Enhanced Flower Yield and Quality Attributes of Chrysanthemum (Dendranthema grandiflora Tzvelev) Inoculated with Phosphorus Solubilizing and Mobilizing Bioinoculants at Different Levels of Phosphorus

Harish, S. Doddajjappalavar1*, B. Hemla Naik2, S.Y. Chandrashekar1, M.S. Nandeesh1 and Y. Kantharaj1

1Department of Floriculture & Landscape Architecture, College of Horticulture, Mudigere-577132, India
2University of Agricultural and Horticultural Sciences, Shivamogga, Karnataka, India

*Corresponding author

Abstract

A field experiment was conducted to know the effect of phosphorus solubilizing and mobilizing bioinoculants on flower yield and quality attributes of chrysanthemum (Dendranthema grandiflora Tzvelev) at the, College of Horticulture, Mudigere during 2016-17. Plants treated with (T11) 75 per cent RDP + PSF + PSB recorded significantly maximum flowers per plant (70.83), flower yield per plant (318.00 g), flower yield per plot (10.74 kg), flower yield per hectare (18.08 t) and individual flower weight (6.30 g), flower diameter (6.23 cm), number of petals per flower (118.37), shelf life (7.00 days), vase life (13.87 days). The lowest values for all the above parameters were recorded with RDF alone.

Keywords

Chrysanthemum, Bioinoculants, Phosphorous solubilizing bacteria (Pseudomonas striata), Phosphorous solubilizing fungus (Asperigillus awamori), Recommended Dose of Phosphorus (RDP).

Introduction

Chrysanthemum (Dendranthema grandiflora Tzvelev) commonly known as Gul-e-Daudi or ‘Glory of the East’ belongs to the family Compositae (Asteraceae) and it is commonly called as “Queen of east”. Chrysanthemum is mainly grown for its cut flower for making bouquets, garlands, veni and for decoration during religious and social functions. Nutrition plays an important role for growth, yield and higher quality of chrysanthemum flowers. The increasing costs of fertilizers prevent their use by poor farmers (Adhikary and Gantayet, 2012). Therefore, nowadays attention is shifted towards the alternate sources i.e., use of bioinoculants. The role of bioinoculants to make the soil healthy as well as make unavailable form of soil nutrients to available form by enhancing mineralization and solubilization process, decomposition of plant residues, stimulating plant growth and development. In soil by adding and microbial agents make easy uptake of nutrients when...
crop required comparing to chemical fertilizers (Vanilarasu and Balakrishnamurthy, 2014). The present study was undertaken to investigate the effect of phosphorus solubilizing and mobilizing bioinoculants on flower yield and quality attributes of chrysanthemum (*Dendranthema grandiflora* Tzvelev) and also to improve the performance of chrysanthemum and to minimize fertilizer usage.

**Materials and Methods**

The present investigation was carried out during 2016-17 at College of Horticulture, Moodigere, Chikkamagaluru, Karnataka. Rooted terminal cuttings of chrysanthemum var. Marigold used for planting on ridges and furrows in plot size of 3m x 2m with spacing 45 x 45cm (30 plants/plot). The experiment was laid out in a Randomized Block Design (RCBD) with three replications. There were Twelve treatments which were applied as: T1-Control (RDF); T2 - 75 % RDP; T3 - 50 % RDP; T4 - 100 % RDP + PSF; T5 - 75 % RDP + PSF; T6 - 50 % RDP + PSF; T7 - 100 % RDP + PSB; T8 - 75 % RDP + PSB; T9 - 50 % RDP + PSB; T10 - 100 % RDP + PSF + PSB; T11 - 75 % RDP + PSF + PSB; T12 - 50 % RDP + PSF + PSB.

At the time of transplanting the rooted cuttings were dipped in bioinoculant solution according to treatments and after 30 days after planting (DAP) bioinoculants were applied, and the observations on growth and flower yield parameters were recorded from the tagged plants and the data were analyzed scientifically and interpreted the results and discussed as below.

**Results and Discussion**

The application of 75 per cent phosphorous with combination of bioinoculant treatments had a significant effect on number of flowers per flower (70.83), flower yield per plant (318.00 g), flower yield per plot (10.74 kg), flower yield per hectare (18.08 t). However, T1 with un-inoculated control (RDF) recorded minimum alone (Table 1). The other treatments were also found statistically significant over the control for all the parameters. The possible reason for better performance of yield attributes and higher yield could be due to the better physical condition of soil and increased population of microflora, thereby enhanced availability of nutrients through solubilization and mobilization process. Moreover, biofertilizers produce the growth stimulating substances viz., auxin, gibberellins and cytokinins which contribute towards vigorous growth of the plant and subsequently higher number of flowers per plant and higher flower yield per hectare. This in turn increases photosynthesis and enhances food accumulation and also diversion of photosynthates towards sink resulting in better quality flowers.

And the difference in yield components could be attributed to the physiological characters, both in vegetative and reproductive phases of crop growth. Difference in dry matter production and its distribution into different plant parts (leaf, stem and flower) with the inoculation of bioinoculants were mainly responsible for the increased in flower yield, number of flowers and flower size. The results are in agreement with the earlier findings of Swaroop (2011) also confirms these findings in marigold, Kirar *et al.* (2014) in China aster.

The treatment (T11) 75 per cent RDP + PSF + PSB showed the highest individual flower weight (6.30 g), flower diameter (6.23 cm), number of petals per flower (118.37). However, T1 with un-inoculated control (RDF) recorded minimum (Table 2). The other treatments were also found statistically significant over the control for all the parameters.
### Table 1: Effect of phosphorus solubilizing and mobilizing bioinoculants with graded levels of phosphorus on flower yield parameters of chrysanthemum

| Treatments                      | No. of flowers/ plant | Flower yield/ plant (g) | Flower yield (kg/plot) | Flower yield (t/ha) |
|--------------------------------|-----------------------|-------------------------|------------------------|---------------------|
| **T1** RDF (Control)           | 48.00                 | 235.00                  | 7.71                   | 12.00               |
| **T2** 75 % RDP               | 57.50                 | 284.33                  | 8.53                   | 14.22               |
| **T3** 50 % RDP               | 51.00                 | 269.00                  | 8.15                   | 13.30               |
| **T4** 100 % RDP + PSF        | 58.17                 | 290.00                  | 8.77                   | 14.62               |
| **T5** 75 % RDP + PSF         | 59.23                 | 292.67                  | 8.70                   | 14.50               |
| **T6** 50 % RDP + PSF         | 57.33                 | 288.00                  | 8.64                   | 14.33               |
| **T7** 100 % RDP + PSB        | 68.52                 | 309.33                  | 9.90                   | 15.83               |
| **T8** 75 % RDP + PSB         | 60.17                 | 300.00                  | 8.99                   | 14.28               |
| **T9** 50 % RDP + PSB         | 58.33                 | 294.00                  | 8.82                   | 14.53               |
| **T10** 100 % RDP + PSF + PSB | 67.50                 | 311.33                  | 10.25                  | 17.08               |
| **T11** 75 % RDP + PSF + PSB  | 70.83                 | 318.00                  | 10.74                  | 18.08               |
| **T12** 50 % RDP + PSF + PSB  | 58.83                 | 299.33                  | 9.00                   | 15.33               |
| **SEm ±**                      | 1.23                  | 5.61                    | 0.20                   | 0.87                |
| **CD (P=0.05)**                | 3.61                  | 16.46                   | 0.58                   | 2.56                |

**Note:**
* N and K constant as per the RDF and vesicular arbuscular mycorrhiza (*Glomus fasciculatum*) applied commonly for all treatments
* RDF - Recommended dose of fertilizers
* RDP - Recommended dose of phosphorus
* PSF - Phosphorus solubilizing fungus (*Aspergillus awamori*)
* PSB - Phosphorus Solubilizing Bacteria (*Pseudomonas striata*)
**Table 2** Effect of phosphorus solubilizing and mobilizing bioinoculants with graded levels of phosphorus on flower quality parameters of chrysanthemum

| Treatment                      | Flower weight (g/flower) | Flower diameter (cm) | Number of petals per flower |
|--------------------------------|--------------------------|----------------------|----------------------------|
| T₁ RDP (Control)               | 4.13                     | 3.57                 | 81.67                      |
| T₂ 75 % RDP                    | 4.53                     | 4.00                 | 88.93                      |
| T₃ 50 % RDP                    | 4.27                     | 3.80                 | 85.13                      |
| T₄ 100 % RDP + PSF             | 4.80                     | 4.83                 | 94.67                      |
| T₅ 75 % RDP + PSF              | 5.27                     | 5.07                 | 98.00                      |
| T₆ 50 % RDP + PSF              | 5.00                     | 4.33                 | 91.97                      |
| T₇ 100 % RDP + PSB             | 5.80                     | 5.63                 | 108.80                     |
| T₈ 75 % RDP + PSB              | 5.60                     | 5.23                 | 105.30                     |
| T₉ 50 % RDP + PSB              | 5.33                     | 4.57                 | 97.30                      |
| T₁₀ 100 % RDP + PSF + PSB      | 5.87                     | 5.83                 | 111.33                     |
| T₁₁ 75 % RDP + PSF + PSB       | 6.30                     | 6.23                 | 118.37                     |
| T₁₂ 50 % RDP + PSF + PSB       | 5.13                     | 4.40                 | 98.57                      |

|               | S. Em ±                 |                      |                            |
|---------------|-------------------------|----------------------|---------------------------|
|               | 0.20                    | 0.17                 | 2.76                      |

|               | C. D. @ 0.05            |                      |                            |
|---------------|-------------------------|----------------------|---------------------------|
|               | 0.60                    | 0.51                 | 8.10                      |

**Note:**
*N and K constant as per the RDF and vesicular arbuscular mycorrhiza (*Glomus fasciculatum*) applied commonly for all treatments
*RDF* - Recommended dose of fertilizers
*RDP* - Recommended dose of phosphorus
*PSF* - Phosphorus solubilizing fungus (*Aspergillus awamori*)
*PSB* - Phosphorus solubilizing bacteria (*Pseudomonas striata*)
**Table 3** Effect of phosphorus solubilizing and mobilizing bioinoculants with graded levels of phosphorus on flower shelf and vase life of chrysanthemum

| Treatments            | Shelf life (Days) | Vase life (Days) |
|-----------------------|-------------------|------------------|
| T1 RDF (Control)      | 2.77              | 7.70             |
| T2 75 % RDP           | 3.67              | 9.00             |
| T3 50 % RDP           | 3.17              | 8.47             |
| T4 100 % RDP + PSF    | 4.17              | 9.60             |
| T5 75 % RDP + PSF     | 4.33              | 10.30            |
| T6 50 % RDP + PSF     | 4.20              | 9.23             |
| T7 100 % RDP + PSB    | 5.00              | 11.97            |
| T8 75 % RDP + PSB     | 4.37              | 10.23            |
| T9 50 % RDP + PSB     | 4.17              | 8.73             |
| T10 100 % RDP + PSF + PSB | 6.20   | 12.33            |
| T11 75 % RDP + PSF + PSB | 7.00   | 13.87            |
| T12 50 % RDP + PSF + PSB | 4.37   | 9.37             |
| **S. Em ±**            | **0.69**          | **0.34**         |
| **C. D. @ 0.05**      | **2.01**          | **0.97**         |

Note:
*N and K constant as per the RDF and vesicular arbuscular mycorrhiza (*Glomus fasciculatum*) applied commonly for all treatments
*RDF - Recommended dose of fertilizers
*RDP - Recommended dose of phosphorus
*PSF - Phosphorus solubilizing fungus (*Aspergillus awamori*)
*PSB - Phosphorus solubilizing bacteria (*Pseudomonas striata*)
Maximum individual flower weight might be due to the significant increase in average flower weight may be due to higher phosphorus availability through PSB and RDF (Laishram et al., 2013). Maximum flower diameter may be assigned to early breaking of apical dominance followed by easy and better translocation of nutrients to the flowers brought about by inoculation with beneficial microbial inoculants like PSF and PSB. Phosphate in soil which helps the plant in healthy growing condition resulting into the production of flower having more diameter. PSB might have helped in increasing phosphorus availability by solubilizing fixed phosphorus in soil and making it available to plant and release the enzymes resulting in the production of larger flowers (Kumar et al., 2006 in marigold).

Similar results are reported by Warade et al., (2007) in dahlia, Pravina et al., (2007) in marigold. The increase in number of florets per flower it might be due to the combined beneficial effect of organic manures, biofertilizers and RDP. Similar results are reported by Verma et al., (2011) and Laishram et al., (2013) in chrysanthemum.

The treatment (T11) 75 per cent RDP + PSF + PSB showed the maximum shelf life (7.00 days) and vase life (13.87 days). However, T1 with uninoculated control (RDF) recorded minimum (Table 3). The other treatments were also found statistically significant over the control for all the parameters. It may be due to higher retention of water in the cells of flowers and flower desiccation as caused due to the beneficial effect of bio fertilizer like PSB and FYM (Kumar et al., 2009). It might also be due to the presence of ethylene inhibitors or due to the presence of cytokinins which delay senescence of flowers. These findings are matching with those of Mashaldi (2000) in marigold 2011 and Palagani et al., 2013 in chrysanthemum.

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