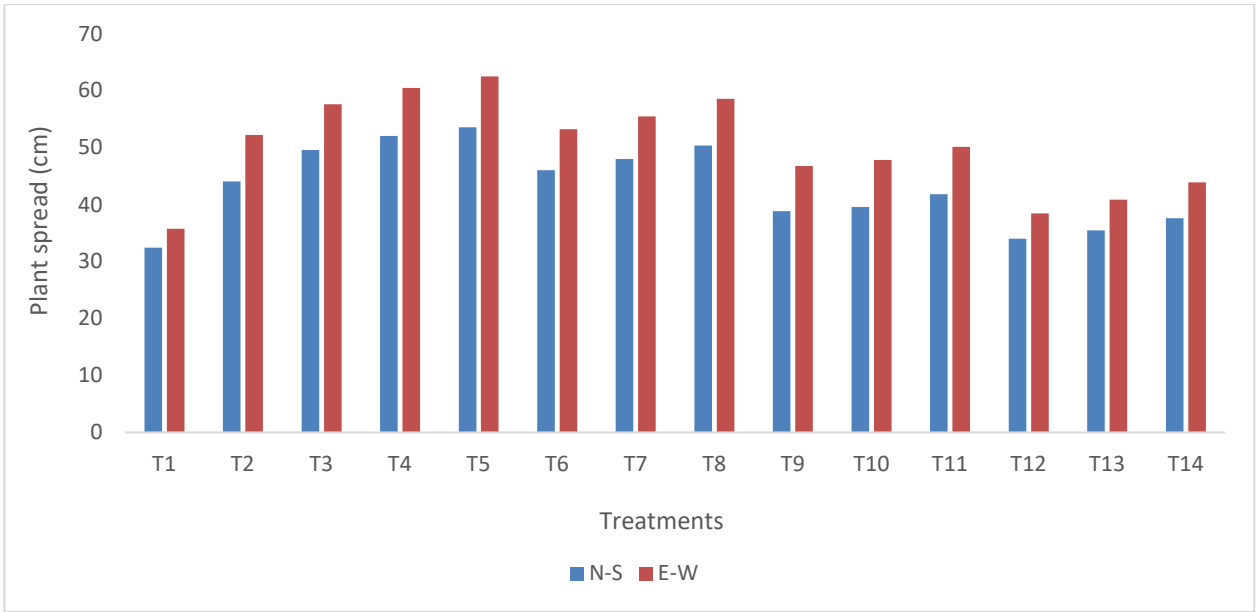

Figure 1: Effect of different levels of nitrogen in combination with nano urea on plant spread (cm) of crossandra (*Crossandra infundibuliformis* L.) cv. Lakshmi

The leaf area (95.41 cm^2), chlorophyll content (0.840 mg g^{-1}) and dry matter production (91.53 g $plant^{-1}$) were observed the maximum in the treatment T_5 (100% PK + 75% N through urea + 0.4% Nano urea (3 sprays)), followed by T_4 (100% PK + 75% N through urea + 0.3% Nano urea (3 sprays)) with leaf area (93.37 cm^2), chlorophyll content (0.792 mgg^{-1}) and dry matter production (87.16 g $plant^{-1}$). The minimum leaf area (64.27 cm^2), chlorophyll content (0.391 mg g^{-1}) and dry matter production (47.34 g $plant^{-1}$) were observed in control (T_1). When nano urea sprayed on leaves, it easily enters through stomata and hence, increase the nutrient availability which increases the cell expansion and level of chlorophyll providing dark green colour to leaves, necessary for photosynthesis. The dry matter production increased with crop growth stage reaching a peak at later stage of crop growth. Similar results were obtained by Al-Juthery and Al-Maamouri (2020) in potato and Bhatti *et al*. (2023) in guava.

Yield Attributes

The data pertaining to the effect of different levels of nitrogen in combination with nano urea on yield attributes of crossandra are presented in Table 2**.**

Table 2: Effect of different levels of nitrogen in combination with nano urea on yield attributes of crossandra (*Crossandra infundibuliformis* L.) cv. Lakshmi

Treatments	No. of spikes $plant^{-1}$	No. of flowers $Spike^{-1}$	Flower yield $plant^{-1}$ (g $plant^{-1}$)	Flower yield $plot^{-1}$ (g $plot^{-1}$)
T_1	21.65	26.54	29.50	623.40
T_2	28.72	33.66	41.05	830.18
T_3	29.73	34.58	43.83	848.67
T_4	30.48	35.12	44.77	864.65
T_5	33.63	37.19	48.79	915.63
T_6	31.68	36.07	46.56	888.39
T_7	35.09	38.18	50.01	944.15
T_8	36.27	39.21	51.03	974.76
T_9	26.21	31.36	36.24	773.16
T_{10}	26.72	31.79	37.22	787.59
T_{11}	27.74	32.72	39.81	811.82
T_{12}	22.63	28.19	32.44	654.92
T_{13}	23.60	29.44	32.92	699.54
T_{14}	24.58	30.46	34.82	737.48
S. Ed	0.48	0.46	0.58	9.81
CD (p=0.05)	0.96	0.93	1.17	19.72

The maximum number of spikes in a plant (36.27) and number of flowers per spike (39.21) were observed in the treatment T_8 (100% PK + 50% N through urea + 0.4% Nano urea (3 sprays)), followed by T_7 (100% PK + 50% N through urea + 0.3% Nano urea (3 sprays)) with number of spikes per plant (35.09) and number of flowers per spike (38.18).The minimum number of spikes in a plant (21.65) and flowers per spike (26.54) were observed under control (T_1). At different nitrogen levels, the vegetative growth of plant and more accumulation of food reserves are diverted to flower bud differentiation and spray of nano urea to crop canopy resulted in more number of spikes per plant. The increased number of spikes under optimum dose of nitrogen may be attributed to more number of flowers per spike. The findings were comparable with Sendhilnathan and Manivannan (2019) in tuberose, Gowthami *et al*. (2018) and Priyanka *et al*. (2018) in crossandra.

The flower yield $plant^{-1}$ (51.03 g $plant^{-1}$), flower yield $plot^{-1}$ (974.76 g $plot^{-1}$) and estimated flower yield $hectare^{-1}$ (32.49 q ha^{-1}) (Fig. 2) were recorded the maximum in T_8 (100% PK + 50% N through urea + 0.4% Nano urea (3 sprays)), followed by the treatment T_7 (100% PK + 50% N through urea +0.3% Nano urea (3 sprays)) with the values of flower yield $plant^{-1}$ (50.01 $gplant^{-1}$), flower yield $plot^{-1}$ (944.15 g $plot^{-1}$) and estimated flower yield $hectare^{-1}$ (31.47 q ha^{-1}). The minimum flower yield per plant (29.50 g $plant^{-1}$), flower yield per plot (623.40 g $plot^{1}$) and estimated flower yield per hectare (20.78 q ha^{-1}) were noticed in control (T_1). The higher flower yield was due to more number of flowers $spike^{-1}$,

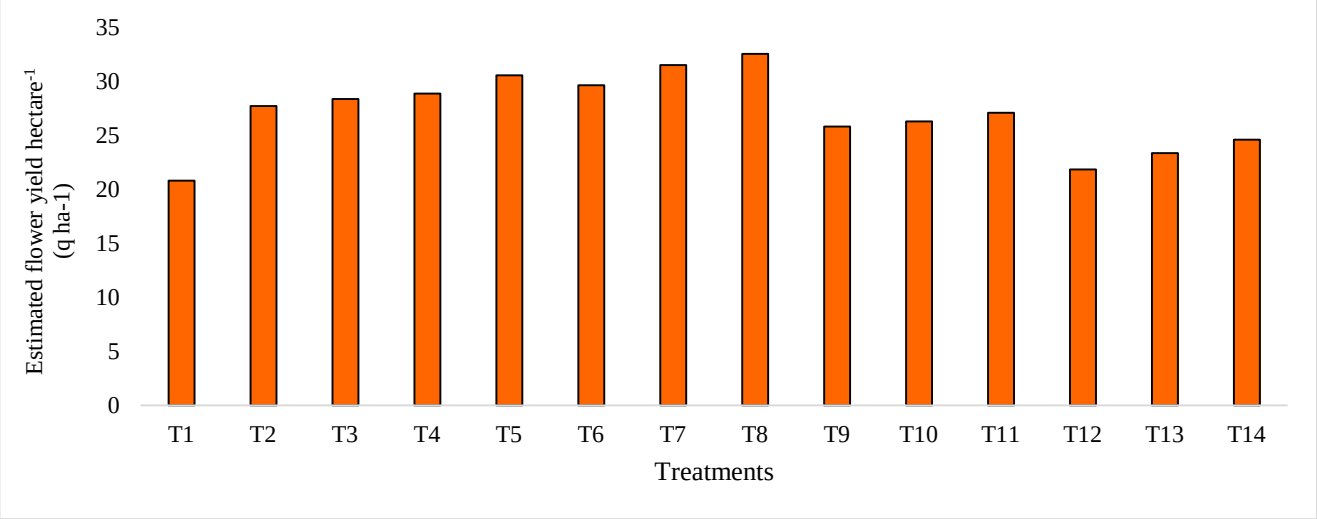

Figure 2: Effect of different levels of nitrogen in combination with nano urea on estimated flower yield hectare^{-1} (q ha^{-1}) of crossandra (*Crossandra infundibuliformis* L.) cv. Lakshmi

flower weight and increased flower size. The optimum supply of nutrients to the crop at the different growth stages, ultimately increasing the carbohydrates assimilates which leads to acceleration in flower yield of the plant and plot. The present findings are in close affirmative with Priyanka *et al*. (2018) in crossandra, Tiwari *et al.* (2021) in potato and Venkatesh *et al*. (2022) in African marigold.

From the study, the treatment T_5 (100% PK + 75% N through urea + 0.4% Nano urea (3 sprays)) recorded higher values for growth parameters but showed significantly lesser yield attributes because of the vigorous vegetative growth of the plants leads to poor penetration of sunlight and improper partitioning of photosynthates. This led to reduced flower production and ultimately resulted in reduced yield. But the treatment T_8 (100% PK + 50% N through urea + 0.4% Nano urea (3 sprays)) showed optimum vegetative growth and better yield attributes. Therefore, it is concluded that application of 100% PK + 50% N through urea + 0.4% Nano urea (3 sprays) (T_8) was found to be the best combination for obtaining proper growth with plant height (80.55 cm), stem girth (7.37 cm), number of branches plant^{-1} (23.14), number of leaves plant^{-1} (93.65), plant spread in North-South and East-West direction (50.31 cm and 58.53 cm respectively), leaf area (90.89 cm^2), chlorophyll content (0.781 mg g^{-1}) and dry matter production (84.01 g plant^{-1}) and better yield attributes like maximum number of spikes plant^{-1} (36.27), number of flowers spike^{-1}(39.21), flower yield plant^{-1}(51.03 g plant^{-1}),flower yield plot^{-1} (974.76 g plot^{-1}), estimated flower yield hectare-1 (32.49 q ha^{-1}) under open field conditions.

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