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Integrated nutrient management on growth, yield and quality of gerbera (*Gerbera jamesonii* bolus.) cv.singapore yellow under protected condition

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Abstract
Studies were conducted to investigate the effect of integrated nutrient management on growth, yield and quality of Gerbera (*Gerbera jamesonii* Bolus.) cv. Singapore Yellow under protected condition. The study carried out at the Department of Horticulture, GKVK, UAS, Bengaluru. In general, the results presented here are the data recorded at 180 days after imposition of the treatments. The application of 50 per cent recommended dose of nitrogen, phosphorus and potassium + *Azotobacter* + PSB + VAM Fungi had significantly improved the growth, flowering and yield attributes. There was a significant increase in plant height (46.50 cm), plant spread (46.00 cm^2), number of leaves per plant (27.18) and number of suckers per plant (4.10). Similarly in reference to flower parameters, the first flower harvest occurred as early as 29.12 days, maximum stalk length of flower, 57.93 cm, diameter of the flower, 12.67 cm, the girth of the flower stalk, 0.58 cm, number of flowers per plant 20.24 and flower yield 141.70 per m^2 recorded were found to be significantly higher. The maximum shelf life (12.92 days), highest net returns and cost: benefit ratio (2:15) per 100 m^2 per year were also recorded with this treatment. The soil nutrient analysis showed significantly increased levels of available nitrogen, phosphorus and potassium content as recorded at six months after imposition of the treatments. It was also observed that general microbial population of bacteria, fungi and Actinomycetes and beneficial microbial population of *Azotobacter sp*., *Bacillus sp*., and VAM were higher at 180 days.

Keywords: *Azatobactor, bacillus*, PSB, shelf life, VAM

Introduction
Gerbera (*Gerbera jamesonii* Bolus.) commonly known as Transvaal Daisy, Barberton Daisy and African daisy is an ideal flower widely used as a cut flower besides for beds, pots, borders and rock gardens. Gerbera is native to South African and Asiatic regions and belongs to the family Compositae. The awareness on the usage of cut flowers for various occasions has raised the demand for flowers in the market. The production of cut flowers has gone upto 9,441 million stems in 2013 and 2,071 million stems in 2007. This is due to improvement in the standard of living and quality of life which ultimately increased the growth of domestic and export markets (Jafar, 2011). India has been identified as one of the major forces in the world floriculture scenario. With liberalization of Indian economy, floriculture has become a new rising industry in agribusiness.

Integrated soil fertility management practices involving the use of combination of organic manures, bio-fertilizers and chemical fertilizers seems to be a feasible option for sustained horticultural production and profitable scale. In addition, they are eco-friendly, easily available and cost effective. Therefore, emphasis is now focused on the use of organic manures such as compost, vermicompost, farmyard manures and bio-fertilizers like *Azotobacter*, *Vascular Arbuscular mychorrhiza* (VAM) fungi and phosphate solubilizing bacteria (PSB). Vermicompost is a rich source of micronutrients and regulates the availability of metabolic micronutrients like iron and zinc to the plants apart from increasing the plant growth and yield by providing nutrients in the available form.

Materials and Methods
The present study entitled 'Integrated nutrient management on growth, yield and quality of gerbera (*Gerbera jamesonii* Bolus.) Cv. Singapore Yellow under protected condition' was undertaken at the Precision Farming Development Centre (PFDC), Division of Horticulture, University of Agricultural Sciences, Gandhi Krishi Vigyan Kendra, and Bengaluru during 2016-17. The fifteen treatments were planted in Randomized Block Design with three replications. The treatments are Recommended dose of fertilizer as control(T_1), 50 per cent RDF +*Azotobacter*(T_2), 50 per cent RDF + PSB(T_3), 50per cent RDF + VAM(T_4), RDF + *Azotobacter*(T_5), RDF + PSB(T_6), RDF + VAM(T_7), 50per cent RDF + *Azotobacter* + PSB(T_8), 50 per cent RDF + *Azotobacter* + VAM(T_9), 50 per cent RDF + PSB + VAM(T_{10}), 50per cent RDF +*Azotobacter* + PSB + VAM(T_{11}), RDF +*Azotobacter* + PSB + VAM(T_{12}), RDF + PSB + VAM(T_{13}), RDF + *Azotobacter* + VAM(T_{14}) and RDF + *Azotobacter* + PSB(T_{15}).

Observations were made on five growth parameters *viz.*, plant height, plant spread, number of leaves, days taken for sucker production and number of suckers per plant; five flower parameters *viz.*, days taken for first flower bud appearance, days taken for first flower opening and first harvest, flower diameter, flower stalk length and girth of the flower stalk; and four yield parameters *viz.*, number of flowers produced per plant, number of flowers produced per square meter, number of flowers per hectare and vase life.

Results and Discussion
On the basis of results obtained in the study it is found that in T_{11} recorded the highest plant height 28.95 cm 31.10 cm, 35.46 cm, 40.64cm, 45.11cm and 46.5cm at 30,60,90,120 and 150 days after imposing treatments respectively. Plants under control treatment supplemented only with

recommended dose of fertilizers (T_1) showed lowest plant height at all the time of interval (*i.e*., 28.03 cm, 28.48cm, 30.34 cm, 32.17 and 35.38 cm respectively). Not much difference in spread of plants was noticed up to 60 days after imposing the treatments. However at 90, 120, 150 and 180 days after imposing the treatments, the spread of the plants differed significantly. Higher spread was recorded in T_{11} at 30, 60, 90, 120,150 and 180 days after imposing treatments (24.40 cm^2, 27.60 cm^2, 31.63 cm^2, 37.41 cm^2, 42.07 cm^2 and 46.00 cm^2 respectively). No much difference in production of leaves per plant was noticed up to 60 days after imposing treatments. However at 90, 120, 150, and 180 days after imposing the treatments the production of leaves per plant differed significantly. The highest number of leaves was recorded inT_{11} (13.00, 14.20, 18.45, 20.21, 24.21 and 27.18 leaves respectively). The lowest number of leaves was recorded in uninoculated control plants supplied only with recommended dose of fertilizers (10.00, 11.07, 13.04, 13.42, 14.01 and 15.43 leaves respectively). T_{11} was took minimum number of days (39.30 days) for sucker production. This was on par with the treatment T_{12}, 100 per cent RDF + *Azotobacter* + PSB + VAM (39.80 days). T_1 (100% RDF) was found to be late which took 46.58 days for sucker production. The highest number of suckers per plant (4.10) was recorded in treatment T_{11} which was on par with T_{12} (3.99 suckers). Minimum numbers of suckers (2.12) were recorded in plants supplied with recommended dose of fertilizers alone.

Application of bio-fertilizers has significantly influenced the number of days taken for flower bud appearance in gerbera. Early flower bud appearance (19.83 days) was noticed in the plants supplied with 50 per cent RDF + *Azotobacter* + PSB + VAM. Delay in flower bud appearance was noticed in plants supplied only with full RD (29.42 days). The number of days taken for the first harvest of flowers differed significantly with treatments. Plants provided with 50 per cent RDF + *Azotobacter* + PSB + VAM took minimum number of days (29.12 days) for the first harvest of flowers. Whereas highest number of days taken for first harvest of flowers was recorded in control (39.20 days) plants which were supplied only with full recommended dose of fertilizer. Among the different treatments T_{11} showed highest flower diameter at all the 6 stages (*i.e.*, 30, 60, 90, 120, 150 and 180 days after imposing treatments) of plant growth (10.35 cm, 10.42 cm, 10.45 cm, 11.97 cm, 12.31 cm and 12.67 cm respectively). Plants provided with 50 per cent recommended dose of nitrogen, phosphorus and potassium + *Azotobacter* + PSB + VAM produced highest number of flowers per plant (2.22, 3.01, 3.31, 3.85, 3.86 and 3.99 flowers per plant respectively) and the minimum (1.77, 2.25, 2.35, 2.39, 2.40 and 2.52 flowers per plant respectively) was recorded in T_1. The maximum vase life of (12.92 days) was recorded in flowers obtained from the treatment T_{11}. While the minimum vase life was recorded in the flowers of treatment T_1 (*i.e.* 7.73 days).

Based on the findings of the present investigation, it could be concluded that integrated nutrient management had significant influence on growth, yield and quality attributes of gerbera. Application of 50 per cent RDF + *Azotobacter (10g/m2)* + PSB (10g/m2)+ VAM (5g/m2) is ideal for maximizing growth, yield and quality parameters. It was also found beneficial in obtaining higher net returns and benefit cost ratio. Thus, the integral use of organic manure (FYM) (Vermicompost 1kg/m^2) and inorganic fertilizers along with bio-fertilizers can be recommended for sustainable production and for the achieving maximum yield of gerbera flowers.

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