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Effect of bio-organic and inorganic nutrient sources on the growth and flower yield of marigold

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Abstract
An investigation was carried out to study the effect of bio-organic and inorganic nutrient sources on the growth and flower yield of marigold during *Rabi* season of the year 2013-14. The experiment comprised of three replications laid out in Randomized Block Design having twelve treatment combinations of bio-organic and inorganic nutrient sources. Application of *Azo* + PSB + Cow Urine (5%) + 50% RD'N' through VC + 50% RDF was found to be more effective in increasing the vegetative growth parameters like plant height**,** plant spread**,** number of primary and secondary branches plant^{-1} as well as flowering attributes viz., days to 50% flowering, flower diameter, number of flowers plant^{-1}, fresh flower weight plant^{-1}, dry flower weight pant^{-1}, flower yield plot^{-1}, ha^{-1} and duration of flowering. Longest shelf life was also recorded with the treatment receiving *Azo* + PSB + Cow Urine (5%) + 50% RD'N' through VC + 50% RDF. However, the effect of *Azo* + PSB + 50% RD'N' through VC + 50% RDF was found to be *at par* with *Azo* + PSB + Cow Urine (5%) + 50% RD'N' through VC + 50% RDF. But maximum benefit: cost ratio was obtained in *Azo* + PSB + Cow Urine (5%) + 50% VC equivalent to RD'N' + 50% RDF.

Keywords: Bio-organic, flowering attributes, growth, inorganic, yield

1. Introduction
Marigold (*Tagetes erecta* L.) occupies a prominent place in ornamental horticulture and is one of the most important commercially exploited flower crop belonging to the family Asteraceae. It has great demand for loose flowers, garlands, garden display and decorative purposes at various religious and social functions. Nutrient management plays an important role in determining the growth and flowering in marigold. Among the various reasons behind low productivity of marigold, poor soil and nutrient management is one of them. Therefore, nutrient management has prime importance for its successful cultivation. The use of organic manures and biofertilizers along with the balanced use of chemical fertilizers is known to improve the physico-chemical and biological properties of soil, besides improving the efficiency of applied fertilizers (Verma *et al.* 2011) [15]. Biofertilizers improve crop growth and quality by fixation of atmospheric nitrogen and also by dissolving insoluble form of phosphorus. *Azospirillum* fixes atmospheric nitrogen to some extent and makes available the fixed soil nitrogen to the crop, whereas phosphorus solubilising bacteria (PSB) possesses the ability to convert insoluble phosphorus into soluble forms in the soil by secreting organic acids. Recently, the use of cow urine is being given importance as it has been reported to act as growth promoter of plants and is a vital component in improving soil fertility. It not only possesses an inherent property of acting as a fertilizer but also as a mild biocide (Singh *et al.* 2012) [12]. Keeping the above facts in view, the present experiment was carried out to study the

Effect of effect of bio-organic and inorganic nutrient sources on the growth and flower yield of marigold.

2. Materials and methods

The present investigation was conducted at the Department of Horticulture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India during the *Rabi* season of 2013-2014. The experiment was laid out in randomized block design with three replications and twelve treatments. Individual plot size was of 1.2 m × 1.2 m with a spacing of 30cm x 30cm. All the recommended package of practice was followed to raise a healthy crop. The treatments included inorganic form of N (200 kg ha^{-1}), P_2O_5 (200 kg ha^{-1}) and K_2O (200 kg ha^{-1}) as recommended dose of fertilizer (RDF), vermicompost in quantities equivalent to 50% of recommended dose of N as well as biofertilizers viz., *Azospirillum* (200 g ha^{-1}), PSB (200 g ha^{-1}) and cow urine (5%). The recommended dose of NPK was applied in two splits i.e. 50 per cent N and full dose of P and K at the time of transplanting and remaining 50 per cent 'N' was applied 40 days after transplanting in the form of urea, super phosphate and muriate of potash, respectively. Vermicompost was applied as per the treatment to each experimental plot before planting. Slurry of 200 g culture of *Azospirillum* and PSB were prepared in 1000 ml of water individually and also combinations of both 100 g Azospirillum and 100 g PSB were prepared in 1000 ml of water. *Azospirillum* and PSB were applied through seedling root treatment for 30 minutes before transplanting. Cow Urine (5%) spray was applied at 30 days after transplanting. Observations were recorded on five randomly selected plants from each treatment. The data were recorded on various parameters of growth, flowering behaviour, yield attributes and flower yield and were subjected to statistical analysis as described by Panse and Sukhatme (1989) [8].

3. Results and discussion

3.1. Vegetative growth parameters

Perusal of data presented in Table 1 reveals that different nutrient sources affected various vegetative parameters of marigold. The treatment *Azo* + PSB + Cow Urine (5%) + 50% RD'N' through VC + 50% RDF recorded maximum plant height (53.31 cm), plant spread (37.78 cm), number of primary branches $plant^{-1}$ (19.47) and number of secondary branches $plant^{-1}$ (39.53) followed by *Azo* + PSB + 50% RD'N' through VC + 50% RDF which, however, had *at par* effect. Combined application of bio-organic nutrient sources along with 50% inorganic nutrient sources proved to be beneficial for robust growth of plant as compare to other treatment. Bioinoculent like *Azospirillum* and PSB may have proved to be beneficial in fixing the atmospheric nitrogen and solubilizing fixed phosphorous in soil and making it available to plant and also the secretion of growth substances like auxin, might have stimulated the plant metabolic activity and photosynthetic efficacy leading to better growth and development of plant. Above results are in conformity with the findings of Shubha *et al*. (2006) [11]. Gotmare *et al*. (2007) [2]. Mittal *et al*. (2010) [5]. and Mohanty *et al*. (2013) [6]. in marigold.

Table 1: Effect of bio-organic and inorganic nutrient sources on growth parameters of marigold after 90 DAT

Treatments	Plant height (cm)	Plant spread (cm)	No. of primary branches $plant^{-1}$	No. of secondary branches $plant^{-1}$
100% RDF	49.22	33.96	17.60	36.07
50% RD'N' through VC + 50% RDF	4.49	29.00	15.47	28.73
Azo + 75% RD'N' + 100% RD'P' and 'K'	46.27	30.05	16.50	31.43
PSB + 75% RD'P' + 100% RD'N' and' K'	46.94	31.58	16.80	31.50
Cow Urine (5%) + 75% RD'N' + 100% RD'P and 'K'	45.03	29.24	15.80	30.83
Azo + 50% RD'N' through VC + 50% RDF	47.37	32.63	17.33	32.30
PSB + 50% RD'N' through VC + 50% RDF	50.16	35.25	18.13	37.97
Cow Urine (5%) + 50% RD'N' through VC + 50% RDF	48.59	33.74	17.40	35.40
Azo + PSB + 50% RD'N' and 'P' + 100% RD'K'	40.02	27.20	13.33	28.43
Azo + PSB + Cow Urine (5%) + 50% RD'N' and 'P' + 100% RD'K'	44.23	28.94	15.53	29.27
Azo + PSB + 50% RD'N' through VC + 50% RDF	52.29	35.80	19.13	38.33
Azo + PSB + Cow Urine (5%) + 50% RD'N' through VC + 50% RDF	53.31	37.78	19.47	39.53
CD (P=0.05)	6.31	4.83	2.60	5.09

Where,

RDF - Recommended Dose of Fertilizer, VC - Vermicompost, *Azo* - *Azospirillum*, PSB - Phosphorus Solubilizing Bacteria, RD'N' - Recommended dose of nitrogen, RD'P' - Recommended dose of phosphorus, RD'K' - Recommended dose of potassium, C.D. Criticaldifference

3.2. Flowering and yield attributes

Data presented in Table 2, on flowering and yield attributes showed significant response to different treatments of bio-organic and inorganic nutrients sources. With respect to days required for 50% flowering, the application of *Azo* + PSB + Cow Urine (5%) + 50% RD'N' through VC + 50% RDF recorded minimum number of days for 50% flowering (41.85) which was having statistically equal value with *Azo* + PSB + 50% RD'N' through VC + 50% RDF (46.13). The present finding are in conformity with the finding of Chandrikapure *et al*. (1999) [1]. Sehrawat *et al*. (2003) [10]. Gupta *et al*. (2012) [3]. in marigold. Maximum flower diameter (6.18 cm) was recorded on the application of *Azo* + PSB + Cow Urine (5%) + 50% RD'N' through VC + 50% RDF followed by *Azo* + PSB + 50% RD'N' through VC + 50% RDF. The same trend was observed for highest number of flowers $plant^{-1}$ (32.80), fresh flower weight $plant^{-1}$ (198.83 g) and dry flower weight $plant^{-1}$ (44.96 g) with maximum being observed under *Azo* + PSB + Cow Urine (5%) + 50% RD'N' through VC + 50% RDF which also recorded highest flower yield $plot^{-1}$ (3.18 kg $plot^{-1}$) and flower yield ha^{-1} (22.09 t ha^{-1}). However, *Azo* + PSB + Cow Urine (5%) + 50% RD'N' through VC + 50% RDF had *at par* effect with *Azo* + PSB + 50% RD'N' through VC + 50% RDF. The higher values recorded for flowering attributes and yield may be due to active and rapid multiplication of bacteria especially in rhizosphere creating favourable condition for nitrogen fixation and phosphorus solubilisation at higher rate making it available to the plants leading to more uptakes of nutrients and water. This in turn increases photosynthesis and enhances food accumulation and also diversion of photosynthates towards sink resulting in better growth and subsequently higher number of flowers

plant^{-1} and higher flower yield ha^{-1} (Verma *et al*. 2011[15]. Kumar *et al*. 2009) [4]. The present finding are in conformity with the findings of Sunitha *et al*. (2007) [13]. Mittal *et al*. (2010) [5]. Mohanty *et al*. (2013) [6]. and Thumar *et al*. (2013) [14]. in marigold. Maximum duration of flowering (76.16 days) and longer shelf life of flowers (7.89 days) was recorded in treatment *Azo* + PSB + Cow Urine (5%) + 50% RD'N' through VC + 50% RDF which was found to have statistically similar effect with *Azo* + PSB + 50% RD'N' through VC + 50% RDF. The results are in agreement with the finding of Patel *et al*. (2011) [9]. and Gupta *et al*. (2012) [3]. in marigold. However, highest net profit and B: C ratio (Rs. 258681/- and 3.56, respectively) was found in the treatment *Azo* + PSB + Cow Urine (5%) + 50% VC equivalent to RD'N' + 50% RDF. Hence, the treatment of *Azo* + PSB + Cow Urine (5%) + 50% VC equivalent to RD'N' + 50% RDF proved to be most profitable. Optimum fertilizer use by reducing the recommended dose of fertilizer to 50 per cent and supplementing the deficit by using 50 per cent vermicompost equivalent to RDN along with *Azospirillum*, PSB and cow urine (5%) resulted in higher profit without depleting the soil macro nutrients. The results are in agreement with the findings of Shubha *et al*. (2006) [11]. Kumar *et al*. (2009) [4]. and Owayez Idan *et al*. (2014) [7]. in African marigold.

Table 2: Effect of bio-organic and inorganic nutrient sources on yield and yield attributes of marigold

Treatments	Days to 50% flowering	Flower diameter (cm)	No. of flowers Plant^{-1}	Fresh flower weight plant^{-1} (g)	Dry flower weight plant^{-1} (g)	Flower yield (kg plot^{-1})	Flower yield (t ha^{-1})	Duration of flowering (days)	Shelf life (days)	Net return (Rs ha^{-1})	Benefit cost ratio
100% RDF	48.39	5.51	30.33	175.07	37.94	2.80	19.45	72.80	7.08	222786	3.23
50% RD'N' through VC + 50%RDF	52.94	4.73	25.87	131.47	29.01	2.10	14.61	67.88	4.84	148935	2.12
Azo + 75% RD'N' + 100% RD'P' and 'K'	50.91	5.15	26.60	141.74	31.64	2.27	15.75	70.15	6.25	166757	2.40
PSB + 75% RD'P' + 100% RD'N' and' K'	50.89	5.15	27.47	150.38	31.90	2.41	16.71	71.81	6.28	182552	2.68
Cow Urine (5%) + 75% RD'N' + 100% RD'P and 'K'	51.08	5.01	26.53	140.17	31.58	2.24	15.57	69.08	6.24	163867	2.35
Azo + 50% RD'N' through VC + 50% RDF	49.46	5.31	28.20	155.99	34.76	2.50	17.33	72.46	6.66	188683	2.65
PSB + 50% RD'N' through VC + 50% RDF	46.35	6.05	31.07	180.81	39.34	2.89	20.09	73.05	7.79	230060	3.23
Cow Urine (5%) + 50% RD'N' through VC + 50% RDF	48.78	5.40	28.67	160.93	37.27	2.57	17.88	72.71	6.83	196648	2.75
Azo + PSB + 50% RD'N' and 'P' + 100%RD'K'	53.29	4.27	22.87	106.68	28.03	1.71	11.85	62.13	4.73	113036	1.75
Azo + PSB + Cow Urine (5%) + 50% RD'N' and 'P' + 100% RD'K'	52.48	4.89	26.33	136.79	29.94	2.19	15.20	68.25	5.23	161838	2.45
Azo + PSB + 50% RD'N' through VC + 50% RDF	46.13	6.07	32.20	189.40	39.78	3.03	21.04	74.48	7.51	243988	3.40
Azo + PSB + Cow Urine (5%) + 50% RD'N' through VC + 50% RDF	41.85	6.18	32.80	198.83	44.96	3.18	22.09	76.16	7.89	258681	3.56
CD (P=0.05)	6.39	0.90	5.15	32.09	7.09	0.51	3.57	7.24	1.55	-	-

4. Conclusions

It could be concluded from the present investigation that, marigold growth and yield was higher when inorganic fertilizers were supplemented with biofertilizers and organic manures like vermicompost and cow urine as compared to only inorganic fertilizers. Application of *Azo* + PSB + Cow Urine (5%) + 50% RD'N' through VC + 50% RDF was found to be more effective in increasing the vegetative growth, yield attributes, yield and also gave the highest B : C ratio.

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