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Research Article

Response of Different Biofertilizers and NPK Levels on Growth and Flowering of Marigold cv. Pusa Narangi Gainda

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Abstract: The experiment was carried out to see response of different biofertilizers and NPK levels on growth and flowering of marigold cv. Pusa Narangi Gainda at Agriculture Farm, School of Agricultural Sciences & Technology, RIMT University, Mandi Gobindgarh, Punjab, India during 2019-20. The field experiment was laid out in Randomized Block Design with ten treatments and replicated thrice. The treatments were made by the making the combination of *Azotobactor*, *Pseudomonas*, NPK and RDFYM. The obtained results show that different biofertilizers along with the different levels of NPK have released significant effect on growth and flowering of marigold. Growth parameters like maximum number of number of primary branches/plant, length of primary branches and plant spreading were resulted when plants treated with T_{10} nevertheless, treatment T_9 resulted in maximum number of secondary branches and highest plant height. In concern with flowering parameters, the results revealed that the minimum days to bud initiation was recorded under the T_9 notwithstanding, lesser days to flowering, maximum bud diameter, bud length and diameter of flower were measured with T_{10}. The results revealed that the overall performance of marigold plant was greatly enhanced under treatment T_{10}.

Keywords: Marigold, Azotobactor, Pseudomonas, NPK and RDFYM and Pusa Narangi Gainda.

Introduction

Marigold (*Tagetes erecta*) is an important commercial flower of India belongs to family Asteraceae (Compositae) having chromosome number 2n=24. It was originated in central and South America especially Mexico (Dikr and Belete 2017). Marigolds are broadly divided into two groups, namely, African marigold and French marigold (Yadav et al. 2014). Marigold is a medicinal and ornamental plant as well as extensively used for making garlands, beautification and other purposes i.e. pigment and oil extraction and therapeutic uses. Apart from these uses marigold is a widely grown in gardens and pots. It is highly suitable for bedding purpose, herbaceous border and newly planted shrubberies to provide color and fill the space (Yadav et al. 2015). Bio-fertilizer is a substance which contains living microorganisms which and when applied to seed, plant surfaces, soil, colonizes the rhizosphere or the interior of the plant and promotes growth by increasing the supply or availability of primary nutrients to the host plant (Vessey 2003). The term bio-fertilizers or microbial inoculants can be define as the preparations containing strains of micro-organism which can augment the mcrobiological process viz. nitrogen fixation, phosphate solubilisation or mineraliztion, extraction of plant growth promoting substances or cellulose or lignin biodegradation in soil, compost or other environment (Gaur 2010). Nitrogen is an important metabolism element for growth and development of plant of marigold. It is essentially considered as metabolic activities, transformation of energy, essential for metabolism of protein and other biochemical product such as nucleic acid, chlorophyll and protoplasm (Kumar and Kumar 2017). Phosphorous is also a major nutrient required by the crops. About 98 per cent soil of cultivated area in India needs phosphorous fertilization for good harvest (Ahirwar *et al*. 2012).The use of phosphate solubilizing bacteria as inoculants simultaneously increases P uptake by the plant and crop yield. Strains from the genera *Pseudomonas*, *Bacillus* and *Rhizobium* are among the most powerful phosphate solubilizers (Pandey et al. 2018).

Materials and Methods

The experiment carried out at Agricultural Farm, School of Agricultural Sciences and Technology, RIMT University, Mandi Gobindgarh, Punjab where adequate facilities for irrigation and drainage existed. The maximum temperature often exceeds 40 °C during summer whereas, minimum temperature decreases below 6 °C with some coldest spells during the winter month of December and January occurs. The average annual rainfall of Mandi Gobindgarh is 730.2 mm, about 3/4 th of which is contributed by the South-West monsoon during July to September. Scanty rainfall is received during winter months of December, January and February. Total ten treatments which contain *Azotobactor*, *Pseudomonas*, RDFYM and different levels of NPK along with control i.e. T_1:Control, T_2:*Azotobactor*, T_3:*Pseudomonas*, T_4:*Azotobactor* + *Pseudomonas* + RDFYM, T_5:50% NPK + *Azotobactor*, T_6:50% NPK + *Pseudonomas*, T_7:50% NPK + *Azotobactor* + *Pseudomonas* + RDFYM, T_8:75% NPK + *Azotobactor*, T_9:75% NPK + *Pseudomonas* and T_{10}:75% NPK + *Azotobactor* + *Pseudomonas* + RDFYM and Pusa Narangi Gainda cultivar were used as experimental material for the investigation. The treatments were given through soil application. The experiment was laid out in a randomized block design with three replications. Observations on various growth and flowering parameters were recorded. Results thus obtained, were subjected to statistical analysis.

Results and Discussion

Growth Parameters

The data on growth parameters presented in table 1. The different biofertilizers and NPK levels exerted significant effect on number of primary branches. The maximum numbers of primary branches/plant (10.73) were recorded with T_{10}. Whereas, minimum number of primary branches/plant were counted with T_2 (7.79). NPK provide available nutrient in the soil, due to combine effect of number of primary branches. These results confirm the findings of Gotmare et al. (2007), Sunita et al. (2007) and Pushkar et al. (2008) in marigold. Treatment T_9 resulted in maximum number of secondary branches/plant (26.08). While, T_2 recorded with lesser number of secondary branches/plant (17.88) in compare to other treatments. Biofertilizers are involve in fixing of nitrogen, phosphorus solubilizing and decomposing organic matter at faster rate and thus help in improving the soil fertility and boosting crop plant size (Jadhav et al. (2014). Greater length of primary branches (40.67 cm) was recorded with T_{10} notwithstanding, the lower plant spreading (28.09 cm) was recorded with T_1. This might be due to nitrogen is an essential part of nucleic acid this plays vital role in promoting the plant growth. It is obvious that phosphorus is a constituent of chlorophyll and is involved in many physiological processes including cell division, development of meristematic tissue, photosynthesis, metabolism of carbohydrates, fats and proteins etc. Similar results had also been reported by Yadav et al. (2018); Prakash et al. (2002); Barman et al. (2003) and Acharya and Dashora (2004). Greater plant spreading (33.78 cm) was recorded with T_{10} whereas, lower plant spreading (22.41 cm) was recorded with T_1 (22.41 cm). These findings are accordance with the Jahan et al. (2012). Similar result was found by Ravindra et al. (2013) in China aster and Renukaradhaya (2006) in carnation. The reason is availability of congenial growing conditions for growth of African marigold during summer season and subsequently the plants could put up more vegetative growth. These results are in confirmation with these results are in close to agreement with the earlier work of Dilta et al. (2007) in China aster. Similar findings reported by Rao and Reddy (2006). Treatment T_9 reported with highest plant height (132.73 cm) and it was lower (110.91 cm) with T_2. The nitrogen fixing abilities of the microbial inoculants, the capacity to releasing phyto-hormones especially gibberellins should be regarded which increases the flower size. Also the different partitioning of photosynthesis towards the sink by *Azospirillum* inoculation increased the plant height of chrysanthemum. It might be attributed to the fact that the conjoint application of *Azotobacter* and PSB along with reduced dose of chemical fertilizers would have increased the total beneficial microbial population in the rhizosphere of the plant roots which in turn resulted in an increased leaf area by increasing the availability of nutrients (P, K, Zn, Cu etc.) as well as plant growth hormone production (Chandrikapure et al. 1999).

Table: 1. Response of different biofertilizers and NPK levels on growth of marigold cv. Pusa Narangi Gainda

Treatments	Number of primary branches/plant	Number of secondary branches/plant	Length of primary branches (cm)	Plant spreading (cm)	Plant height (cm)
T_1	8.77	18.23	28.09	22.41	115.00
T_2	7.79	17.88	31.27	25.34	110.91
T_3	7.82	19.41	32.51	29.52	115.45
T_4	9.80	20.09	34.25	31.93	115.90
T_5	10.03	21.46	37.10	30.09	116.37
T_6	10.04	20.70	38.10	30.35	127.32
T_7	10.22	22.30	39.73	31.41	130.46
T_8	9.99	22.57	39.96	29.93	132.32
T_9	9.98	26.08	40.59	31.49	132.73
T_{10}	10.73	26.04	40.67	33.78	131.33
S.Em.±	0.80	1.59	2.04	1.56	2.99
P=0.05%	2.40	4.75	6.07	4.65	8.91

Table: 2. Response of different biofertilizers and NPK levels on flowering of marigold cv. Pusa Narangi Gainda

Treatments	Days to bud initiation	Days to flowering	Bud diameter (cm)	Bud length (cm)	Diameter of flower (cm)
T_1	49.15	57.93	1.42	1.83	4.92
T_2	47.08	57.90	1.44	2.00	5.21
T_3	45.85	57.27	1.44	2.03	5.16
T_4	46.45	58.94	1.51	1.97	5.33
T_5	44.85	57.46	1.49	2.12	5.32
T_6	44.78	54.76	1.52	2.13	5.31
T_7	44.38	54.75	1.67	2.11	5.51
T_8	44.30	53.22	1.71	2.20	5.50
T_9	41.69	53.39	1.72	2.30	6.18
T_{10}	41.99	51.36	1.76	2.30	6.20
S.Em.±	1.36	1.75	0.05	0.07	0.20
P=0.05%	4.05	5.21	0.15	0.21	0.62

Flowering Parameters

The obtained results on flowering characters are depicted in table 2. Minimum days to bud initiation (41.69 days) were recorded with T_9 nevertheless, T_1 recorded with maximum days to bud initiation (49.15 days). Bohra and Kumar (2014) reported that the treatment combination of NPK along with *Azospirillum* was more effective in improving earlier bud initiation and floral character of Dendrobium. The better efficiency in combination with inorganic fertilizers and organic manure, the enhanced photosynthetic activity due to *Azotobactor* inoculation might have favoured an increased accumulation of dry matter and also efficient partitioning of photosynthates towards the sink (Kumar et al. 2006). The finding was also accordance with the results of Yadav et al. (2017). Treatment T_{10} resulted minimum number of days to flowering (51.36 days). Whereas, maximum number of days taken for bud initiation (57.93 days) was resulted by control. This may be ascribed to the easy uptake of nutrients and simultaneous transport of growth promoting substances like auxins, gibberellins, vitamins and organic acids produced by biofertilizers to the axillary buds resulting in earliness to reach harvesting stage. Sheergojri et al. (2013) observed minimum number of days taken for full opening of flower with an application of NPK along with Azotobacter inoculation in dahlia. Narashima and Haripriya (2001) in crossandra obtained similar findings regarding days taken to bud appearance and days taken to first flower opening. Also, Mansour et al. (2002) found that inoculation globe artichoke with Nitrobine + 50% recommended N had positive effect on early yield which might be due to increasing available nitrogen.

Treatment T_{10} reported with greater bud diameter (1.76 cm) of marigold plant. The lesser bud diameter (1.42 cm) was recorded with T_1. The increase in diameter might be due to the fact that the balanced application of fertilizers resulted in increased carbohydrate assimilation leading to increased vegetative growth. These carbohydrates when translocated to reproductive organs underwent hydrolysis and got converted into the reducing sugars which ultimately helped in increasing bud size (Naik 2014). Maximum bud length (2.30 cm) was measured with T_{10} while, T_1 recorded with the minimum bud length (1.83 cm). The results are in conformity with those obtained by Barakat and Gaber (1998) who found that tomato bud length was greatly improved by inoculation *Azotobacter sp*. and *Azospirillum sp*. Also, Rather et al. (2003) observed a maximum increase in onion leaf length as a result of inoculation with *Azotobacter* and *Azospirillum*. Treatment T_{10} reported with greater diameter of flower (6.20 cm) while, the lesser diameter of flower (4.92 cm) was recorded with T_1. The increase in flower diameter might be due to the fact that the balanced application of fertilizers resulted in increased carbohydrate assimilation leading to increased vegetative growth. These carbohydrates when translocated to reproductive organs underwent hydrolysis and got converted into the reducing sugars which ultimately helped in increasing flower size (Naik 2014). The above results are in corroboration with the findings of Renukaradya et al. (2011) in Carnation. Similar results were obtained by Yadav et al. (2017), Krishna et al. (1999) and Bhalla et al. (2007).

Conclusion

Biofertilizers are the new cost effective renewable source of plant nutrients. The use of bio-fertilizers like *Azotobacter*, *Pseudomonas* along with doses of chemical fertilizers is a recent attempt for increasing the growth and yield of different crops. On the basis of obtained result it can be concluded that most of the growth parameters like number of primary branches/plant, length of primary branches (cm) and plant spreading (cm) showed significantly positive result when treated with 75% NPK + *Azotobactor* + *Pseudomonas* + RDFYM. Whereas, 75% NPK + *Pseudomonas* exhibited significant effect on some of important flowering parameters like days to bud initiation, days to flowering and bud length (cm). Rest of the flowering characters i.e. bud diameter (cm) and diameter of flower (cm) were enhanced positively with the application of 75% NPK + *Azotobactor* + *Pseudomonas* + RDFYM .

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