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Review on the Effect of Organic fertilizers, Biofertilizers and Inorganic Fertilizers (NPK) on Growth and Flower Yield of Marigold (*Targets' erecta* L.)

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African marigold is one of the medical plants which was native to South America especially Mexico and belongs to the family Asteraceae (Compositae). Like other crops the flowering plant also has different response to different rate organic manures and inorganic fertilizers as well as bio fertilizers, N12 P80 K40/ha has an effect on early flowering of marigold and the flowering stem height was affected significantly by the application of NPK fertilization, poultry manure give better yield as compared to other organic manures. Physiological parameters of marigold were greatly increased by the use of NPK fertilizer and bacterial inoculation (Table 1 and 2). Application of bio-fertilizer significantly improved quality and quantity features in marigold, both NPK and bio fertilizers have a significant effect on morphological traits and effect NPK on P & K traits of marigold (Table 3 and 4), the yield and economics of marigold as influenced by various treatments of treatments of organic fertilizers(Table 5). Azotobacter is the free living nitrogen fixing bacteria which fix the nitrogen equivalent to 30-40 kg ha-1. Organic manure has a role in improving the soil chemical as well as physical properties of soil. The role of bio-fertilizers containing symbiotic or non-symbiotic nitrogen-fixing bacteria in augmenting vegetative growth characters, yield and yield components, essential oil productivity and/or chemical composition (including chlorophyll a, b and carotenoids and/or N, P and K leaf percent and content.

Keywords: African marigold, Biofertilizers, Inorganic fertilizers(NPK) and Organic fertilizers

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INTRODUCTION

Marigold is native of central and South America especially Mexico and belongs to the family Asteraceae (Compositae). There are 33 species of genus tegetes. The cultivated types of marigold are African marigold and French marigold. In India, the marigold occupied area 55.89 thousand hectare and production was 511.39 thousand metric tonnnes as loose flower (NHB 2013-14). It is cultivated in State of Madhya Pradesh, Maharashtra,

Gujarat, Haryana, Tamil Nadu, Rajasthan, West Bengal and Delhi. In Madhya Pradesh, the area under Marigold cultivation is consolidated around Ujjain, Dewas, Indore, Rewa, Sidhi, Shahdol, Jabalpur, Satna and Khandwa districts.

The African marigold (*Tagetes erecta Linn.*) is hardy about 90-100 cm tall, erect and branched leaves are pinnately divided and leaflets are lanceolate and serrate. Flowers are single to fully double and its colour varies from lemon yellow to golden yellow or Orange and having large globular flowers of diameter 15 cm and above.

Regular irrigation, weeding and hoeing are required to obtain more of large flowers. Initial flower buds are disbudded to obtain bushy and compact growth. Flower heads are harvested when they have attained full size. Regular plucking of flowers increases the flower production.

The flower yield is 8-12 tonnes/ha for French marigold and 11-18 t/ha for African marigold. Both the leaves and flower of marigold are equally important from medicinal point of view however, all parts of the plant contain essential oil in varying concentrations. The oil is commercially obtained by steam distillation for 3-4 hours, absorbing the distillate in petroleum ether or benzene. Prolonged distillation spoils the fragrance. Marigold yields 0.02-0.08% oil giving 8-15 kg oil/ha/year. African marigold flower oil is reddish yellow in colour, possessing characteristic marigold odour and polymerizing readily in air. Leaf and stem oils are greenish yellow in colour **(**Joy et al., 2001)

The roots of marigold are also known to suppress soil nematode population. The essential oil of marigold may be used in perfume industry. Since last few years in foreign countries, the powder of petals of orange colored varieties of marigold is being feed to poultry birds through feed, to obtain dark orange colored yolk in eggs. Few industries in India, particularly in Andhra Pradesh, Karnataka and Maharashtra are exporting the powder of orange colored marigold flowers.

The eco-friendly nature of organic manures provide healthy environment as sustainability to horticulture. Profit from the cultivation of flowers by application of organic manures, the quality of flowers can be enhanced. Now a day's use of organic manures has played significant role in floriculture. Modern agriculture is based on the use of organic manures, which play a major role for producing the good quality and higher yield per unit area. There is need to seek alternative nutrient sources, which should be cheap and eco-friendly so that farmers may be able to reduce the investment made on fertilizer with maintaining good soil environmental conditions leading to ecological sustainable farming. Farm yard manure (FYM) is a store –house of plant nutrients including micronutrients.

It improves the physicochemical properties of the soil, which is very useful for the sustainable crop productivity as well as soil fertility and productivity. Organic manures like F.Y.M., Vermicompost, NADEP, Poultry manures and Agrich are very popular among the farmers because of its eco-friendly nature and simply availability. These products are helpful in minimizing the environmental hazards and increase of soil fertility. For a sustainable agriculture system, it is imperative to utilize renewable inputs which can maximize the ecological benefits and minimize the environmental hazards (kizikay R. 2003). Chemical fertilizers have contributed significantly toward the pollution of water, air and soil. Therefore the current trend is to explore the possibility of supplementing chemical fertilizers with organic ones that are ecofriendly and cost-effective (El-Hawary Ml et al. 2002).

Using bio fertilizer and selection of the best microbial strains have vital role when integrating human society with vulnerable ecosystems. Biological fertilizers, which are called biofertilizers, may be used in a way of to maintain soil fertility and soil improvement. Bio fertilizers differ from chemical and organic fertilizers in that they do not directly supply any nutrients to crops and are cultures of special bacteria and fungi. Some microorganisms have positive effects on plant growth promotion, including the plant growth promoting rhizobacteria (PGPR) such as Azospirillum, Azotobacter, Pseudomonas fluorescens, and several gram positive Bacillus spp.

According to the Arab et al. (2015) results show that by increasing NPK rates up to 100% dose, number of branches, number of flowers, number of leaf, capitulum diameter, capitulum, bracket diameter, phosphorus and potassium content were significantly increased when compared with the zero NPK. (Chemical fertilizer NPK with four levels including: 0, 25, 50, 100% NPK (full dose of NPK fertilizer = 150:75:50 mg/kg).

The objective of this review was;

- To evaluate the effect of organic manures, biological fertilizer and in organic fertilizers on the growth and flower yield of marigold.
- To find out the effect of organic and inorganic manures on growth and yield of African marigold (*Tagetes erecta L.*)" and to assess the feasibility those different type of fertilizers.

LITERATURE REVIEW

Effect of both organic and inorganic (NPK) fertilizers on number of Flowers per Plant and its characteristics

The different treatment of organic manures significantly affected the number of flowers per plant. Among the different treatment, the maximum number flowers 39.75 were recorded with Poultry manure 20 t/ha followed by

FYM 20 t/ha 36.67, Vermicompost 20 t/ha 34.33. The minimum number of flowers per plant was recorded with Control 22.15. The flowering and yield characters like number and yield of flowers/plant, circumference of flower and fresh weight of flower were increased up to maximum due to application of N120 P80 K40 fertilizer dose. This may be due to increased supply of major plant nutrients, which are required in larger quantities for the growth and development of plants. The application of nitrogen at optimum level attributed to acceleration in development of growth and reproductive phases. Moreover, higher content of nitrogen might have accelerated protein synthesis, thus promoting earlier floral primordial development (Singh et al.2015*).* The findings of Acharya and Dashora (2004) were also in African marigold the increase in phosphorus found to be involved in the initiation of flower primordial formation leading to increase in size and number of flowers in African marigold.

Effect of Biofertilizers for soil microbial activity

Using biofertilizer and selection of the best microbial strains have vital role when integrating human society with vulnerable ecosystems. Biological fertilizers, which are called biofertilizers, may be used in a way of to maintain soil fertility and soil improvement. Biofertilizers are products containing living cells of different types of microorganisms, which have an ability to convert nutrionally important elements (N, P,….) form unavailable to available from through biological process such as Nitrogen fixation an solubilization of rock phosphate. One possible way of achieving biofertilizers is to decrease dependence on use of chemical Nitrogen fertilizers by harvesting the atmospheric nitrogen through biological processes. The use of growth promoting bacteria, like a symbiotic nitrogen ($N_{2)}$ fixing bacteria, is known as bio-fertilizers and has recently gained importance in crop production. It is well known that these bacterial species, mostly those associated with the plant rhizosphere, are able to extra beneficial effect upon plant growth. Therefore, their use as bio-fertilizers for agriculture improvement have been a focus of numerous studies recently (kizikay R .2003). Fertilization is the most important and controllable factor affecting the nutritional value of vegetables. The type and value of fertilizer and the level of application directly influence the level of nutrients available in plants and indirectly influence plant physiology and the biosynthesis of secondary compounds in plants. Secondary compounds in plants are known as secondary metabolites or phytonutrients (Heaton S, 2001). Biofertilizers differ from chemical and organic fertilizers in that they do not directly supply any nutrients to crops and are cultures of special bacteria and fungi. Some microorganisms have positive effects on plant growth promotion, including the plant growth promoting rhizobacteria (PGPR) such as Azospirillum, Azotobacter, Pseudomonas fluorescens, and several gram positive Bacillus spp. (chenJ. 2006).Various Pseudomonas species have shown to be effective in controlling pathogenic fungi and stimulating plant growth by a variety of mechanisms, including production of siderophores, synthesis of antibiotics, production of phytohormones, enhancement of phosphate uptake by the plant, nitrogen fixation, and synthesis of enzymes that regulate plant ethylene levels (Abdul JC,.et al 2007) . Good soil fertility management ensures adequate nutrient availability to plants and increases yields.

High above-ground biomass yield is obviously accompanied by an active root system, which releases an array of organic compounds into the rhizosphere (Mandal, 2007). Positive response of nitrogen fertilizers has been reported by (Koul (Kow GG, 1997), and Omer EA., 1998). (Sharma RK. 1973) observed that addition of nitrogen fertilizer increased plant height. Increase in plant height resulted in an increase in leaf number per plant as reported by (Akintoye A., 1996). Several workers studied the response of various medicinal and aromatic plants to nitrogen-fixing bacteria. The role of bio-fertilizers containing symbiotic or non-symbiotic nitrogen-fixing bacteria in augmenting vegetative growth characters, yield and yield components, essential oil productivity and/or chemical composition (including chlorophyll a, b and carotenoids and/or N, P and K leaf percent and content) was revealed by Kandeel et al,2001; on fennel Nofal et al., 2001; on Ammivisnaga, Abdu and El-Sayed, 2002; on caraway, Safwat and Badran ,2002; on cumin, Abd El-Kader and Ghaly.,2003; on coriander, Badran and Safwat.,1997; on fennel.

Many studies were executed to explore the effectiveness of phosphorein bio-fertilizer (phosphate dissolving bacteria) on different vegetative growth traits, seed yield and essential oil productivity of some medicinal plants. In this respect, Soliman HS.,1997; Abd El-Kader and Ghaly, 2003; and Abdou et al., 2004; they showed that phosphore in biofertilizer succeeded in enhancing vegetative growth parameters, seed yield and essential oil productivity of Nigella sativa , fennel , coriander, anise and fennel plants, respectively. All the vegetative and flowering characters like plant height, number of branches per plant, total number of flowers per plant, flowers yield per plant, flowers yield per plot, flowers yield per m^2 and hectare, gross realization ($^{`-ha}$), and net return ($^{`-ha}$) were significantly affected by different organic and inorganic fertilizer rate in marigold Cv. Pusa Basanti Gainda (Jadhav et al., 2 014).

Effect of organic farming on the soil media and nutrient content

Yard manure, vermicompost and compost to make crop

cultivation sustainable. Organic farming is not mere non-chemical agriculture, but it is a system integrating relations between soil, plant and water. Organic farming helps in soil health, proper energy flow in soil, crop, water environment systems, keeps biological life cycle alive and helps in sustaining considerable levels in yield (Lampkin.N.1990). It is mainly based on principles of restoration of soil organic matter in the form of humus, increasing microbial population, skilful application of the factors contributing soil life and health and treating manures in bio-dynamic way (PathankR.K. and Ram, R.A. 2003). Application of organics which is an important component in organic farming, apart from improving the soil physical, chemical and biological properties with direct impact on moisture retention, root growth and nutrient conservation, can also reduce the cost of production in agriculture. Keeping these benefits points in view an investigation was carried out to find out the "Effect of organic manures on, flower yield of African marigold (Tagetes *erecta* L.)"

Plant nutrients supplied through organic sources had profound effect on growth and productivity of the crop either by acceleration of respiratory process with increasing cell permeability and hormonal growth action or by combination of all these processes. Through their biological decomposition processes the organic sources supply nutrients to the plants in the available form. They are also rich in micro nutrients besides having plant growth promoting substances viz., hormones, enzymes and humus forming beneficial microbes. Organic sources, on application to the soil, improve the physical properties of soil such as aggregation, aeration, permeability and water holding capacity (Mukesh K. 2007) which promote growth and development of plants. It has been reported that among the organic sources of nutrients, poultry manure proved to be the (Razzaq Owayez. et al .2014)best source of organic manure which helped in improving physico-chemical properties (pH, EC, organic carbon, macro and micro nutrients) of soil because of its higher analytical values Govindarajan K. and Thangaraju.M. (2001). It contained 2.00, 1.97, 4.92% NPK, respectively and 113.2, 71.0, 140.6 and 310.5 mg/kg of total zinc, copper, iron and manganese, respectively Jeyabasakaran K.J.et al 2001. It has also been experimentally proved that considerable amount of N present in poultry manure consist of uric acid, which is readily available to the plants. The carbon nitrogen ratio (C: N ratio) of poultry manure reported to be narrower than others, which attenuates the release of nitrogen Gopal Reddy, B. (1997). Poultry manure when supplied to soil improves texture makes soil loose increase water holding capacity and uplift humus status which maintain the optimum conditions for microorganism activity. Since 20 t/ha is supplied with poultry manure .therefore the treatment 20 t/ha gives better result in all, flowers yield. Application of vermicompost increased microbial biomass, humic materials and other plant growth influencing substances such as plant growth hormone, produced by microorganism during vermicomposting and dehydronagnose activity in soil (Aracon *et al*., 2005). These findings are in close conformity with Sharma and Agrawal (2004) and Gaur *et al*. ,(2006). The beneficial effect of FYM and poultry manure on growth characters of marigold and other flowering plant have also been reported by Singh *et al*. (2002) and Singh & Singh (2003)

Vermi compost for soil fertility

Vermicomposting process significantly changed the physico-chemical properties of different waste mixtures. The vermicompost was much darker in color, had good esthetics and processed into a homogeneous mixture after earthworm activity. The total amount of waste mixture was reduced 1.4–2.5 times after vermicomposting. This clearly indicated that the vermicomposting process significantly helps in abatement of organic matter pollution load in the environment.

Electrical conductivity (EC) of vermicompost was higher than soil, which may be due to the presence of more salts in the feed of cattle (Sangwan et al. 2010). The micronutrients content was significantly higher in vermicomposts than soil but was within permissible limits as recommended by European and American limits of micronutrients in the compost (Brinton 2000). Vermicompost is an excellent soil conditioning agent. Incorporation of vermicompost in soil improves the texture, structure, permeability and water holding capacity of soil.

Effect of both organic and in organic fertilizers (NPK) on the Growth characters of marigold

According Lampkin.N. (1990) to the organic manures and inorganic fertilizers, the application of N120 P80 K40 gave the maximum vegetative growth characters like plant height (66.02cm), girth of stem (1.42cm), number (18.10) and length (58.97cm) of branches per plant, plant spread along the row (38.17cm) and across the row (38.02cm). This might be due to nitrogen is an essential part of nucleic acid this plays vital role in promoting the plant growth. This confirms the finding of Mandloi *et al*. (2008) and Singh & Singh (2003). 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 Prakash *et al*. (2002), Mohd. Rafi *et al.* (2002), Barman *et al.* (2003) and Acharya & Dashara (2004) of the organic manures vermicompost significantly enhanced the growth of the

Table 1: Growth attributed of marigold as influenced by various amount of organic manues (Singh et al. 2015)

Treatments	Plant/height(cm) 85 DAT	Girth of stem (cm) 85 DAT	Length of Branch/ plant 85 DAT	No. of branch/plant 85 DAT	Plant spread (cm) along the row 85 DAT	Plant spread (cm) across the row 85 DAT
Vermicompost (5t/ha)	65.17 1.39	1.39	55.27	17.10	36.23	35.14
FYM (24t/ha)	59.89	1.36	53.40	15.95	34.89	34.32
Poultry manure (3.16 t/ha)	61.75	1.37	54.30	16.50	35.70	34.77
NADEP compost (14.6 t/ha)	58.58	1.32	51.35	15.85	34.36	34.11
N120 P80 K40	66.02	1.42	58.22	18.10	38.17	38.02
Agriculture (1.25 t/ha)	57.00	1.30	50.22	14.97	34.04	33.98
Control	55.09	1.24	48.70	13.87	33.82	33.12
S.Em ±	1.99	0.015	0.84	0.85	0.67	0.80
C.D. (P = 0.05)	5.93	0.046	2.51	NS	2.00	2.40

plants as compared to poultry manure, FYM, NADEP and Agrich. Maximum height of plant (65.17 cm) was recorded with the application of vermicompost followed by poultry (61.75 cm), FYM (59.89 cm), NADEP (58.58 cm), and Agrich (57.00 cm), respectively with rate 22t/ha for each.).

The lower response of marigold towards NADEP compost and Agrich may be due to difference in their sources and availability of nutrients as well as nutrient composition.

Effect of NPK with bacterial inoculation Physiology Traits

Physiological parameters of marigold were greatly increased by the use of NPK fertilizer and bacterial inoculation (Table 2 and 3). As shown in Table 2 the phosphorus content is significantly increased when fertilized with different NPK rates. The highest and lowest values of phosphorus content were 0.007gr and 0.001gr with 100% and zero NPK fertilization, respectively. Also, result showed that with the increasing amount of NPK fertilization, the leaf potassium concentration had decreased from 0.76% in zero NPK to 0.52% in 100% NPK treatment, whereas potassium content in marigold significantly increased from 0.012 gr (zero NPK) to 0.02gr (100% NPK). The nutritional requirements of (NPK) for Umbilliferae Family and other plants were reported by many researchers. In this concern, (El-Sakov et al.,2001; worked on some medicinal and aromatic plants, Kozera and Nowak, 2004; on Silybum marianum, Niakan et al.,2004;on Menthapiperita, Lee et al.,2005 on Chrysanthemum boreale, Gomaa and Youssef, 2007)on fennel and lovage plants concluded that NPK fertilizers had an important physiological and biochemical functions on structure of photosynthetic pigments, metabolism of carbohydrates and protein and these effects were observed with significant increase in growth, vegetative and seed yield and essential oil content of the different plant species.

Both (inorganic fertilizer and organic manures) effects on the Phonological Characters of marigold

Amongst the organic manures and inorganic fertilizers, vermicompost had resulted in earliest flowering in 68.55 days, followed by Agrich (69.35 days) and the N120 P80 K40 (70.85 days). Rajdurai and Beaulah (2000) also found that increasing levels of NPK fertilizers resulted in earlier flowering of African marigold (by the use of vermi compost=5t/ha, poultry=3.16t/ha, NADEP=14.6t/hand Agrich=1.25t/ha Singh et al. 2015). Agrich, which also brought about earliest flowering, contains essential plant nutrients like N, P, K, Ca, Fe, S, Mg, Zn, Mo, Cu, Mn, Cobalt and Boron in a balanced amount in addition to biofertilizers, which gave rise to earlier flowering.

As regards number of flower inorganic treatment *i.e.* application of N120 P80 K40/ha produced significantly more number of flowers as compared to organic manure *viz.*, vermicompost, poultry manure and FYM. Maximum number of flowers (24.10) were produced by the application of N120 P80 K40/ha followed by vermicompost and poultry manure. This could be attributed to a higher C/N ratio and increased plant

Table 2. Effect of NPK fertilizer and biofertilizer on physiology traits of marigold

Biofertilizers		Concentrations (%)			Content(gr)	Chlorophyll
Uninoculated	NPK	N	F	N	F	index
	Zero	2.09 a	10.20 p	0.033 cde	4.05 m	24.33 ab
	25%	1.22 b	10.63 op	0.075 ab	10.19 h	32.97 a
	50%	0.66 b	10.82 op	0.021 de	13.81 f	32.43 a
	100%	0.80 b	11.43 o	0.037 cde	22.05 cd	30.70 a
*P.fluorescens*178	Zero	0.82 b	15.10 n	0.014 e	4.26 m	8.37 b
	25%	0.98 b	15.93 n	0.023 cde	12.98 fg	30.27 a
	50%	2.70 a	19.90 m	0.085 a	12.87 fg	35.50 a
	100%	0.68 b	23.68 k	0.037 cde	25.76 b	33.37 a
P.fluorescens 187	Zero	0.70 b	20.85 lm	0.011 e	4.89 lm	9.03 b
	25%	1.01 b	21.60 l	0.028 cde	8.65 i	23.60 ab
	50%	1.05 b	27.65 ij	0.027 cde	18.92 e	29.27 a
	100%	0.81 b	27.09 j	0.035 cde	22.99 c	35.30 a
P. putida	Zero	0.88 b	28.60 i	0.016 de	5.80 kl	21.87 ab
	25%	0.79 b	32.38 h	0.018 de	7.49 j	30.23 a
	50%	0.92 b	37.49 g	0.030 cde	21.70 d	28.20 a
	100%	0.95 b	40.70 f	0.044 cd	22.16 cd	32.07 a
NPK		NS	*	**	*	**
Bio		NS	*	*	*	NS
NPK* Bio		**	*	**	*	*

*(*Arab *et al., 2015) NS: not significant, * significant at the 0.05 level, ** significant at the 0.01 level, N: nitrogen, F: flavonoids.)*

metabolism. The increased vegetative growth and balance C/N ratio could lead to increased synthesis of carbohydrate which ultimately promoted greater flowering. Similar results were also reported by Chkraborty *et al*. (2009). On the other hand, FYM brought about the late flowering of marigold in 78.3 days *i.e.* late by 9.48 days over vermicompost. The flowering duration was also maximum (up to 24.51 days) due to application of vermicompost. This is may be due to differences in their source and nutrients composition as well as timing of nutrients availability to the flowering plants.

Effect of organic manure on Fresh Weight of Flower

According to (Razzaq Owayezidan.et al. 2014) the maximum weight of flower marigold was recorded Poultry manure 20 t/ha 9.20 followed by FYM 20 t/ha 8.85 and Vermicompost 20 t/ha 8.75 and Compost 20 t/ha 8.61 Flower Yield per Plot -1 (kg) respectively, From it is observed that treatment Poultry manure 20 t/ha gave highest flower per plot (3.29 kg) followed by FYM 20 t/ha which gave (2.92kg) and Vermi compost 20 t/ha which gave (2.70kg) minimum, (Control) which gave (1.52kg). Similar findings were obtained by Pooja G. S. and Kumari D., S. N. (2012) in (marigold), Rajanna.P.H. (2001) in (China aster), these results are also similar with Bhat D. J., et al (2010) in (marigold), in A. K. and Vijai Kumar. (2006) marigold) and (Mukesh K.; et al 2007) in marigold).

Effect of mixed fertilizer on Flower dry weight

According to Ali Shams et al. 2013 indicated that utilization of different fertilizers and years (fall and spring planting) had significant effects on flower dry weight in different flowering stages however effect of different ecotype on flower dry weight wasn't significant. In 50% flowering stage, interaction between year and fertilizer treatment was significant. In spring planting, the highest and lowest flower dry weight was obtained by application of mixed fertilizer and non-application of fertilizer treatments. In spring planting and 50% flowering stage,

utilization of manure and chemical fertilizer has similar effects on flower dry weight and application of mixed, manure and chemical fertilizers increased 325%, 189% and 104.6% on flower dry weight in compare with control

However in spring planting and 100% flowering stage, there wasn't significant difference between application of mixed and manure fertilizers on flower dry weight but the highest and lowest flower dry weight was obtained by application of mixed fertilizer and non-application of fertilizer treatments. The study of Ali Shams et al. 2013 on the Effect of organic and chemical fertilizers on Amount of Essence, biological yield and harvest index of Matricaria *chamomile* indicated also that utilization of mixed, manure and chemical fertilizers increased 135%, 114% and 82.9% on flower dry weight in compare with control in spring planting and 100% flowering stage.

Very few researches were done in relation to how biological and chemical fertilizers had an effect on increasing the amount Flavonoids in plants. Results represented that plant height was significantly affected by different fertilizer treatments and years (fall and spring planting) however different ecotypes and interaction between treatments hadn't significant effect on this morphological trait (Ali Shams et al. 2012), also indicated that in spring planting, utilization of manure and mixed fertilizers had similar effects on plant height and the highest and lowest plant height was gained by application of mixed fertilizers and non-application of fertilizer treatments respectively. Utilization of mixed fertilizer, manure and chemical fertilizers in spring planting increased 64.27%, 47.84% and 38.33% on plant height in compare with control. Utilization of mixed fertilizer, manure and chemical fertilizers in fall planting increased 60.9%, 38% and 65.54% on plant height in compare with control (Ali Shams et al. 2012).

Effect of phosphate and biofertilizer on Plant height

According to Hashemabad et al. 2012 results showed that plant height was significantly ($p \leq 0.01$) affected by biological phosphate fertilizer and pure chemical phosphorus on quantity and quality features of marigold (Tagetes *erecta L.*).

It shows also mean comparison of data in different treatments showed that the highest plant height (25.59 cm) was achieved by application of bio-fertilizer on seeds and transplant roots along with 400 mg l^{-1} chemical phosphate. The lowest plant height (21.68 cm) was obtained in control treatment (100 mg l^{-1} chemical phosphate without application of bio-fertilizer. Among the bio-fertilizer treatments, the highest (25.59 cm) and lowest (24.00 cm) plant height were obtained by application of bio-fertilizer on seeds and transplant roots, and control, respectively. There is also similar research data, those reported by Shaalan (2005), Singh et al. (2008) and Ezz et al. (2011). Bio-fertilizers increase root uptake through root development (Yosefi et al., 2011). Furthermore, application of bio-fertilizers increases the plant height by promoting the plant growth regulators (Senthil-Kumar et al., 2009).

Effect of vermi compost on marigold plant height

According to Gupta et al. 2014 the minimum height was observed in control (soil), in all the treatments, plant height increased with the percentage of the vermicompost in the soil.

In cow dung vermicompost-containing treatments, maximum plant height. Similar results of higher plant height with the use of pig manure vermicompost-amended potting media on tomatoes plants were observed by Atiyeh et al. (2000). May be due to more nutrient availability for plant growth in vermicomposts. Raviv et al. (1998) have attributed it to slow release of nutrients for absorption with additional nutrients like permissible limits as recommended by European and American limits of micronutrients in the compost (Brinton 2000).

Effect of 'NPK" on Morphology Traits of marigold

The flowering stem height was affected significantly by the application of NPK fertilization. The highest value of flowering stem height was 14.23 cm with 100% NPK fertilization. The increase in plant height with NPK fertilization can be attributed to the fact that Macro elements, particularly nitrogen promotes plant growth increases the number and length of the internodes which results in progressive increase in plant height. Similar results were reported by Turkhede and Rajendra,.1978, Saigusa et al., 1999 and Gasim 2001. Also, results indicated that plant height was affected significantly by the interaction between NPK fertilization rates and biofertilizer. With increasing NPK fertilization rates, flowering stem height increased either in the all biofertilizer treatments. But inoculation with P.fluorescens 169 + 100% NPK and *P.* fluorescens 187 +100% NPK showed good results for this trait, i.e. 124.00 and 122.43 cm, respectively (Arab et al. 2015). These PGPR inhabit plant roots and affect plant growth promotion by mechanisms such as increased solubilization and uptake of nutrients and/or production of plant growth regulators (Klopper JW Lifshitz R, and Zablotowicz RM .1989, Arshad M, FrankenbergerJr WT. 1993).

Productivity and net return of both organic and in organic fertilizers on Marigold

It is obvious that amongst the organic manures and Inorganic fertilizers, the application of N120 P80 K40 gave the maximum flower yield up to 246.14 q/ha as well

Table 3. Effect of NPK fertilizer and biofertilizer on morphology traits of Marigold

Treatment	Flowering stem height (cm)	No. of branches	No. of flowers	No. of leaf	Capitulum diameter (cm)	Capitulum bracket diameter(cm)
Zero	7.61 c	1.44 c	2.27 c	60.17 c	4.13 b	1.86 b
25% NPK	12.23 b	5 bc	101.7 b	6.68 a	6.68 a	3.14 a
50% NPK	11.89 b	6.88 b	8.22 b	115.28 b	7.11 a	3.02 a
100% NPK	14.23 a	19.16 a	19.5 a	196.11 a	7.1 a	3.01 a
ANOVA						
NPK	**	**	**	**	**	**
Bio	NS	NS	NS	NS	NS	NS
NPK* Bio	*	NS	NS	NS	NS	NS

*NS: not significant, * significant at the 0.05 level, ** significant at the 0.01 level (Arab et al., 2015)*

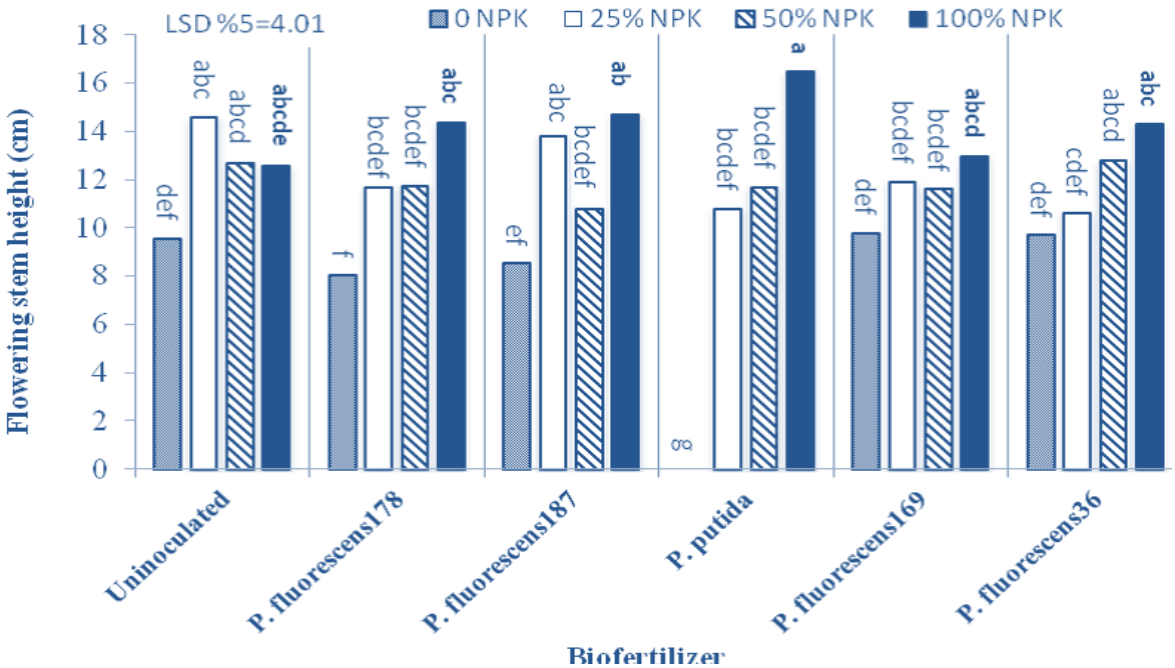

Figure 1. Effect of biological and chemical fertilizer on flowering stem height of marigold *(*Arab *et al.2015)*

Table 4. Effect of NPK fertilizer on phosphorus (p) and potassium (K) traitsof marigold

Treatment	**Concentrations (%)**			
	P	N	P	K
Zero NPK	0.11 a	0.76 a	0.001 b	0.012 c
25% NPK	0.13 a	0.65 ab	0.003 ab	0.018 b
50% NPK	0.10 a	0.56 bc	0.002 b	0.016 bc
100% NPK	0.15 a	0.52 c	0.007 a	0.02 a

*NS: not significant, * significant at the 0.05 level, ** significant at the 0.01 level (**Arab et al., 2015**)*

Table 5: Yield and economics of marigold as influenced by various treatments organic fertilizers.

Treatments	Flower yield Q/ha	Vase life of flower (days)	Gross income	Cost of cultivation	Net income	B: C ratio	IBCR
Vermicompost (5t/ha)	219.37	9.92	1,09,685	43,578	66,107	2.51	1.51
FYM (24t/ha)	176.97	8.52	88,485	33,378	55,107	2.65	1.65
Poultry manure (3.16 t/ha)	196.97	9.47	98,485	30,474	68,011	3.23	2.23
NADEP compost (14.6 t/ha)	171.66	171.66	8.32	85,830	35,878	49,952	1.39
N120 P80 K40	246.14	9.23	123,070	31,594	91,476	3.89	2.89
Agriculture (1.25 t/ha)	163.54	8.18	84,770	32,078	49,692	2.64	1.54
Control	138.22	7.8	69,110	28,578	40,532	2.41	1.41
S.Em ±	12.08	0.33	-	-	-	-	-
C.D. (P = 0.05)	35.89	0.97	-	-	-	-	-

(***Arab et al., 2015***)

as net return up to Rs. 91476/ha. This was closely followed by vermicompost and poultry manure giving the 196.97 to 219.37 q/ha flower yield and Rs. 66,107 to 68,011/ha net returns the higher yield under NPK and vermicompost treatments may be due to higher growth and yield – attributing characters in these treatments as compared to those of other treatments. These finding are in close agreement with those of Baboo and Singh (2003), Singh and Singh (2003), Barman *et al*. (2003) and Sharma *et al*. (2004). Although, the vermicompost and poultry manure gave the lower productivity as well as lower net return per hectare, but still these are considered very beneficial for maintaining the soil fertility sustainable productivity and for a better soil health. Because, the organic sources of fertilizer not only supply the essential plant nutrients but also brought about sound physiochemical properties and biological activities in the on a sustained basis. In contrast to this chemical fertilizers when applied alone would spoil the physical properties of soil together with the deficiency of several secondary nutrients as well as micronutrients.

The population of beneficial soil microorganisms and their activities would also be decreased in a due to course of time ultimately, the final results is decreased crop yields (Lal Singh et al 2015). The maximum gross return (516930.4 per ha), net return (` 435810.4 per ha) and cost of benefit cost ratio (5.37:1) was maximum in treatment with 75% RDN + 60kg P_2O5 ha^{-1} + 60kg K_2O ha^{-1} + Azotobacter 5L ha-1 + Enriched Banana pseudo stem Sap 1% followed by 75% RDN + 60kg P_2O5 ha^{-1} + 60kg K2O ha^{-1} + Azotobacter 5L ha-1 + VAM 15kg ha^{-1}.While least BCR value (3.02:1) was found in 75% RDN + 60kg P2O5 ha^{-1} + 60kg K2O ha^{-1} + Vermicompost 0.1kg m^2.

However according to Jadhav.P.B et al.2014, Plant nutrients supplied through organic fertilizer sources have profound effect on growth and yield of crop as the biological decomposition processes of the organic sources supply nutrients to the plants in the available forms. The plants nourished with the treatment which received- 75% RDN + 60kg P_2O5 ha^{-1} + 60kg K_2O ha^{-1} + Azotobacter 5L ha^{-1} + Enriched Banana pseudo stem Sap 1% had resulted in the higher values of growth and yield attributes. These founding was explained that the combined application of inorganic and biofertilizers are effective in producing more number of branches than the inorganic fertilizers alone. Results pertaining to the above growth parameters could be attributed to the appropriate nutrients in available from under this type of combination. Nitrogen is the major constituent of proteins, enzymes, hormones, vitamins, alkaloids, chlorophyll and their synthesis in plants that influence plant growth. Plant growth is thus known to be accelerated by the adequate supply and availability of nitrogen in association with biofertilizers, S. Kukde. et al.2006. and E.Yasari and A.M.Patwardham.2007. Azotobacter is the free living nitrogen fixing bacteria which fix the nitrogen equivalent to 30-40 kg ha-1. It also produces hormones like IAA and GA3, vitamin like biotin (Vitamin B7) and folic acid M.A. Kader.2002 and with judicious use of organic matter ensures good growth and increase productivity. The contribution of Azotobacter in plant growth is also due to excretion of ammonia in presence of root exudes that enhance and regulate nutrient uptake by plants as explained earlier by (E.Yasari and A.M.Patwardham.2007). Banana pseudo stem enriched

sap contains essential plant nutrients along with growth regulators like GA3 and cytokinin and trace of micronutrients (R.J.Patil and B.N. Kolambe.2011), which boosts the plant growth.

Application of organic sources, in soil, improve the physical properties of soil such as aggregation, aeration, permeability and water holding capacity (K.Govindarajan and M.Thangaraju.2001), which further promote growth and development of plants. Further, efficacy of the inorganic fertilizer in combination with biofertilizers has also been known to have pronounced effect on plant growth and development by production of more photosynthates as also observed by E.Yasari and A.M.Patwardham.2007. Thus, the treatment which received (75% RDN + 60kg P_2O_5 ha^{-1} + 60kg K_2O ha^{-1} + Azotobacter 5L ha-1 + Enriched Banana pseudo stem.

CONCLUSION

African marigold is one of the medicinal plants both leaf and its flower an economical part of it. Organic fertilizer, biofertilizer and inorganic fertilizers (NPK) have a significant role on the growth and yield parameter of it. In conclusion the response of African marigold varies with application of organic and inorganic manures but the application of 75% RDN + 60kg P_2O_5 ha^{-1} + 60kg K_2O ha^{-1} + Azotobacter 5L ha-1 + Enriched Banana pseudo stem Sap 1% to African marigold cv. Pusa Basanti Gainda gave maximum growth and yield attributes with high benefit cost ratio (Jadhav.P.B et al.2014). Bio-fertilizers are widely applied in crop production and they are proper substitutions for chemical fertilizers. Application of bio-fertilizer significantly improved quality and quantity features in marigold. Organic farming is not mere non-chemical agriculture, but it is a system integrating relations between soil, plant and water. Organic farming helps in soil health, proper energy flow in soil, crop, water environment systems, keeps biological life cycle alive and helps in sustaining considerable levels in yield (Lampkin.N.1990). Amongst the organic manures and Inorganic fertilizers, the application of N120 P80 K40 gave the maximum flower yield of African marigold. Manure has a significant effect on plant height, fresh weight of flower, branch number, increase soil property and microbial activity in the soil, has long lasting supply as compared to NPK.

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