



Peer-Reviewed, Refereed, Open Access Journal

Research Article

## Response of Integrated Nutrient Management on Vegetative and Flowering Characters of Marigold (*Tagetes erecta* L.)

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Received: 7.12.2019 | Revised: 16.01.2020 | Accepted: 22.01.2020

### ABSTRACT

The present investigation was under taken on periodical observations (30, 60 and 90 DAT) on vegetative growth at C.S. Azad University of Agriculture and Technology, Kanpur. Results indicated that all the growth parameters such as number of leaves, plant spread, diameter of plant stem, increased to the maximum upto the 75 % nitrogen level with or without biofertilizers. As regard the flowering characters there was a significant reduction in days taken to first flower bud initiation and days taken to first flower bud opening, under the combined application of biofertilizers (*Azotobacter* + PSB) alongwith 75 % nitrogen ( $T_8$ ) in both the years. While, Application of 100 % nitrogen alongwith biofertilizer inoculation delayed both the parameters. However, the maximum days were required under control ( $T_{14}$ ).

**Keywords:** *Azotobacter*, Biofertilizers, Marigold, PSB.

### INTRODUCTION

Marigold is native of Central and South America, especially Mexico (Randhawa & Mukhopadhyaya, 1986). Marigold is known as 'friendship flower' in United States and 'student lumen' (student's flower) in Germany. Marigold (*Tagetes erecta* L.), the most popular and commercial flower, apart from their aesthetic and industrial values, marigold is also got a wide range of application such as a trap crop and as a biopesticide in various horticultural and field crops. The main period for growing marigold in plains during winter season is from August to January. It is also grown in other seasons,

like winter (November–April), summer (February–July) and rainy (May–October). As a result of continuous use of chemical fertilizers, the soil gets depleted year by year and there is pollution of soil and water bodies through leaching, volatilization, denitrification and fixation of phosphorous in soil. Nitrogen being highly mobile in soil can pollute soil and ground water, therefore, management of nitrogenous fertilizer such as rate, type of nitrogen fertilizer, application time is very important. Combination of *Azotobacter* + PSB + Phytoincremin with 75% N was found most effective in increasing the flower yield of marigold (Gupta et al., 1999).

**Cite this article:** Chaudhary, V.R., Bala, S., Shukla, H.S., Singh, I.P., & Yadava, D. (2020). Response of Integrated Nutrient Management on Vegetative and Flowering Characters of Marigold (*Tagetes erecta* L.), *Ind. J. Pure App. Biosci.* 8(4), 86-90. doi: <http://dx.doi.org/10.18782/2582-2845.7830>

However, the detailed scientific information regarding up to what extent nitrogenous fertilizers can be reduced with the use of different bio-inoculants is not available. Thus, keeping in view the above facts, this experiment was undertaken to “Effect of graded levels of nitrogen alone and with integration of biofertilizers on vegetative and flowering characters of marigold (*Tagetes erecta* L.)”.

### MATERIALS AND METHODS

The present investigation was carried out on African marigold cv. “Pusa Narangi” in the Garden of the Department of Horticulture, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, U.P., during the winter season of two consecutive years of 2008-09 and 2009-10. The 14 treatments were tested. The experiment was laid out in three replicated RBD. The number of treatment is 12, number of replication is 03 and the design followed is Randomized block design. The experiment was carried out in sandy loam, well drained soil having average fertility conditions. The soil samples were collected during October, November, January and February with the help of soil auger from different places of the experimental field at 0-15 cm depth, and were mixed together, air dried and were finally made into powder after proper grinding. The population of various types of the soil micro-organisms was enumerated by dilution planting method. A well rotten FYM @ 250 q ha<sup>-1</sup> was incorporated and mixed well in experimental plots, two weeks before the transplanting. Full dose of phosphorus and potassium was applied as basal dose in soil at the time of transplanting, with all the graded nitrogen treatments except control and AZB + PSB alone. Nitrogen was applied in two splits first half (100 kg) at the time of transplanting and rest half (100kg) after 30 days of transplanting as top dressing. The bio-fertilizers namely *Azotobacter* and Phosphate Solubilizing Bacteria (PSB) were used. The number of leaves, diameter of plant stem (cm), days taken to first flower bud initiation and days taken to first flower bud opening from the randomly selected plants was computed under

cultivar *Pusa Narangi*. The irrigations were given as and when required. The data recorded were analyzed as per method described by Fisher (1937).

### RESULTS AND DISCUSSION

In general the number of leaves showed an increasing trend with increased dose of nitrogen with *Azotobacter* and PSB, used alone or in combination but at higher level of nitrogen (100% N), there was a decline in the number of leaves. The maximum number of leaves was recorded in T<sub>8</sub> (65.60, 66.63 at 30 DAT, 356.00, 363.53 at 60 DAT and 390.00, 396.00 at 90 DAT) followed by T<sub>4</sub> and T<sub>7</sub>. The minimum number of leaves was found with T<sub>14</sub> (30.80, 31.53 at 30 DAT, 220.00, 223.00 at 60 DAT and 223.00, 254.20 at 90 DAT). A perusal of data given in Table 2 shows that the diameter of main stem was significantly influenced by the different treatments over control, except T<sub>13</sub>, during both the years. The mean values clearly indicate that T<sub>8</sub> attained the maximum diameter (1.03, 1.06 cm at 30 DAT, 1.42, 1.46 cm at 60 DAT and 1.64, 1.66 cm at 90 DAT) followed by T<sub>4</sub>. However, T<sub>4</sub> did not exhibit any significant difference with T<sub>8</sub> during both the years. The minimum diameter of stem was recorded under control i.e. T<sub>14</sub> (0.77, 0.78 cm at 30 DAT, 1.21, 1.23 cm at 60 DAT and 1.38, 1.40 cm at 90 DAT) during both the years, respectively. Similar effects also reported by Dhama (2008) in marigold.

From Table 3, it may be evident from data that there was significant influence of treatments on plant spread as compared to control during both the years. The highest plant spread (17.15, 17.45 cm at 30 DAT, 42.02, 42.82 cm at 60 DAT and 52.00 and 52.78 cm at 90 DAT) could be obtained under T<sub>8</sub> treatment, followed by T<sub>4</sub>. T<sub>4</sub> was found to be at par with T<sub>8</sub> while T<sub>6</sub> and T<sub>3</sub> were found at par with each other. Plant spread was found to be minimum (10.63, 10.97 cm at 30 DAT, 27.40, 28.23 cm at 60 DAT and 40.44, 41.32 cm at 90 DAT) with control (T<sub>14</sub>) and T<sub>13</sub> did not show any significant variation with control in both the respective years. Thus, an increase in the growth parameters may be due to the stimulating and beneficial effects of Biofertilizers in solubilizing and utilization of

nutrients and biosynthesis of plant growth regulators like IAA, GA and cytokinins as well as vitamins and organic acids.

From Table 4, it is revealed that the number of days taken to first flower bud initiation was maximum with T<sub>14</sub> treatment (42.46, 41.33) during 2008-09 and 2009-10, respectively. The minimum number of days (35.26, 34.46) to first flower bud initiation was observed with 75% N + *Azotobacter* + PSB treatment (T<sub>8</sub>) followed by T<sub>7</sub> and T<sub>6</sub> in 2008-09 and 2009-10, respectively. T<sub>4</sub>, T<sub>5</sub>, T<sub>6</sub> and T<sub>7</sub> were found to be at par with each other. The data clearly indicate that days to first flower bud initiation, decreased with increase in the level of N up to 75% with or without bio-fertilizer and thereafter any increase in nitrogen alone or with association of bio-fertilizer, increased the days to first flower bud initiation. The minimum number of days to first flower bud opening was recorded in T<sub>8</sub> treatment (47.80, 46.93) followed by T<sub>7</sub> and T<sub>6</sub> in 2008-09 and 2009-10, respectively. T<sub>3</sub>, T<sub>4</sub> and T<sub>5</sub> were found to be at par with each other. The maximum number of days to first flower bud opening was observed in control (57.87, 56.53) i.e. T<sub>14</sub>, during the respective years as

also reported by Yadav et al. (2004) in marigold and Joshi et al. (2008) in chrysanthemum. Early flowering so observed may be due to the synergistic effect of chemical fertilizer and biofertilizers (*Azotobacter* and PSB). The possibility of an increase in the synthesis of cytokinins in the root tissues and its simultaneous transport to auxiliary buds would have resulted in better sink for mobilization of photoassimilates at a rapid rate. This might have helped in the early transformation phase. Such results have also been corroborated by Kumar et al. (2006), in marigold. This might be due to favourable action of biofertilizers in soil, which compensated the requirement of chemical fertilizers upto certain extent. This might be explained in the light of the fact that due to favourable action of bioinoculants which provided nutrients in proportion and availability of growth promoting substances which helped to enhance growth attributes like plant height, number of primary branches, plant fresh and dry weight, duration of flowering and number of flowers. Similar findings have been reported earlier by Yadav (2010) in different flower and fruit crops.

**Table 1: Effect of integrated nutrient management on number of leaves in African marigold**

| S. No. | Treatment       |                                   | Number of leaves |        |        |         |        |        |
|--------|-----------------|-----------------------------------|------------------|--------|--------|---------|--------|--------|
|        |                 |                                   | 2008-09          |        |        | 2009-10 |        |        |
|        |                 |                                   | 30 DAT           | 60 DAT | 90 DAT | 30 DAT  | 60 DAT | 90 DAT |
| 1.     | T <sub>1</sub>  | 100% N                            | 53.26            | 295.40 | 333.40 | 54.00   | 301.66 | 336.00 |
| 2.     | T <sub>2</sub>  | 100% N + <i>Azotobacter</i>       | 55.40            | 316.66 | 350.80 | 56.73   | 325.20 | 353.33 |
| 3.     | T <sub>3</sub>  | 100% N + PSB                      | 59.13            | 323.13 | 368.86 | 60.80   | 330.06 | 375.06 |
| 4.     | T <sub>4</sub>  | 100% N + <i>Azotobacter</i> + PSB | 63.40            | 343.26 | 381.66 | 64.60   | 348.66 | 387.00 |
| 5.     | T <sub>5</sub>  | 75% N                             | 54.86            | 302.93 | 338.20 | 55.33   | 307.33 | 342.40 |
| 6.     | T <sub>6</sub>  | 75% N + <i>Azotobacter</i>        | 57.93            | 320.73 | 358.20 | 58.33   | 329.73 | 364.00 |
| 7.     | T <sub>7</sub>  | 75% N + PSB                       | 60.93            | 335.66 | 374.40 | 61.93   | 342.00 | 380.33 |
| 8.     | T <sub>8</sub>  | 75% N + <i>Azotobacter</i> + PSB  | 65.60            | 356.00 | 390.00 | 66.33   | 363.53 | 396.80 |
| 9.     | T <sub>9</sub>  | 50% N                             | 40.53            | 254.66 | 286.00 | 41.26   | 257.00 | 290.66 |
| 10.    | T <sub>10</sub> | 50% N + <i>Azotobacter</i>        | 41.66            | 262.53 | 289.26 | 42.20   | 266.13 | 296.66 |
| 11.    | T <sub>11</sub> | 50% N + PSB                       | 42.13            | 272.60 | 300.66 | 43.00   | 279.33 | 305.33 |
| 12.    | T <sub>12</sub> | 50% N + <i>Azotobacter</i> + PSB  | 47.66            | 284.00 | 318.00 | 45.53   | 290.00 | 324.53 |
| 13.    | T <sub>13</sub> | <i>Azotobacter</i> + PSB alone    | 35.40            | 232.20 | 268.00 | 36.20   | 238.20 | 276.00 |
| 14.    | T <sub>14</sub> | Control                           | 30.80            | 220.00 | 249.40 | 31.53   | 223.00 | 254.20 |
| SE(d)± |                 |                                   | 3.08             | 21.79  | 20.77  | 2.86    | 19.169 | 20.99  |
| CD 5%  |                 |                                   | 6.34             | 44.79  | 42.70  | 5.88    | 39.38  | 43.15  |

**Table 2: Effect of integrated nutrient management on diameter of plant stem (cm) of African marigold**

| S. No. | Treatment  | Diameter of plant stem (cm) |        |        |         |        |        |
|--------|--|-----------------------------|--------|--------|---------|--------|--------|
|        |  | 2008-09                     |        |        | 2009-10 |        |        |
|        |  | 30 DAT                      | 60 DAT | 90 DAT | 30 DAT  | 60 DAT | 90 DAT |
| 1.     | T <sub>1</sub> 100% N                            | 0.93                        | 1.33   | 1.53   | 0.95    | 1.35   | 1.55   |
| 2.     | T <sub>2</sub> 100% N + <i>Azotobacter</i>       | 0.95                        | 1.35   | 1.56   | 0.98    | 1.37   | 1.57   |
| 3.     | T <sub>3</sub> 100% N + PSB                      | 0.98                        | 1.37   | 1.59   | 1.02    | 1.40   | 1.60   |
| 4.     | T <sub>4</sub> 100% N + <i>Azotobacter</i> + PSB | 1.00                        | 1.40   | 1.62   | 1.03    | 1.44   | 1.64   |
| 5.     | T <sub>5</sub> 75% N                             | 0.95                        | 1.35   | 1.55   | 0.97    | 1.37   | 1.57   |
| 6.     | T <sub>6</sub> 75% N + <i>Azotobacter</i>        | 0.96                        | 1.37   | 1.57   | 0.99    | 1.39   | 1.59   |
| 7.     | T <sub>7</sub> 75% N + PSB                       | 0.99                        | 1.39   | 1.60   | 1.03    | 1.43   | 1.62   |
| 8.     | T <sub>8</sub> 75% N + <i>Azotobacter</i> + PSB  | 1.03                        | 1.42   | 1.64   | 1.06    | 1.46   | 1.66   |
| 9.     | T <sub>9</sub> 50% N                             | 0.80                        | 1.26   | 1.45   | 0.82    | 1.28   | 1.47   |
| 10.    | T <sub>10</sub> 50% N + <i>Azotobacter</i>       | 0.82                        | 1.28   | 1.47   | 0.85    | 1.31   | 1.49   |
| 11.    | T <sub>11</sub> 50% N + PSB                      | 0.85                        | 1.31   | 1.50   | 0.89    | 1.33   | 1.52   |
| 12.    | T <sub>12</sub> 50% N + <i>Azotobacter</i> + PSB | 0.89                        | 1.34   | 1.54   | 0.92    | 1.35   | 1.56   |
| 13.    | T <sub>13</sub> <i>Azotobacter</i> + PSB alone   | 0.78                        | 1.24   | 1.41   | 0.80    | 1.26   | 1.43   |
| 14.    | T <sub>14</sub> Control                          | 0.77                        | 1.21   | 1.38   | 0.78    | 1.23   | 1.41   |
| SE(d)± |  | 0.02                        | 0.01   | 0.01   | 0.05    | 0.01   | 0.01   |
| CD 5%  |  | 0.05                        | 0.04   | 0.03   | 0.05    | 0.03   | 0.03   |

**Table 3: Effect of integrated nutrient management on plant spread (cm) of African marigold**

| S. No.  | Treatment  | Plant spread(cm) |        |        |         |        |        |
|---------|--|------------------|--------|--------|---------|--------|--------|
|         |  | 2008-09          |        |        | 2009-10 |        |        |
|         |  | 30 DAT           | 60 DAT | 90 DAT | 30 DAT  | 60 DAT | 90 DAT |
| 1.      | T <sub>1</sub> 100% N                            | 14.48            | 33.61  | 44.85  | 14.82   | 34.56  | 45.22  |
| 2.      | T <sub>2</sub> 100% N + <i>Azotobacter</i>       | 15.10            | 35.60  | 46.86  | 15.42   | 36.37  | 47.52  |
| 3.      | T <sub>3</sub> 100% N + PSB                      | 15.80            | 37.92  | 48.20  | 15.91   | 38.73  | 48.93  |
| 4.      | T <sub>4</sub> 100% N + <i>Azotobacter</i> + PSB | 16.62            | 40.16  | 51.15  | 16.94   | 40.88  | 51.84  |
| 5.      | T <sub>5</sub> 75% N                             | 15.23            | 35.46  | 45.25  | 15.54   | 36.28  | 46.00  |
| 6.      | T <sub>6</sub> 75% N + <i>Azotobacter</i>        | 15.88            | 37.75  | 47.78  | 16.17   | 38.91  | 48.49  |
| 7.      | T <sub>7</sub> 75% N + PSB                       | 16.40            | 40.21  | 48.81  | 16.69   | 41.00  | 49.82  |
| 8.      | T <sub>8</sub> 75% N + <i>Azotobacter</i> + PSB  | 17.15            | 42.02  | 52.00  | 17.45   | 42.82  | 52.78  |
| 9.      | T <sub>9</sub> 50% N                             | 12.00            | 30.00  | 42.35  | 12.31   | 30.16  | 42.91  |
| 10.     | T <sub>10</sub> 50% N + <i>Azotobacter</i>       | 12.75            | 31.04  | 43.38  | 13.02   | 31.82  | 44.10  |
| 11.     | T <sub>11</sub> 50% N + PSB                      | 13.28            | 32.75  | 43.92  | 13.60   | 33.55  | 44.62  |
| 12.     | T <sub>12</sub> 50% N + <i>Azotobacter</i> + PSB | 13.90            | 34.54  | 44.45  | 14.19   | 35.14  | 44.93  |
| 13.     | T <sub>13</sub> <i>Azotobacter</i> + PSB alone   | 11.40            | 28.83  | 41.80  | 11.57   | 29.57  | 42.50  |
| 14.     | T <sub>14</sub> Control                          | 10.63            | 27.40  | 40.44  | 10.97   | 28.23  | 41.32  |
| SE(d) ± |  | 1.04             | 0.93   | 1.03   | 0.86    | 0.99   | 0.89   |
| CD 5%   |  | 2.14             | 1.91   | 2.12   | 1.77    | 2.04   | 1.83   |

**Table 4: Effect of integrated nutrient management on days taken to first flower bud initiation and days taken to first flower bud opening in African marigold**

| S. No.  | Treatment       |                                   | Days taken to first flower bud initiation |         | Days taken to first flower bud opening |       |
|---------|-----------------|-----------------------------------|---|---------|--|-------|
|         |                 |                                   | 2008-09                                   | 2009-10 | 2008                                   | 2009  |
| 1.      | T <sub>1</sub>  | 100% N                            | 38.73                                     | 37.86   | 52.73                                  | 51.66 |
| 2.      | T <sub>2</sub>  | 100% N + <i>Azotobacter</i>       | 38.40                                     | 37.53   | 52.33                                  | 51.20 |
| 3.      | T <sub>3</sub>  | 100% N + PSB                      | 37.93                                     | 37.06   | 51.60                                  | 50.53 |
| 4.      | T <sub>4</sub>  | 100% N + <i>Azotobacter</i> + PSB | 37.13                                     | 36.26   | 50.53                                  | 49.47 |
| 5.      | T <sub>5</sub>  | 75% N                             | 36.86                                     | 36.00   | 49.87                                  | 48.87 |
| 6.      | T <sub>6</sub>  | 75% N + <i>Azotobacter</i>        | 36.53                                     | 35.66   | 49.40                                  | 48.33 |
| 7.      | T <sub>7</sub>  | 75% N + PSB                       | 36.00                                     | 35.20   | 48.80                                  | 47.73 |
| 8.      | T <sub>8</sub>  | 75% N + <i>Azotobacter</i> + PSB  | 35.26                                     | 34.46   | 47.80                                  | 46.93 |
| 9.      | T <sub>9</sub>  | 50% N                             | 40.80                                     | 39.93   | 55.47                                  | 54.40 |
| 10.     | T <sub>10</sub> | 50% N + <i>Azotobacter</i>        | 40.33                                     | 39.53   | 54.93                                  | 53.93 |
| 11.     | T <sub>11</sub> | 50% N + PSB                       | 39.80                                     | 39.00   | 54.26                                  | 53.26 |
| 12.     | T <sub>12</sub> | 50% N + <i>Azotobacter</i> + PSB  | 39.06                                     | 38.20   | 53.33                                  | 52.26 |
| 13.     | T <sub>13</sub> | <i>Azotobacter</i> + PSB alone    | 41.40                                     | 40.53   | 57.33                                  | 55.27 |
| 14.     | T <sub>14</sub> | Control                           | 42.46                                     | 41.33   | 57.87                                  | 56.53 |
| SE(d) ± |                 |                                   | 0.63                                      | 0.58    | 0.891                                  | 0.620 |
| CD 5%   |                 |                                   | 1.30                                      | 1.19    | 1.832                                  | 1.276 |

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