**Influence of spacing and nano urea application on growth and flowering in marigold (*Tagetes erecta* L.)**

**Abstract**

**Aim:** To study the effect of spacing and nano urea application on growth and flowering parameters in marigold.

**Study design:** Split plot design

**Place and Duration of Study:** New orchard, Main Agricultural Research Station, University of Agricultural Sciences, Raichur during 2023-24.

**Methodology:** Spacing at 3 levels in combination with 3 different doses of nano urea.

**Results:** The results revealed that significantly minimum days to first flower initiation and 50 per cent flowering (25.22 and 31.00 Days after transplanting) in S3. But the highest number of branches (22.51), stem girth (1.62 cm), number of flowers per plat (50.54), fresh weight of flowers (128.76 g), recorded significantly highest in S1. Between different nano urea applications, N3 registered significantly highest number of branches per plant (23.04), stem girth (1.66 cm), minimum days to first flower initiation (25.78 days from transplanting) and 50 per cent flowering (30.89 days), maximum number of flowers (49.09), fresh weight of flowers (128.25 g).

**Conclusion:** The wider spacing (60 cm x 45 cm) showed the best results for growth and flowering parameters. The N3 [50% RDN (25% BD+25% TD)+0.2% NUS at 40 and 60 DAT] treatment also recorded superior compare to other treatments for all growth and flowering parameters *viz*., number of branches, stem girth, days to first flower initiation, days to 50 per cent flowering, number of flowers, fresh weight of flowers. Hence, planting with wider spacing S1 and N3 [60 cm x 45 cm and 50% RDN (25% BD+25% TD)+0.2% NUS at 40 and 60 DAT] were found to be superior.

**Keywords:** Flowering, marigold, nano urea application and Spacing.

**Introduction**

Marigold (*Tagetes erecta* L.) is one of the most commercially significant annual flower crop, valued for its vibrant blooms, variety of colors, sizes, shapes, and forms, which contribute to its visual appeal.

The flower represents the radiant energy of the sun and is associated with feelings of joy, optimism and positivity. Often referred to as the "versatile crop" with a "golden harvest," marigolds are primarily cultivated for loose flower production and are in high demand during festivals for garlands and decoration. Additionally, they are used to beautify public spaces, for religious offerings, and in the production of various products, including pigments, essential oils, and therapeutic applications.

Several factors influence marigold flower production, including temperature, photoperiod, planting time, spacing, pinching, irrigation and fertilizer application. Both plant spacing and nitrogen levels are critical for optimal growth, yield, and flower quality.

Proper spacing allows plants to efficiently use moisture, light, and nutrients, resulting in healthier growth and higher-quality flowers. Marigold crops, which require significant amounts of nitrogen, typically receive this nutrient through urea application. However, this practice raises environmental concerns, such as nitrate leaching, global warming, ozone depletion, and groundwater contamination.

Nano fertilizers offer a promising solution, as they can be applied directly to the soil or sprayed on plant leaves, allowing nutrients to enter the plant more efficiently and reducing waste. When sprayed, nano fertilizers penetrate the plant's protective layers and release nutrients gradually, promoting faster growth. Since marigold plants have a high demand for nitrogen compared to other crops, they benefit greatly from such precise nutrient delivery. However, traditional nitrogenous fertilizers applied to the soil often result in lower nitrogen use efficiency and reduced productivity. Nano Urea is a revolutionary, nanotechnology-based fertilizer developed by Indian Farmers Fertilizer Cooperative Limited (IFFCO). It boasts 50-60% higher efficiency than conventional urea, requiring only 500 ml per acre compared to 40-50 kg. This eco-friendly solution reduces soil and water pollution, while also being cost-effective. By enhancing nutrient absorption, Nano Urea boosts crop productivity and quality, supporting sustainable agriculture practices. Its benefits have made it a game-changer for farmers, promoting environmentally conscious farming while increasing yields.

**Material and Methods**

The field experiment was conducted with three spacing (S1- 60 x 45 cm, S2- 45 x 45 cm, S3- 45 x 30 cm) and three nano urea applications *viz*., N1- 100% RDN, N2- 50% RDN+0.2% NUS at 40 and 60 DAT and N3-50% RDN (25% BD+25% TD)+0.2% NUS at 40 and 60 DAT during Rabi 2023-24 at New orchard, MARS, Raichur. The flowers were harvested when it reached full bloom stage for all the treatments. The flowers harvested from field experiment was used to assess the flower reproductive yield and quality parameters using split plot design with three replications to know the effect of spacing and nano urea application in marigold flower quality.

**Observations**

The observations were recorded for number of branches, stem girth (cm), days to first flower initiation (days), days to 50 per cent flowering (days), number of flowers, fresh weight of flowers (g). The data pertaining to several characteristics of flower quality were statistically analysed using the methodology outlined by Gomez and Gomez (1984) [3].

**Results and Discussion**

The results showed that spacings and nano urea applications had shown significant difference for number of branches per plant, stem girth (cm), days to first flower initiation (days), days to 50 per cent flowering (days), number of flowers, fresh weight of flowers (g). But, for number of branches, stem girth, days to first flower initiation, days to 50 per cent flowering interactions had shown a non significant difference.

The wider spacing (S1) recorded significantly maximum number of branches per plant (22.51) compared to S3 spacing (17.05). Among different nano urea application N3 [50% RDN (25% BD+25% TD)+0.2% NUS at 40 and 60 DAT] recorded significantly highest number of branches (23.04) compared to N1 (16.61) (Table 1). This might be because of the availability of more space for growth of roots and shoots as well as utilization of more nutrients by the plants and positive impact of nitrogen on plant growth may be attributed to its synchronization with high physiological activity and maximum nutrient conversion to accessible form, which in turn stimulates the production of axillary buds and in turn number of branches. The similar results were demonstrated through the experiments conducted by Shivakumar (2000) [13], Amuamuha *et al*. (2011)[1]  in marigold, Saeed *et al*. (2020)[11] in marigold and Gowtham *et al*. (2024) in crossandra.

The (S1) showed significantly highest stem girth (1.62 cm) compared S3 spacing (1.27 cm). Among different nano urea application N3 [50% RDN (25% BD+25% TD)+0.2% NUS at 40 and 60 DAT] recorded significantly highest stem girth (1.66 cm) compared to N1 (1.32 cm) (Table 1). This might be due to enough space between the plants, and less competition amongst them, which could lead to a higher availability of nutrients to the plants that lead to an increase in stem thickness. Similar results were also reported by Karavadia and Dhaduk (2002) [5] in chrysanthemum and constant availability of nitrogen which plays a crucial role in the biosynthesis of nucleic acids when applied through both soil and foliar with nano urea which promoted cell division, cell elongation, and protein synthesis, resulting in increased stem girth. These findings similar with those of Manisha *et al*. (2014) [7] in African marigold.

The closer spacing (S3) recorded significantly minimum days to first flower initiation and 50 per cent flowering (25.22 and 28.00 days) compared S1 spacing (29.22 and 35.33 days). Among nano urea applications, N3 [50% RDN (25% BD+25% TD)+0.2% NUS at 40 and 60 DAT] recorded significantly minimum days to first flower initiation and 50 per cent flowering (25.78 and 30.89 days) compared N1 spacing (29.22 and 37.33 days) (Table 1). Closer plant spacing increases competition, leading to earlier flowering as plants compete for resources and complete vegetative growth faster. These findings are supported by studies on African marigold by Mohanty *et al*. (1993) [8] and chrysanthemum by Belgaonkur *et al*. (1997) [2]. Additionally, lower nitrogen rates promote earlier flowering, while higher doses delay it, as observed by Sharma *et al*. (2006) [12] in chrysanthemum and Thaneshwari (2014) [15] in hydrangea.

The wider spacing (S1) recorded significantly highest number of flowers (50.54) than S3 (38.55). Among different nano urea application, N3 treatment observed significantly more number of flowers (49.09) than the treatment N1 (40.54). The interaction S1N3 recorded significantly highest number of flower per plant (60.97) compare to other interactions. The minimum number of flowers per plant recorded in S3N3 (36.74). Wider spacing which provided more area per plant for absorption of nutrients and moisture, without shade effect which ultimately increased the rate of net photosynthesis and translocation of assimilates to the storage organs, which promotes more flowers in plants as compared to lesser area per plant. Similar results were also reported by Singh *et al*. (2018) [14] in African marigold. More branches provide more sites for flower bud formation, leading to an increase in the total number of flowers per plant. A similar results was found in Gowthami *et al*. (2018) [4] in crossandra.

The significantly highest fresh weight of 25 flowers was recorded in S1 (128.76 g) when compared to S3 (105.14 g). Among nano urea applications N3 recorded significantly highest test weight of flowers (128.25 g) than N1 (105.94 g). This might be due to less competition for resources leads to better plant establishment, resulting in larger and heavier flowers, as reported by Kumar *et al*. (2012) [6] in marigold. The increased flower weight is likely due to nitrogen from nano urea improving cell wall permeability, allowing more water into the flowers. These findings align with studies by Monish *et al*. (2008) [9] in China aster and Nikbakht *et al*. (2008) [10] in gerbera.

It was found that significantly highest number of flowers and fresh weight recorded for the interaction (S1N3) of spacing and nano urea application when compared other interactions and there was a non-significant difference for the interaction of different spacing and nano urea application for number of branches per plant, stem girth, days to first flower initiation, days to 50 per cent flowering (Table 2).

**Table 1. Effect of spacing and nano urea application on growth and flowering**

 **in marigold**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Treatments** | **Number of branches** | **Stem girth (cm)** | **Days to first flower initiation** | **Days to 50 per cent flowering** | **Number of flowers per plant** | **Fresh weight of 25 flowers (g)** |
| Spacings |
| S1 | 22.51 | 1.62 | 29.22 | 40.00 | 50.54 | 128.76 |
| S2 | 19.81 | 1.46 | 27.56 | 34.00 | 42.48 | 118.25 |
| S3 | 17.05 | 1.27 | 25.22 | 31.00 | 38.55 | 105.14 |
| S.Em.± | 0.77 | 0.04 | 0.63 | 1.04 | 1.45 | 3.51 |
| CD @5% | 3.03 | 0.17 | 2.50 | 4.09 | 5.69 | 13.77 |
| Nano urea application |
| N1 | 23.04 | 1.32 | 29.22 | 37.33 | 40.54 | 105.94 |
| N2 | 19.72 | 1.37 | 27.00 | 36.78 | 41.93 | 117.97 |
| N3 | 16.61 | 1.66 | 25.78 | 30.89 | 49.09 | 128.25 |
| S.Em.± | 0.68 | 0.05 | 0.68 | 1.05 | 1.03 | 2.85 |
| CD @5% | 2.11 | 0.15 | 2.12 | 3.23 | 3.20 | 8.77 |

 **Legend:**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Spacings** |  |  | **Nano urea application** |  |  |
|  **S1:** | 60 x 45 cm  |  | **N1:** 100% RDN |  |
| **S2:** | 45 x 45 cm |  | **N2:** 50% RDN + 0.2% NUS at 40 and 60 DAT |  |
| **S3:** | 45 x 30 cm |  | **N3:** 50% RDN (25% BD+ 25% TD)+ 0.2% NUS at 40 and 60 DAT |  |

 **Note: NS:** Non-significant

**RDN:** Recommended dose of nitrogen

**NUS:** Nano urea spray

**DAT:** Days after transplanting

**BD:** Basal dose

**TD:** Top dressing

**Table 2. Effect of interaction between spacing and nano urea application on growth and**

 **flowering in marigold**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Treatment** | **Number of branches** | **Stem girth (cm)** | **Days to first flower initiation** | **Days to 50 per cent flowering** | **Number of flowers per plant** | **Fresh weight of 25 flowers (g)** |
| Interactions (S x N) |
| S1N1 | 20.34 | 1.38 | 31.67 | 42.67 | 44.25 | 126.03 |
| S1N2 | 23.03 | 1.52 | 28.67 | 42.00 | 46.60 | 128.92 |
| S1N3 | 24.17 | 1.95 | 27.33 | 35.33 | 60.97 | 131.31 |
| S2N1 | 15.42 | 1.33 | 29.33 | 36.67 | 40.63 | 100.30 |
| S2N2 | 21.41 | 1.34 | 27.33 | 36.00 | 41.86 | 124.76 |
| S2N3 | 22.58 | 1.72 | 26.00 | 29.33 | 44.93 | 129.69 |
| S3N1 | 14.06 | 1.24 | 26.67 | 32.67 | 36.74 | 91.48 |
| S3N2 | 14.70 | 1.26 | 25.00 | 32.33 | 37.53 | 100.22 |
| S3N3 | 22.38 | 1.30 | 24.00 | 28.00 | 41.37 | 123.74 |
| S.Em.± | 1.41 | 0.09 | 1.35 | 0.21 | 2.31 | 6.05 |
| CD @5% | NS | 0.29 | NS | NS | 7.12 | 18.65 |

**Legend:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Spacings** |  |  | **Nano urea application** |  |
|  **S1:** | 60 x 45 cm  |  | **N1:** 100% RDN |
| **S2:** | 45 x 45 cm |  | **N2:** 50% RDN + 0.2% NUS at 40 and 60 DAT |
| **S3:** | 45 x 30 cm |  | **N3:** 50% RDN (25% BD+ 25% TD)+ 0.2% NUS at 40 and 60 DAT |

 **Note: NS:** Non-significant

**RDN:** Recommended dose of nitrogen

**NUS:** Nano urea spray

**DAT:** Days after transplanting

**BD:** Basal dose

**TD:** Top dressing

**Conclusion**

From the study it can be concluded that wider spacing (60 cm x 45 cm) was found superior for all the growth and flowering parameters *viz*., number of branches per plant, stem girth, number of flowers per plant, fresh weight of flowers than other levels of spacing. Among different nano urea applications, N3 [50% RDN (25% BD+25% TD) +0.2% NUS at 40 and 60 DAT] was found superior for all the growth and flowering parameters *viz*., number of branches per plant, stem girth, days to first flower initiation, days to 50 per cent flowering, number of flowers per plant, fresh weight of flowers.

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