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Integrated Nutrient Management in Marigold (*Tagetes erecta* L.) cv. Pusa Narangi Gainda

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A B S T R A C T

An investigation was carried out to study the combined effect of organic fertilizers and bio-fertilizers on the vegetative and flowering characters of marigold (*Tagetes erecta* L.) cv. PusaNarangiGaindaat the horticultural instructional farm, NEHU, Tura campus, Chasingre, Meghalaya during the year 2017-18. The experiment was conducted in randomized complete block design (RCBD) with three replications and twelve treatment combinations comprising of FYM, vermicompost and biofertilizers *viz*. *Azotobacter* and *Azospirillum*. All the treatment combinations showed significant response in vegetative, flowering and yield characters during entire investigation. The treatment combinations *Azospirillum* + *Azotobacter* + vermicompost + 50% RDF showed maximum plant height (106.25cm), primary and secondary branches (16.83 and 22.00), leaf area (62.11 cm^2) and plant spread (53.56 cm E-W and 46.03 cm N-S) per plant,number of flowers per plant (30.50), flower yield per plant (326.05 g), flower yield (293.44 q/ha) and seed yield (14.67 kg/ha), whilst highestleaf length and breadth (15.91 cm and 3.95 cm), increased flower diameter (60.25 mm), enhanced flower bud initiation (53.67 days) and prolonged duration of flowering (103.33 days)was associated with *Azospirillum* + *Azotobacter* + FYM + 50% RDF. Maximum carotenoid content in fresh petals (11.65 mg/100 g fresh petals) and dry petals (11.37 mg/100 g dry petals) was associated with treatment *Azospirillum* + *Azotobacter* + vermicompost + 50% RDF), however, chlorophyll B (61.92 mg/g leaves) content was recorded to be highest in the treatment *Azospirillum* + *Azotobacter* + FYM + 50% RDF).

Introduction

Marigold (*Tagetes erecta* L.) is most important flower crops commercially grown in India. Marigold gains popularity among flower growers due to its easy cultivation, wide adaptability to diverse soil and climatic conditions, habit of profuse flowering, short duration to produce marketable flowers, eclectic spectrum of attractive colours, shape and good keeping quality. Flowers are extensively used as loose form for floral decoration, religious offerings, garlands making and flower baskets.

Besides its ornamental value, marigold petals are concentrated source of xanthophylls and a rich source of lutein (80-90 per cent). Dry petal of marigold flower contains about 90 per cent (w/w) carotenoids.

These dried petals or concentrates are used as feed additives to improve the pigmentation of the poultry skin and the eggs of laying hens. Nutritional management through organic manure is helpful for enhancing growth, yield and quality of marigold flowers (Kumar and Sharma 2013). Generally, marigold responds very well to the application of inorganic and organic fertilizers.

Nutritional management through organic manure are helpful for enhancing growth, yield and quality of flowers. However, indiscriminate and long term use of fertilizer have resulted in deterioration of soil health in terms of its physical and chemical properties, reduction in organic content, soil humus, decline in soil microbial activities and increased pollution hazards of soil, water and air besides causing health hazards to a society and has it also affected the growth and production of flowers.

Bio-fertilizer usually consists of live or latent cells of micro-organisms which include biological nitrogen fixers, P-solubilizing, mineralization of nitrogen and transformation of several elements into available forms. *VAM*, *Azotobacter*, *Azospirillum* and phosphate solubilizing bacteria are regularly applied bio-fertilizers in horticultural crops (Zaredost *et al.,* 2014). Use of bio-fertilizers lessens per unit consumption of inorganic fertilizers and upsurges the quality and quantity of flowers (Syamal *et al.*, 2006).

Bio-fertilizers help in the fixation of atmospheric nitrogen as well as improving phosphorus uptake by plants (Kumar *et al.*, 2006). Vermicompost and farm yard manure (FYM) proved to be beneficial to fix atmospheric nitrogen and solubilize fixed phosphorus in soil and also secrete growth substances like auxins, which stimulated the plant metabolic activities and photosynthetic efficacy leading to better growth and development of plant. Yadav *et al.,* (2017) noticed that growth and yield attributes increased with bio- fertilizers in marigold.

Organic and bio-fertilizer like vermicompost, farm yard manure azotobacter and azospirillum plays an important role in improving the plant growth because of major constituent in chlorophyll, protein and amino acids, resulted in increased production of green leaves.

The combined application of Azotobacter, phosphate solubilizing bacteria, *Azospirillum*, FYM and Vermicompost along with nitrogen and phosphorus has been provento be beneficial for robust growth of plants. Studies indicate the greater influence of organic fertilizers on growth, flower production and quality blooms in many ornamental flowering plants. The integrated soil fertility management practices involving judicious combination of organic manures, bio fertilizers and chemical fertilizers seems to be a feasible option for sustained agriculture on a commercial and profitable scale (Singh *et al.*, 2015).

The yield and quality of marigold flowers may be improved by espousing integrated nutrient management practices which include the judicious and combined use of organic, inorganic and bio-fertilizers. The research over conventional nutritional requirement (recommended dose of NPK fertilizers) has been standardized. However, systematic research and documentation on the effect of organic sources of nutrient for marigold is still lacking. Therefore, the present investigation has been carried out to find out the suitable treatment to get the maximum vegetative growth, flowering and yield of marigold (*Tagetes erecta* L.) cv. Pusa Narangi Gainda under the agro-climatic conditions of Tura, West Garo Hills, Meghalaya.

Materials and Methods

The experiment was carried out at the experimental farm of Department of Horticulture, NEHU, Tura campus, Chasingre, Meghalaya from September, 2017 to April 2018. The district is located approximately between the latitudes 90° 30' and 89° 40' E and the longitudes of 26° and 25° 20' N with an average elevation of 349 metres (1145 feet).The prevailing weather of the region is sub-tropical, experiences a relatively high temperature in summer and cool winters. The average rainfall of the district is 3300mm, of which more than two-third occurs during the monsoon, however, winter being practically dry.

Twelve treatments *viz.*Control (100% RDF), *Azospirillum* +75% RD ‘N’ +100% RD ‘P’ and ‘K’, Azotobacter+75% RD ‘P’ +100% RD ‘N’ and ‘K’, FYM +50% RDF, VC + 50% RDF, *Azospirillum*+ FYM +50% RDF, *Azospirillum*+ VC +50% RDF, Azotobacter +FYM +50% RDF, Azotobacter +VC +50%RDF, *Azospirillum*+ Azotobacter + 50% RD ‘N’ and ‘P’ +100% RD ‘K’, *Azospirillum*+ Azotobacter + FYM + 50% RDF and *Azospirillum*+ Azotobacter + VC +50% RDFwere compared to find out suitable dose of integrated nutrients under agro-climatic conditions of Tura.

Recommended dose of nitrogen (120 kg/ha), phosphorous (80kg/ha), potassium (60kg/ha) in the form of urea, single super phosphate (SSP), murate of potash (MOP), respectively, well decomposed FYM @ 25 t/ha, vermicompost @ 2.5 t/ha and biofertilizers @ 5 kg/ha were incorporated into the soil before transplanting. The suitable combinations of organic and inorganic fertilizers were applied basal before transplanting. The experiment was conducted in randomized completely block design (RCBD) with three replications. Uniform size (10-15cm) of marigold seedlings cv. Pusa narangigainda was transplanted on raised beds at spacing 30x30cm. The observations on vegetative and flowering characters *viz.* plant height, number of primary branch, number of secondary branch, leaf length, leaf breadth, leaf area, plant spread, initiation of flower buds, flowering duration, flower diameter, number of flowers per plant, flower yield per plant, flower yield, fresh weight of flower and seed yield were recorded and analysed statistically as suggested by (Gomez and Gomez, 2010). Chlorophyll-A and Chlorophyll-B content of leaf tissue and carotenoid were determined by using the method described by (Sadasivam and Manickam, 2005).

Results and Discussion

Response of organic manures and bio-fertilizers on vegetative growth characters

Both vegetative and floral characters were found to be improved by integrated nutrient management. Significant response of organic manures and bio-fertilizers on growth characters are presented (Table 1, Fig. 1). The maximum plant height (106.91 cm) was associated with application of *Azotobacter* + Vermicompost + 50% RDF which was at par with *Azospirillum* + *Azotobacter* + Vermicompost + 50% RDF (106.25 cm) and *Azotobacter* + FYM + 50% RDF (106.63cm).

The increase in plant height with combination of organic manure and bio-fertilizers might be due to the upsurge in transport of metabolites and rate of photosynthesis in the plant, which empowers the plant for quick and better upward vegetative growth. Combination of organic manure and bio-fertilizers proved to be the best for attaining the maximum plant height (Keisam *et al.,* 2014; Swaroop *et al.*, 2017**)** in gladiolus.

Nutrient management through judicious combination of organic manure, bio-fertilizers and inorganic fertilizers showed significant response in number of branches per plant. More number of primary branches per plant (19.33) was found in *Azospirillum*+ *Azotobacter* + FYM + 50% RDF which was at par with *Azotobacter* + FYM + 50% RDF (19.00) and *Azospirillum*+ *Azotobacter* + Vermicompost +50% RDF (16.83). Use of organic manures and biofertilizers helps for maximum number of primary branches and plant spread in China aster (Bohra *et al.*, 2019).

However, number of secondary branches per plant (22.00) was found in *Azospirillum*+ *Azotobacter* + Vermicompost +50% RDFwhich was at par with *Azospirillum*+ *Azotobacter* + FYM + 50% RDF (19.67).Increased leaf length and leaf breadth was observed in treatment combinations of *Azospirillum*+ *Azotobacter* + FYM + 50% RDF (15.91cm and 3.95cm) which was at par with *Azospirillum*+ *Azotobacter* + Vermicompost +50% RDF (15.56cm and 3.57cm) and *Azotobacter* + FYM + 50% RDF (15.05cm and 3.88cm). Whereas, increased leaf area was observed in the plot which received*Azospirillum*+ *Azotobacter* + Vermicompost +50% RDF (62.11cm^2) followed by *Azospirillum*+ 75% RD 'N'+100% RD 'P' and 'K'(50.81cm^2) and *Azotobacter* + FYM + 50% RDF (49.38cm^2). Dubliya *et al.*, (2018) also observed maximum leaf area per plant in tuberose from integrated nutrient management with vermicompost, *Azotobacter* and RDF.

The application of *Azospirillum*+ *Azotobacter* + Vermicompost +50% RDF showed maximum E-W and N-S plant spread (53.56cm and 46.03cm) followed by *Azospirillum* + FYM + 50% RDF (43.03cm and 41.96cm) and *Azospirillum*+ *Azotobacter* + FYM + 50% RDF (39.87cm and 40.30cm). Better performance of vegetative parameters *viz.* plant height, number of primary and secondary branches, plant spread, leaf length, breadth and area were observed when the plants were treated with biofertilizers and organic manures in combination with 50 % RDF. Vermicompost or FYM enhances soil fertility and moisture retention capacity of soil favorable to plant growth which might have contributed to the increase in plant height and leaf area.

These findings are in close conformity with the result of tuberose (Chawla *et al.*, 2018), marigold (Sharma *et al.*, 2017), dahlia (Pandey *et al.*, 2017) and marigold (Singh *et al.*, 2015). Application of vermicompost along with biofertilizers and RDF may be attributed to microbial decomposition resulting in enhanced availability of nutrients which was translocated from soil to the plants during the entire growing season favoring the stimulation and production of auxiliary buds resulting in formation of a greater number of leaves in marigold (Pooja *et al.*, 2012).Significant response in vegetative growth, flowering characters and biochemical parameters and yield characters also observed in china aster (Kumar *et al.*, 2016) and marigold (Tomar *et al.*, 2013).

Response of organic manures and bio-fertilizers on flowering and yield characters

Significant responses of organic manures and bio-fertilizers on flowering characters are presented (Table 2, Fig. 2). Earliness in flower bud initiation showed by Vermicompost + 50% RDF (44.67 days) followed by *Azospirillum* + Vermicompost + 50% RDF (50.00 days), but was on par with *Azospirillum*+*Azotobacter* + Vermicompost +50% RDF (46.17 days). The delayed flowering was observed in control (74.00 days).

Earliness in flower bud initiation with organic manure and bio-fertilizer applications was also observed by Keisam *et al.,* (2014) in gladiolus, Kumari *et al.,* (2014) in chrysanthemum and Zaredost *et al., (*2014) in marigold. Early emergence of flower buds on application of vermicompost along with RDF might be due to increased availability of nitrogen, easy uptake of nutrients and simultaneous transport of growth promoting substances like cytokinin to the axillary buds resulting in breakage of apical dominance and facilitated better sink for faster mobilization of photosynthates and early transformation of plant parts from vegetative to reproductive phase. The present findings are lent credence to the observation of Munikrishnappa *et al.,* (2004);Subha (2006); Kumar *et al., (*2016).

Prolonged duration of flowering was noticed under treatment with *Azospirillum* + *Azotobacter* + Vermicompost +50% RDF (103.33 days) followed by *Azospirillum*+ FYM +50% RDF (98.33 days), but was on par with *Azospirillum* +*Azotobacter*+FYM +50% RDF (100.00 days). While, reduced number of days for bloom was associated with *Azospirillum*+ 50% RD 'N' + 100% RD N & K (65.50 days). Reduction in days taken for flowering was also reported by Pandey *et al.,* (2010) in chrysanthemum, Kumar and Sharma (2013) in marigold and Kumar *et al.,* (2015) in *Dendrobium* orchid.

However, Maximum flower diameter was associated with *Azospirillum* + *Azotobacter* + FYM +50% RD(60.25 mm) which was on par with *Azospirillum* + *Azotobacter* + Vermicompost +50% RDF (58.04 mm) and *Azotobacter*+ Vermicompost + 50% RDF(59.91 mm), whereas, minimum flower diameter was noticed under control (49.12mm).The beneficial effect on earliness in flower bud initiation, large sized flower and number of flower buds might be due to early breaking of apical dominance followed by easy and better translocation of nutrients to the flowers, better plant growth by the increased availability of nutrients and accelerated mobility of photosynthates from source to sink as influenced by the growth hormones released or synthesized from organic manures and bio-fertilizers. Application of vermicompost or FYM along with *Azotobacter* and *Azospirillum* proved to give longer flowering duration, flower diameter and higher flower production which in turn is beneficial for flower yield.

Vermicompost and FYM not only supports the survivability of microbes but also helps in their further multiplication as a result improves the flowering quality of the plant. These results corroborate with the findings of Panchal *et al.,* (2010) in chrysanthemum, Deshmukh *et al., (*2008) in gaillardia; Shashidhara and Gopinath (2005) in calendula; Singh *et al.,* (2015) in marigold.

The present research revealed that application of organic manures and bio-fertilizers along with inorganic fertilizers influenced significantly the quality of flower. Application of *Azospirillum* + *Azotobacter* + Vermicompost +50% RDF produced highest number of flower buds per plant (30.50) followed by *Azospirillum*+ *Azotobacter* + FYM+50% RDF(27.17) and *Azospirillum*+ FYM + 50% RDF(25.50).

Increased number of flower buds might be due to better nutrient uptake, higher photosynthetic efficiency, source-sink relationship and supply of macro and micro nutrients, enzymes and growth hormones. Similar results were noticed by several workers *viz.* Ali *et al.,* (2014) stated that application of biofertilizers resulted in the maximum number of flowers in gladiolus. Keisam *et al.,* (2014) also reported the maximum length of flower stalk, number of flowers per plant and flower weight in gladiolus was obtained with the application of organic nutrients. The nitrogenous compounds such as amino acids may have synthesized as influenced by the phyto-hormones released due to the application of chemical and biofertilizers. This amino acid act as a precursor of polyamines and secondary messenger in the flower initiation and development of more numbers of flower buds per plants in marigold (Kumar *et al., 2*016).

Use of *Azospirillum*+ *Azotobacter* + FYM + 50% RDF showed increased fresh weight of single flower (11.07g) which was on par with *Azospirillum* + *Azotobacter* + Vermicompost +50% RDF (10.69g) and followed by *Azotobacter* + 75% RD P +100% RD N and K (9.25g). Hadwani *et al., (*2013) noticed that integrated nutrient management resulted in the longest flowering duration. Application of organic manure and biofertilizers responded for maximum number of flowers and increased fresh weight might be due to the direct response of organic fertilization which may promote cell proliferation efficiently. Cell division and cell enlargement are accelerated by ample supply of nitrogen which initiates meristematic activity in crops (Crowther, 1935).

Abundant supply of organic manure and biofertilizers might have accelerated the photosynthetic activities of the plants and more assimilates may have translocated into flowers to develop, resulting in increased fresh weight of the flower. Zaredost *et al.,* (2014) observed that combined effect of bio- and chemical fertilizers resulted in the maximum fresh weight of flower in marigold. Enhanced flower yield was noted with *Azospirillum*+ *Azotobacter* + Vermicompost +50% RDF (326.05g and 293.44q/ha) followed by *Azospirillum*+ *Azotobacter* + 50% RD'N' and 'P'+ 100% RDF (244.56g and 220.10q/ha) which was on par with *Azospirillum*+ *Azotobacter* + Vermicompost + 50% RDF (273.04g and 225.00q/ha), while, lowest flower yield was associated with control (207.76g and 186.98q/ha). Increased flower yield had also been observed in chrysanthemum (Aashutosh *et al.,* 2019).

Whereas, maximum seed yield was obtained from the treatment combination of *Azospirillum*+ *Azotobacter* + FYM + 50% RDF (14.67q/ha) which was on par with *Azospirillum* + *Azotobacter* + Vermicompost + 50% RDF (13.41q/ha). These results are in close conformity with the findings of Thumar *et al., (*2013) in marigold; Mittal *et al., (*2010) in marigold; Parya *et al., (*2010) in golden rod; Sharma *et al.,* (2009) in China aster which revealed that application of organic manures and biofertilizers increased significantly flower yield per plant and flower yield per hectare might be due to conversion of photosynthates into proteins resulted in more flower primordia and development of flower buds.

Response of organic manures and bio-fertilizers on biochemical characters

Significant responses in Chlorophyll and carotenoid contents in fresh petals as well as dry petals of various treatment combinations are presented (Table 3, Fig. 3). All the treatment combinations for chlorophyll A content was non-significant, whilst *Azospirillum*+ *Azotobacter* + FYM + 50% RDFshowed increased chlorophyll B content (61.92mg/g) followed by *Azospirillum*+ *Azotobacter* + Vermicompost +50% RDF (57.76mg/g) and FYM + 50% RDF (49.27mg/g). Vermicompost had significant effect on photosynthetic pigments and imparts highest content of chlorophyll and carotenoids in marigold (Sardoei *et al., 2*014).

Table.1 Effect of integrated nutrient management on vegetative parameters of marigold at Tura, West Garo Hills district, Meghalaya

Treatments	Plant height (cm)	Number of primary branches per plant	Number of Secondary branches per plant	Leaf length per plant (cm)	Leaf breadth per plant (cm)	Leaf area (cm^2)	E-W Plant spread (cm)	N-S plant spread (cm)
T_1 Control (100% RDF)	73.90	10.50	14.00	9.95	2.84	30.75	28.01	36.26
T_2*Azospirillum* + 75% RD N + 100% RD P and K	88.27	14.00	18.67	13.93	3.64	50.81	30.51	31.65
T_3*Azotobacter* + 75% RD P + 100% RD N and K	64.20	14.26	17.00	10.9	2.85	32.15	27.05	28.1
T_4 FYM + 50% RDF	96.90	16.17	18.00	13.67	3.40	50.33	34.73	39.31
T_5 Vermicompost + 50% RDF	79.81	9.00	16.67	10.06	2.66	27.95	33.08	34.15
T_6*Azospirillum* + FYM + 50% RDF	95.01	13.17	18.33	13.35	3.20	43.32	43.03	37.08
T_7*Azospirillum* + vermicompost + 50% RDF	101.80	10.67	18.00	14.21	3.18	45.70	35.63	35.78
T_8*Azotobacter* + FYM + 50% RDF	106.63	19.00	19.00	15.05	3.88	49.38	34.21	39.9
T_9*Azotobacter* + vermicompost + 50% RDF	106.91	16.50	16.67	14.26	3.24	47.42	39.43	40.3
T_{10} *Azospirillum* + *Azotobacter* + 50% RD N and P + 100% RD K	87.26	8.67	19.33	13.75	3.42	47.47	35.97	41.96
T_{11}*Azospirillum* + *Azotobacter* + FYM + 50% RDF	95.33	19.33	19.67	15.91	3.95	45.75	39.87	38.75
T_{12} *Azospirillum* + *Azotobacter* + vermicompost + 50% RDF	106.25	16.83	22.00	15.56	3.57	62.11	53.56	46.03
CD at 5 per cent	7.84	2.78	2.88	2.16	0.82	2.92	3.01	3.16
CV (%)	7.76	12.17	9.39	9.54	14.69	3.88	4.91	4.99

Table.2 Effect of integrated nutrient management on flowering parameters of marigold at Tura, West Garo Hills district, Meghalaya

Treatments	Flower bud initiation (days)	Flowering duration (days)	Flower diameter (mm)	Number of flowers /plant	Flower yield per plant (g)	Flower yield (q/ha)	Fresh weight of flower (g)	Seed yield (q/ha)
T_1Control (100% RDF)	74.00	89.33	49.12	24.50	207.76	186.98	8.48	10.90
T_2*Azospirillum* + 75% RD N + 100% RD P and K	50.00	65.50	52.99	26.25	242.81	218.53	9.25	8.59
T_3*Azotobacter* + 75% RD P + 100% RD N and K	69.00	66.00	52.91	23.83	219.47	197.53	9.21	9.30
T_4 FYM + 50% RDF	50.50	92.33	56.28	25.33	265.46	238.91	10.48	12.30
T_5 Vermicompost + 50% RDF	44.67	101.33	54.60	26.33	275.68	248.11	10.47	9.94
T_6*Azospirillum* + FYM + 50% RDF	47.67	98.33	56.56	25.50	257.55	231.80	10.10	9.61
T_7*Azospirillum* + vermicompost + 50% RDF	50.00	96.00	58.48	27.00	284.04	255.64	10.52	12.76
T_8*Azotobacter* + FYM + 50% RDF	58.33	87.67	50.72	26.33	250.00	245.74	10.37	9.78
T_9*Azotobacter* + vermicompost + 50% RDF	54.17	91.83	59.91	25.00	300.77	270.69	10.00	10.25
T_{10}*Azospirillum* + *Azotobacter* + 50% RD N and P + 100% RD K	60.33	87.33	56.08	24.00	244.56	220.10	10.19	14.44
T_{11}*Azospirillum* + *Azotobacter* + FYM + 50% RDF	53.67	100.00	60.25	27.17	273.04	225.00	11.07	14.67
T_{12}*Azospirillum* + *Azotobacter* + vermicompost + 50% RDF	46.17	103.33	58.04	30.50	326.05	293.44	10.69	13.41
CD at 5 per cent	2.55	3.48	2.63	0.97	10.47	23.99	0.77	2.78
CV (%)	2.74	2.29	2.79	9.63	4.12	8.49	14.75	7.48

Table.3 Effect of integrated nutrient management on bio-chemical parameters of marigold at Tura, West Garo Hills district, Meghalaya

Treatments	Chlorophyll content in leaves (mg/g)		Carotenoid content in fresh petals (mg/ 100g)	Carotenoid content in dry petals (mg/ 100g)
	Chlorophyll A	Chlorophyll B		
T_1Control (100% RDF)	39.57	50.79	11.29	8.53
T_2*Azospirillum* + 75% RD N + 100% RD P and K	39.68	51.94	11.05	10.09
T_3*Azotobacter* + 75% RD P + 100% RD N and K	39.48	45.71	11.43	8.54
T_4 FYM + 50% RDF	39.57	49.27	11.56	7.82
T_5 Vermicompost + 50% RDF	39.16	41.17	11.34	10.11
T_6*Azospirillum* + FYM + 50% RDF	39.41	47.68	11.50	9.76
T_7*Azospirillum* + vermicompost + 50% RDF	39.45	47.01	11.34	9.63
T_8*Azotobacter* + FYM + 50% RDF	39.64	55.13	11.54	9.77
T_9*Azotobacter* + vermicompost + 50% RDF	39.72	48.43	11.34	9.76
T_{10}*Azospirillum* + *Azotobacter* + 50% RD N and P + 100% RD K	39.72	57.39	11.28	11.30
T_{11}*Azospirillum* + *Azotobacter* + FYM + 50% RDF	39.79	61.92	11.58	11.37
T_{12}*Azospirillum* + *Azotobacter* + vermicompost + 50% RDF	39.65	57.76	11.65	9.18
CD at 5 per cent	NS	2.91	0.55	0.80
CV (%)	1.88	3.36	2.88	4.89

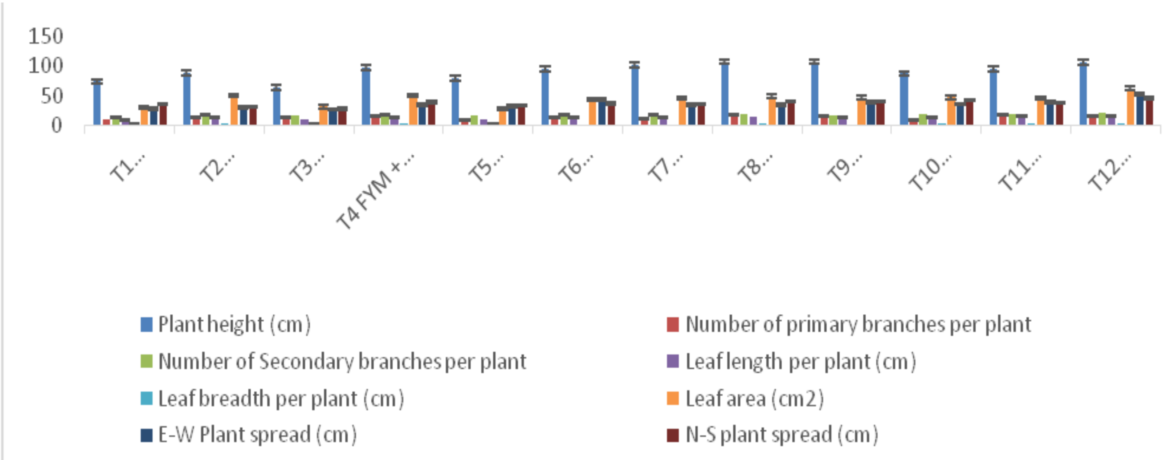

Fig.1 Effect of integrated nutrient management on vegetative parameters of marigold

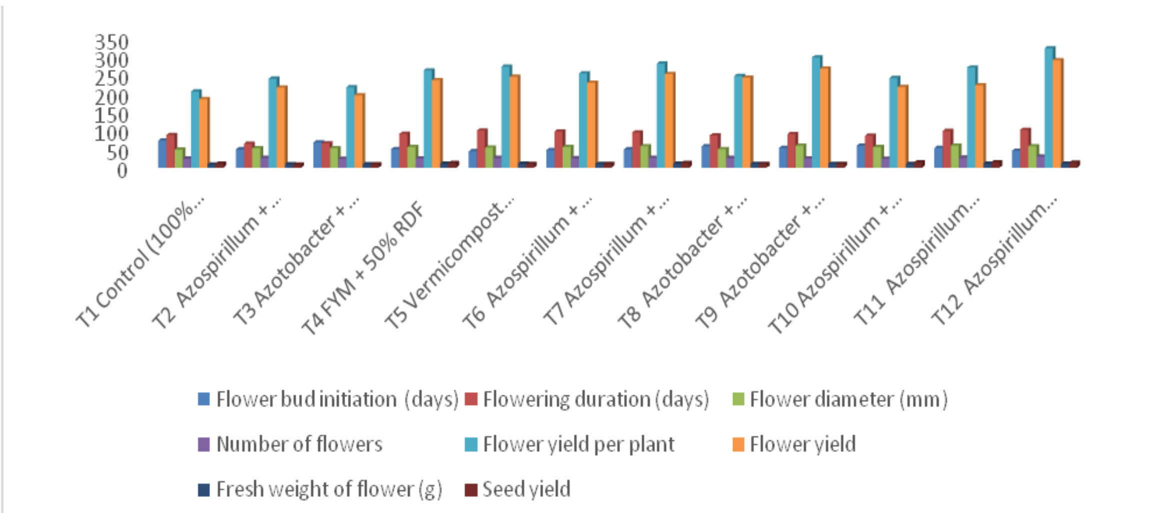

Fig.2 Effect of integrated nutrient management on flower parameters of marigold

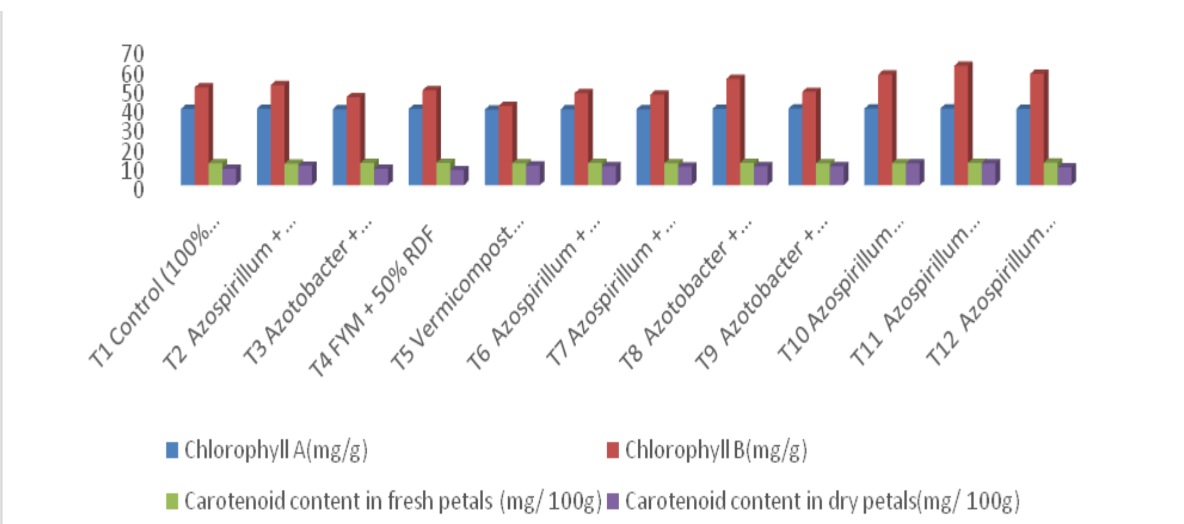

Fig.3 Effect of integrated nutrient management on bio-chemical parameters of marigold

Maximum carotenoid content in fresh petal was obtained in *Azospirillum*+ *Azotobacter* + Vermicompost +50% RDF (11.65mg/100g) which was on par with *Azospirillum*+ *Azotobacter* + FYM + 50% RDF (11.58 mg/100g). However, *Azospirillum*+ *Azotobacter* + FYM +50% RDF produced maximum carotenoid contents in dried petal (11.37 mg/100g) followed by *Azospirillum*+ *Azotobacter* + Vermicompost +50% RDF (9.18 mg/100g) and *Azotobacter* +75%RD 'P'+ 100% RD 'N'&'K' (8.54 mg/100g). The application of vermicompost and manure compost reduced the harmful effects of water deficit and increased the chlorophyll and carotenoid content in pot marigold (Shakib *et al.*, 2019).Kumar and Sharma (2013) also showed significant response towards carotenoid contents in fresh and dried petal of marigold influenced by organic manure.

The present experiment reveals that the addition of organic manures *viz.* FYM, vermicompost and biofertilizers along with RDF had a positive effect on the vegetative, flowering and yield characters of marigold.It was apparent through entire investigation that *Azospirillum*+ *Azotobacter* + Vermicompost +50% RDF and *Azospirillum*+ *Azotobacter* + FYM +50% RDF application was significantly associated for growth, flowering, yield and quality parameters of marigold. Use of adequate organic manures and biofertilizers enhanced the vegetative, flowering, yield and quality parameters of marigold.

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