Study on effect of different levels of nitrogen in combination with nano urea on quality parameters, seed parameters, available nitrogen in soil and nitrogen content in leaves of marigold *(Tagetes erecta* L.*)* Cv. Pusa Narangi Gainda

Abstract

The experiment entitled "Study on effect of different levels of nitrogen in combination with nano urea on growth and yield of marigold *(Tagetes erecta* L.*)* Cv. Pusa Narangi Gainda" was conducted during the *Rabi* season of the year 2021-2022 at College of Horticulture, Rajendranagar, Sri Konda Laxman Telangana State Horticultural University. Among the treatments, the treatment T_4 (50% N + Nano Urea @ 2ml/l (2 sprays at 25 DAT and 50 DAT) recorded maximum shelf life (3.59 days), 100 seed weight (0.34 g), seed yield per flower (0.82 g) and benefit cost ratio (1.95), whereas minimum shelf life (2.50 days) recorded by T_3 while minimum 100 seed weight (0.20 g), seed yield per flower (0.43 g) and benefit cost ratio (1.26) were recorded by T_6 (Nano Urea @ 2 ml/l (3 sprays at 25 DAT, 50 DAT and 75 DAT).

Maximum available nitrogen (286.73 kg ha^{-1}) was recorded by T_1 treatment (100% RDF) and T_6 (Nano Urea @ 2 ml/l (3 sprays at 25 DAT, 50 DAT and 75 DAT) recorded minimum available nitrogen (218.36 kg ha^{-1}).

However, T_7 (Nano Urea @ 4 ml/l (3 sprays at 25 DAT, 50 DAT and 75 DAT) recorded highest germination percentage (86.7%) and maximum nitrogen content in leaves (1.81%), while T_2 treatment recorded minimum germination percentage (82.6%) and T_1 treatment (100% RDF) recorded minimum nitrogen content in leaves (1.55%).

Keywords: Nano urea, Marigold, Pusa Narangi Gainda

1. Introduction

Marigold (*Tagetes erecta* L.) is an important commercial annual flower belonging to the family Asteraceae. It is a native of Central and South America especially Mexico. The genus *Tagetes* comprises about 33 species, of which the commonly cultivated species are *Tagetes erecta*, *Tagetes patula* and *Tagetes minuta.* Amongst these, *Tagetes erecta* is commonly grown by the farmers on large scale for commercial purpose.

Marigold gained popularity amongst gardeners and flower dealers on account of its easy culture and wide spectrum of attractive colours, shape, size and good keeping quality (Chandrikapure *et al*., 1999).

The uses of marigold are many folds, often referred to as the 'versatile crop with golden harvest'. Marigold is extensively used for making garlands, beautification of avenues and other purposes *i.e*., pigment and oil extraction and therapeutic uses. Roots of marigold plants are known to suppress nematode population and hence used as a trap crop in nematode infested fields. Apart from these uses, it is highly suitable for bedding purpose, herbaceous border and newly planted shrubberies to provide colour and fill the space (Yadav *et al.*, 2015).

Marigold is gaining industrial importance due to its huge potential in value addition. A wide array of value-added products are prepared from marigold like pigments, meals, food colorant of essential oils (Swaroop *et al.*, 2007).

The conventional urea usage causes environmental pollution, eutrophication, leaching and volatilization losses compared to nano urea (Prem Babu, 2021).

Nanotechnology is a new emerging and fascinating field of science, permits advanced research in many areas and applications in the field of biotechnology and agriculture. Nanotechnology is providing feasibility of exploiting nanoscale nanostructure materials as fertilizer carriers or controlled release vectors for building of so called "smart fertilizer" as new facility to enhance nutrient use efficiency and reduce costs of environmental protection (Chinnamuthu and Boopathi, 2009).

Nano sized fertilizers are the new frontier of nanotechnology towards a sustainable agriculture. Nano urea manufacturing method provides a simplistic way to develop nano scale material for better crop production, while significantly minimizing the agro chemical leaching to the soil. Nano urea (liquid) contains nano scale nitrogen particles which have more surface area (10,000 times over 1 mm urea prill) and number of particles (55,000 nitrogen particles over 1 mm urea prill). Further, application of nano urea (liquid) improves yield, biomass, soil health and nutritional quality of the produce. Nano urea has manifold benefits over conventional urea,

reduces the requirement of conventional urea by 50 per cent 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 thus, helps in reducing the global warming, it is cheaper than conventional urea and reduce input cost to farmers, leads to increase in farmer's income. (Prem Babu, 2021)

2. Materials and Methods

The present investigation entitled "Study on effect of different levels of nitrogen in combination with nano urea on growth and yield of marigold *(Tagetes erecta* L.*)* Cv. Pusa Narangi Gainda" was carried out during the *Rabi* season of the year 2021-2022 at College of Horticulture, Rajendranagar, Sri Konda Laxman Telangana State Horticultural University. Healthy seed was planted on the raised bed and transplanted in main field at a spacing of 40 cm x 30 cm after one month.

The design adopted was Randomized Block Design with seven treatments replicated thrice. Treatments included T_1- Control 100% RDF (90:75:75 kg NPK ha-1), T_2- 75% N + Nano Urea @ 2ml/l (2 sprays at 25 DAT and 50 DAT), T_3- 75% N + Nano Urea @ 2ml/l (3 sprays at 25 DAT, 50 DAT and 75 DAT), T_4- 50% N + Nano Urea @ 2ml/l (2 sprays at 25 DAT and 50 DAT), T_5- 50% N + Nano Urea @ 2ml /l (3 sprays at 25 DAT, 50 DAT and 75 DAT), T_6- Nano Urea @ 2 ml/l (3 sprays at 25 DAT, 50 DAT and 75 DAT) and T_7- Nano Urea @ 4ml/l (3 sprays at 25 DAT, 50 DAT,75 DAT). Nano urea sprayed on the foliage at 3 intervals *i.e*., @ 25, 50 and 75 Days After Transplanting (DAT) and the observations recorded were shelf life (days), colour intensity, 100 seed weight (g), seed germination (%), seed yield per flower (g), available nitrogen (kg ha^{-1}), nitrogen content in leaves (%) and benefit cost ratio were recorded and the data was statistically analysed.

3. Results and Discussion

3.1 Quality parameters

The effect of different levels of nitrogen in combination with nano urea on quality of marigold *(Tagetes erecta* L.*)* Cv. Pusa Narangi Gainda and the results of the experiment were presented in Table 1.

3.1.1 Shelf life (days)

With respect to shelf life in marigold, treatment T_4 (50% N + Nano Urea @ 2ml/l (2 sprays at 25 DAT and 50 DAT) recorded maximum shelf life (3.59 days). While the minimum shelf life was recorded in T3 (75% N + Nano Urea @ 2ml/l (3 sprays at 25 DAT, 50 DAT and 75 DAT) (2.50 days).

3.2.2 Colour intensity

Using Southern Peony Royal Horticulture Society (RHS) colour matching chart the colour of flowers for all the treatments were observed.

Table 1: Effect of different levels of nitrogen in combination with nano urea on quality parameters of marigold Cv. Pusa Narangi Gainda

Treatments	Shelf life (days)	Colour intensity
T_1: Control 100% RDF (90 kg N -75 kg P_2O_5-75 kg K_2O ha^{-1})	3.36^{b}	Orange group 24 A
T_2: 75% N + Nano Urea @ 2ml/l (2 sprays)	2.56^{de}	Orange group 24 B
T_3: 75% N + Nano Urea @ 2ml/l (3 sprays)	2.50^{e}	Orange group 25 B
T_4: 50% N + Nano Urea @ 2ml/l (2 sprays)	3.59^{a}	Orange group 24 A
T_5: 50% N + Nano Urea @ 2ml/l (3 sprays)	3.11^{c}	Orange group 25 A
T_6: Nano Urea @ 2 ml/l (3 sprays)	2.51^{de}	Orange group 25 B
T_7: Nano Urea @ 4 ml/l (3 sprays)	2.72^{d}	Orange group 24 A
SE m±	0.07	
CD @ 5 %	0.21	

3.2 Seed parameters

The effect of different levels of nitrogen in combination with nano urea on quality of marigold *(Tagetes erecta* L.*)* Cv. Pusa Narangi Gainda and the results of the experiment were presented in Table 2.

3.2.1 100 seed weight (g)

The treatment T_4 (50% N + Nano Urea @ 2ml/l (2 sprays at 25 DAT and 50 DAT) recorded maximum 100 seed weight (0.34 g). Whereas, minimum 100 seed weight was significantly recorded in the treatment T_6 (Nano Urea @ 2ml/l (3 sprays at 25 DAT, 50 DAT and 75 DAT) (0.20 g). The maximum 100 seed weight in treatment T_4 (50% N + Nano Urea @ 2ml/l (2 sprays at 25 DAT and 50 DAT) might be due to nitrogen which helped in improving the protein synthesis and resulted in production of bolder and healthy seeds. These results are in close conformity with the findings of Awchar *et al*. (2010), Saman and Kirad (2013) in Calendula and Swaroop *et al*. (2007) in Marigold.

3.2.2 Seed germination (%)

Among the treatments, T_7 treatment (Nano Urea @ 4 ml/l (3 sprays at 25 DAT, 50 DAT and 75 DAT) (86.7%) recorded maximum germination and was on par with T_4 (50% N + Nano Urea @ 2ml/l (2 sprays) (85.5%) and T_1 (100% RDF) (84.6%). Whereas, minimum germination was recorded in T_2 (75% N + Nano Urea @ 2ml/l (2 sprays at 25 DAT and 50 DAT) (82.6%) and was found to be on par with T_3 (75% N + Nano Urea @ 2ml/l (3 sprays at 25 DAT, 50 DAT and 75 DAT) (83.5%), T_5 (50% N + Nano Urea @ 2ml/l (3 sprays at 25 DAT, 50 DAT and 75 DAT) (84.2%) and T_6 (Nano Urea @ 2 ml/l (3 sprays at 25 DAT, 50 DAT and 75 DAT) (84.4%).

3.2.3 Seed yield $flower^{-1}$ (g)

Significantly maximum seed yield $flower^{-1}$ (0.82 g) was observed in treatment T_4 (50% N + Nano Urea @ 2ml/l (2 sprays at 25 DAT and 50 DAT). Whereas minimum seed yield

flower^{-1} was recorded in treatment T_6 (Nano Urea @ 2ml/l (3 sprays at 25 DAT, 50 DAT and 75 DAT) (0.43 g) and it was on par with T_7 (Nano Urea @ 4ml/l (3 sprays at 25 DAT, 50 DAT and 75 DAT) (0.47 g) and T_2 (75% N + Nano Urea @ 2ml/l (2 sprays at 25 DAT and 50 DAT) (0.51 g). As nano urea has more surface area compared to the conventional urea it can enter into plant parts easily. Based on the results obtained, it may be concluded that seed yield flower^{-1} increased in the treatment T_4 (50% N + Nano Urea @ 2ml/l (2 sprays at 25 DAT and 50 DAT). These results were comparable with the earlier findings of Chavan *et al*. (2010) in China aster and Shinde *et al*. (2014) in African marigold.

Table 2: Effect of different levels of nitrogen in combination with nano urea on seed parameters of marigold Cv. Pusa Narangi Gainda

Treatments	100 seed weight (g)	Seed germination (%)	Seed yield flower^{-1} (g)
T_1: Control 100% RDF (90 kg N -75 kg P_2O_5-75 kg K_2O ha^{-1})	0.27^{b}	84.6^{ab}	0.61^{b}
T_2: 75% N + Nano Urea @ 2ml/l (2 sprays)	0.23^{e}	82.6^{b}	0.51^{cd}
T_3: 75% N + Nano Urea @ 2ml/l (3 sprays)	0.25^{c}	83.5^{b}	0.52^{c}
T_4: 50% N + Nano Urea @ 2ml/l (2 sprays)	0.34^{a}	85.5^{ab}	0.82^{a}
T_5: 50% N + Nano Urea @ 2ml/l (3 sprays)	0.24^{d}	84.2^{b}	0.53^{bc}
T_6: Nano Urea @ 2 ml/l (3 sprays)	0.20^{g}	84.4^{b}	0.43^{d}
T_7: Nano Urea @ 4 ml/l (3 sprays)	0.22^{f}	86.7^{a}	0.47^{cd}
SE m±	0.03	0.68	0.23
CD @ 5 %	0.01	2.12	0.08

3.3 Available nitrogen in soil (kg ha^{-1})

The effect of different levels of nitrogen in combination with nano urea on available nitrogen in soil were presented in Table 3.

Significantly highest available nitrogen was recorded in treatment T_1 (100% RDF) (286.73 kg ha^{-1}) and was found to be superior over all the other treatments. The lowest available nitrogen was recorded in treatment T_6 (Nano Urea @ 2 ml/l (3 sprays at 25 DAT, 50 DAT and 75 DAT) (218.36 kg ha^{-1}) and it was on par with T_7 (Nano Urea @ 4 ml/l (3 sprays at 25 DAT, 50 DAT and 75 DAT) (226.24 kg ha^{-1}). Higher available nitrogen content in treatment T_1 (100% RDF) might be due to higher application rates of nitrogen in the form of urea to the soil.

3.4 Nitrogen content in leaves (%)

The results of the nitrogen content (%) in leaves are presented in Table 3.

Maximum nitrogen content was recorded in T_7 (Nano Urea @ 4 ml/l (3 sprays at 25 DAT, 50 DAT and 75 DAT) (1.81%) and it was on par with T_6 (Nano Urea @ 2 ml/l (3 sprays at 25 DAT, 50 DAT and 75 DAT) (1.78%). Whereas significantly minimum nitrogen content was recorded in T1 (100% RDF) (1.55%). Maximum nitrogen content recorded might be due to the fact that nano urea has large surface area and particle size less than pore size of leaves helped the nano urea to enter into the plant and thereby improved the uptake of nitrogen.

Table 3: Effect of different levels of nitrogen in combination with nano urea on available nitrogen in soil and nitrogen content in leaves of marigold Cv. Pusa Narangi Gainda

Treatments	Available nitrogen (Kg ha^{-1})	Nitrogen content in leaves (%)
T_1: Control 100% RDF (90 kg N -75 kg P_2O_5-75 kg K_2O ha^{-1})	286.73^{a}	1.55^{f}
T_2: 75% N + Nano Urea @ 2ml/l (2 sprays)	251.40^{bc}	1.65^{e}
T_3: 75% N + Nano Urea @ 2ml/l (3 sprays)	255.27^{b}	1.66^{d}
T_4: 50% N + Nano Urea @ 2ml/l (2 sprays)	242.97^{c}	1.70^{c}
T_5: 50% N + Nano Urea @ 2ml/l (3 sprays)	246.80^{bc}	1.73^{b}
T_6: Nano Urea @ 2 ml/l (3 sprays)	218.36^{d}	1.78^{ab}
T_7: Nano Urea @ 4 ml/l (3 sprays)	226.24^{d}	1.81^{a}
SE m±	2.79	0.015
CD @ 5 %	8.61	0.05

3.5 Economics

The data on effect of different levels of nitrogen in combination with nano urea on economics of production of marigold Cv. Pusa Narangi Gainda is presented in Table 4.

The treatment T_4 (50% N + Nano Urea @ 2ml/l (2 sprays at 25 DAT and 50 DAT) recorded highest benefit cost ratio (1.95). Whereas T_6 (Nano Urea @ 2 ml/l (3 sprays at 25 DAT, 50 DAT and 75 DAT) recorded lowest benefit cost ratio (1.26). It is evident from the data that, maximum gross return was recorded in T_4 treatment (50% N + Nano Urea @ 2ml/l (2 sprays at 25 DAT and 50 DAT) which might be due to higher yield of flowers hectare^{-1} as compared to others

Table 4: Effect of different levels of nitrogen in combination with nano urea on economics of cultivation of marigold Cv. Pusa Narangi Gainda

Treatments	Cost of cultivation (₹/ha)	Net income (₹/ha)	B:C ratio
T_1: Control 100% RDF (90 kg N -75 kg P_2O_5-75 kg K_2O ha^{-1})	113013	214000	1.89
T_2: 75% N + Nano Urea @ 2ml/l (2 sprays)	113323	172000	1.51
T_3: 75% N + Nano Urea @ 2ml/l (3 sprays)	113713	182400	1.60
T_4: 50% N + Nano Urea @ 2ml/l (2 sprays)	113173	221000	1.95
T_5: 50% N + Nano Urea @ 2ml/l (3 sprays)	113613	210000	1.84
T_6: Nano Urea @ 2 ml/l (3 sprays)	111470	141000	1.26
T_7: Nano Urea @ 4 ml/l (3 sprays)	112790	168000	1.48

4. Conclusion

From the present study it can be concluded that nano urea significantly influences the quality of flowers, seed parameters and nitrogen content of marigold Cv. Pusa Narangi Gainda.

The treatment T_4 (50% N + Nano Urea @ 2ml/l (2 sprays 25 DAT and 50 DAT) showed positive effect quality parameters and seed parameters as compared to other treatments.

Future scope

The future line of work may be carried out in following lines. Effect of nano urea in combination with nano micronutrients, effect of nano urea in combination with nano phosphorous and nano potassium and effect of nano urea on F_1 hybrids need to be conducted.

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