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Influence of Integrated Nutrient Management on Flower and Seed Yield of African Marigold cv. 'Pusa Narangi Gainda' during Different Season in Mid Hills Condition of H.P.

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A B S T R A C T

The present investigation was carried out to find out influence of integrated nutrient management on flower and seed yield of African marigold cv. 'Pusa Narangi Gainda' during different season in mid hills condition of H.P, at Dr. Yashwant Singh Parmar University of Horticulture and Forestry, Nauni, Solan, HP in the year of 2016-2017 during different season (rainy season and summer season). The experiment was laid out in randomized block design replicated thrice and with 10 treatments. Study showed significant effect on flower yield per plant (196.41 g), flower yield per plot (1767.63 g), seed yield per plant (10.88 g) and seed yield per plot(97.86 g) in plants supplied with Azotobacter + PSB + 70%RDF (T_4). With respect to season, higher flower yield per plant (184.59 g) and maximum flower yield per plot (1661.27 g) were recorded in plants being grown during summer season, however more seed yield per plant (17.28 g) and seed yield per plot (155.52 g) was observed during rainy season planting. Maximum seed weight of seed per head (0.53 g), highest number of seed per head (186.51 g) and 1000 seed weight (3.37 g) were recorded with (T_3) Azotobacter + PSB + 80% RDF during rainy season planting.

Introduction

Marigold (*Tagetes erecta* L.) is one of the most specially grown loose flower crop which belongs to family Asteraceae. Marigold has been named after 'Virgin Mary'. The king Curtez after conquering Mexico got fascinated by the beauty of marigold flowers and he carried it to Spain. It was then offered to the 'attar' of Virgin Mary and thus got its name Mary's gold which is now popularly known as marigold (Marshal, 1969). It is documented that French marigold (*Tagetes patula* L.) was put into cultivation in 1573 AD and African

marigold (*Tagetes eracta* L.) in 1596 AD in the Europe. In India, these were introduced by Portuguese between 1502 and 1550 (Gavhane *et al.*, 2004). Marigold spreads quickly because of the facts that its cultivation is relatively easy, it has longer blooming period and beautiful flowers with a long shelf life. Also, the marigold flowers are utilized on commercial scale for different purposes. In India, about 278 thousand hectares area is presently under floriculture with a production of 1656 thousand MT loose flowers annually. The total area under marigold is 55.89 thousand hectares with a production of about 511.31 thousand MT. In Himachal Pradesh, it occupies an area of 22 ha with a production 19.61,000 MT (NHB 2016-17). Marigold is widely cultivated as bedding plant in landscape design.. The chemical fertilizers are important sources of nutrients but the indiscriminate use of chemical fertilizers poses the threat of environmental pollution and soil health degradation. At present, we are not in a position to abandon the use of chemical fertilizers completely, so the best option available is to use the biofertilizers in lesser amounts. Thus, integrated nutrient management is a strategy for advocating judicious and efficient use of chemical with matching addition of organic manures and biofertilizers. Therefore, emphasis is now focused on the use of organic manures such as farm yard manure, and bio-fertilizers like Azotobacter, Phosphate Solubilising Bacteria (PSB), AM fungi and PGPR (Plant Growth Promoting Rhizobacteria). Azotobacter is a non symbiotic bacterium which fixes atmospheric nitrogen in to soil (Somani, 2005). Phosphate solublizing organism are not only able to solubilize insoluble forms of inorganic P but are also capable to mineralize organic forms of P, thus improving the availability of native soil P. Keeping the above facts in view, the present investigation was conducted with the objectives of to see the effect of biofertlizers and its combinations and to find out appropriate dose of biofertilizers on flower yield and seed yield during different season of African marigold respectively.

Materials and Methods

An experiment was conducted at the at the experimental farm of Department of Floriculture and Landscape Architecture, Dr. Yashwant Singh Parmar University of Horticulture and Forestry, Nauni, Solan, HP in the year of 2016-2017 to the Influence of integrated nutrient management on flower yield and seed yield of African marigold. African marigold cv. 'Pusa Narangi Gainda' was planted during different season i.e. rainy season and summer season respectively with the spacing of 30 x30 cm and with 1x 1 m^2 plot size during 2016-2017. The experiment was laid out in randomized block design with three replications the experiment consisted of 10 treatments *viz*, T_1 100% NPK of RDF, T_2 Azotobacter+PSB+90% (RDF), T_3 Azotobacter+PSB+80% (RDF), T_4 Azotobacter+PSB+70% (RDF), T_5 Azotobacter+AM+70% (RDF), T_6 Azotobacter+AM+80% (RDF), T_7 Azotobacter+AM+70% (RDF), T_8 PGPR+90% (RDF), T_9 PGPR+80% (RDF) and T_{10} PGPR+70% (RDF). The data of both season were analyzed statistically for interpretation of results.

Results and Discussion

The pertaining data on flower and seed yield is presented in Table 1 clearly exhibited, maximum flower yield per plant (196.41 g) and maximum flower yield per plot (1767.63 g) recorded in plants grown with T_4 (Azotobacter + PSB + 70% RDF), while these were minimum (127.62 and 1148.54 g, respectively) with T_1 (100% NPK) during 2016-2017. The increased flower production might be due to that after application of organic manure and biofertlizers (Azotobacter and PSB) there was increase in plant growth

as well as number of branches which directly stimulate flower yield per plant. These results are in close to conformity with the finding of Ajitkumar 2002 in Marigold and Maurya 2003 in Tuberose In contrast of season, more flower yield per plant (184.59 g) and flower yield per plot (1661.27 g) was noticed during summer season planting over rainy season planting. This could be attributed to the existence of congenial climatic conditions during the crop growth period and enabled them to produce increased amount of photosynthates and in turn resulted in more dry matter accumulation. Whereas, due to unfavorable climatic conditions existed during the rainy season planted crops, it failed to produce optimum vegetative growth and better flowering. Similar variation was also observed by Guruprasad (1999) and Nagarjun *et al.,* (2004) in China aster; Chanda and Roychoudhary (1991) in African marigold. The application of different nutritional treatments significantly varied the seed yield per plant over the (5.86 g) T_1 i.e.100% NPK. Among these treatments, seed yield per plant (10.88 g) and seed yield per plot (97.86 g) to be recorded more with T_4 (Azotobacter + PSB +70% RDF) as compared to T_1 (100% NPK), which might be due to the fact that beneficial effect of nitrogen (from the Azotobacter) and phosphorus (from PSB) on flower size and weight of individual flower attributed to increase the protein synthesis, thus promote the development of floral primordial, while phosphorus was found to be involved in formation of floral primordial resulting in more number of flowers obtained which directly affect the seed yield per plant.

Table.1 Influence of integrated nutrient management on flower and seed yield of African marigold during different planting seasons

Treatments	Flower yield per plant (g)			Flower yield per plot (g)			Seed yield per plant (g)			Seed yield per plot (g)		
	Rainy Season	Summer Season	Mean	Rainy Season	Summer Season	Mean	Rainy Season	Summer Season	Mean	Rainy season	Summer season	Mean
T_1	103.81	151.42	127.62	934.26	1362.81	1148.54	9.10	2.62	5.86	81.87	23.58	52.73
T_2	160.08	184.31	172.20	1440.75	1658.76	1549.76	12.33	4.22	8.28	110.97	37.98	74.48
T_3	166.51	194.28	180.40	1497.96	1748.55	1623.26	14.74	4.27	9.51	132.66	38.40	85.53
T_4	179.02	213.79	196.41	1611.18	1924.08	1767.63	17.28	4.47	10.88	155.52	40.20	97.86
T_5	157.49	183.42	170.46	1417.38	1650.75	1534.07	12.23	3.96	8.10	110.10	35.64	72.87
T_6	165.78	189.79	177.79	1492.35	1708.11	1600.23	13.64	4.26	8.95	122.79	38.34	80.57
T_7	172.97	210.44	191.71	1556.76	1893.93	1725.35	15.20	4.34	9.77	136.77	39.06	87.92
T_8	154.93	181.85	168.39	1394.40	1636.68	1396.19	12.06	3.77	7.92	108.54	33.90	71.22
T_9	130.50	155.33	142.92	1186.47	1397.97	1411.58	9.77	3.10	6.44	87.96	27.87	57.92
T_1	135.53	181.24	158.39	1219.74	1631.13	1425.44	11.67	3.47	7.57	105.03	31.26	68.15
Mean	152.80	184.59	168.70	1375.15	1661.27	1518.20	12.80	3.85	8.33	115.22	34.62	74.92
$CD_{0.05}$	Season : 3.10 Treatments : 6.94 SeasonxTreatments : 9.82			Season : 28.05 Treatments : 62.71 SeasonxTreatments : 88.69			Season : 0.81 Treatment : 1.80 SeasonxTreatment : 2.54			Season : 7.27 Treatment : 16.26 Season xTreatments:23.00		

Table.2 Influence of integrated nutrient management on seed attributes of African marigold during different planting seasons

Treatments	Number of seed per head			Weight of seed per flower (g)			1000 seed weight (g)		
	Rainy Season	Summer Season	Mean	Rainy Season	Summer Season	Mean	Rainy Season	Summer Season	Mean
T_1	172.66	68.40	120.53	0.43	0.15	0.29	2.69	2.59	2.64
T_2	251.06	86.43	168.75	0.67	0.21	0.44	2.91	2.82	2.87
T_3	280.68	92.33	186.51	0.84	0.22	0.53	3.42	3.32	3.37
T_4	260.47	106.69	183.58	0.73	0.25	0.49	3.41	3.30	3.36
T_5	242.17	88.58	165.38	0.63	0.22	0.43	3.23	3.27	3.25
T_6	233.84	75.07	154.46	0.61	0.20	0.41	3.20	3.23	3.22
T_7	266.10	102.18	184.14	0.79	0.24	0.52	3.32	3.29	3.31
T_8	191.39	69.04	130.22	0.51	0.16	0.34	2.78	2.70	2.74
T_9	212.29	70.22	142.26	0.58	0.19	0.39	2.83	2.75	2.79
T_{10}	205.84	70.65	138.25	0.57	0.19	0.38	2.83	2.75	2.79
Mean	230.65	82.16	155.20	0.64	0.20	0.42	3.06	3.00	3.03
$CD_{0.05}$	Season : 5.46 Treatments : 12.44 SeasonxTreatment : 17.60			Season : 0.04 Treatment : 0.09 Season xTreatment : 0.12			Season : 0.05 Treatment : 0.12 Season xTreatment : NS		

The similar results were recorded by Singh *et al.*, (2015), Yadav *et al.*, (2017) and Chandrikapure *et al.*, (1999) in African marigold. In general, seed yield per plant and seed yield per plot was higher in rainy season (12.80 g and 115.83 g, respectively) over summer season, which might attributed to there was lesser activity of pollinators during seed setting as well as shedding of seeds due to heavy rains at the time of harvesting during summer season planting as it is evident from meteorological data. These results are in the close conformity with the findings of Meena *et al.*, (2015) and Singh and Arora (1998) in African marigold. As evident from Table 2, more number of seeds per head (186.51) noticed with the application of T_3, (Azotobacter + PSB + 80% RDF), while it was less (120.52) with T_1 (control).. Maximum seed weight per head (0.53 g) was obtained with T_3 (Azotobacter + PSB + 80% RDF), however it was minimum (0.29 g) in plants grown with T_1 (100% NPK), which it is ascribed to the better quality in flower production traits by using chemical, manure, Azotobacter and PSB, which increased the nutritive status of macro and micro nutrients in soil.. The similar findings were also reported by Singh *et al.*, (2015) in marigold cv. 'Pusa Bsanti' and by Bower *et al.*, (1965) in petunia. Rainy season planting exhibited more number of seeds (230.65) per head, seed weight per head (0.64g) and 1000 seed weight (3.06 g).however,1000 seed weight was recorded more (3.37 g with T_3 (Azotobacter + PSB + 80% RDF). Similar results were also reported by Meena *et al.*, *(*2015) in African marigold.

Interaction effect

Interaction between season and treatments exhibited that that plants grown during summer season produced more flower yield per plant (196.41 g), flower yield per plot (1767.63 g) in plants grown with T_4 (Azotobacter + PSB + 70 %RDF) during summer season, while these were higher (17.28, 155.52 g respectively) in plants being grown in rainy season with the same treatment (T_4). More number of seed per head (280.68), highest seed weight per head (0.84 g) and maximum 1000 seed weight (3.37) were recorded with the application of T_3 (Azotobacter + PSB + 80 %RDF) during rainy season.

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