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Effect of integrated nutrient management on nutrient uptake in marigold in different seasons

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Abstract
The investigation was conducted during the year 2011-2013 with the objectives of studying the influence of INM practices comprised of organic inorganic and biofertilizer on dry matter of different parts and nutrient uptake in African marigold cv. Sirakole in three seasons. The experiment was laid out in Randomized Block Design which consisted of 15 treatments, each replicated thrice during Kharif, Rabi and Summer season. The results of the study revealed that various nutrient management practices had significant influence on nutrient uptake characters in all three seasons. Nitrogen, phosphorus and potash uptake was highest in the plants supplied with 25% organic and 75% inorganic fertilizer along with biofertilizers in rabi season. Pooled over the seasons indicated that plants receiving nutrient combination of poultrymanure (25%RDN)+ 75% RD'NP'+biofertilizers exhibited highest nutrient uptake in rabi season.

Keywords: Biofertilizers, poultry manure, vermicompost, uptake of nutrients, drymatter

Introduction
In India marigold is one of the most commonly grown flowers and used extensively on religious and social functions in different forms. Because of their ease in cultivation, wide adaptability to varying soil and climatic conditions, long duration of flowering and attractively coloured flowers of excellent keeping quality, the marigolds have become one of the most popular flowers in our country. Flowers are sold in the market as loose or as garlands. Due to its variable height and colour marigold is especially use for decoration and included in landscape plans.

The increasing use of chemical fertilizers to increase the production of flower is causing concern for the following reasons:

- Soils which receive plant nutrients only through chemical fertilizers are showing declining productivity despite being supplied with sufficient nutrients.
- The decline in productivity can be attributed to the appearance of deficiency in Secondary and micronutrients.
- The physical condition of the soil is deteriorated as a result of long-term use of chemical fertilizers, especially the nitrogenous ones. Therefore, emphasis is now focused on the use of organic manures such as compost, vermicompost, farm yard manures, poultry manure and biofertilizers like *Azotobacter*, *Azospirillum*, phosphate solubilizing bacteria (PSB), etc., in addition to chemical fertilizers.

Material Methods
The present experiment was conducted in marigold for two consecutive cropping and three growing season at the Krishi Vigyan Kendra farm , Jajpur of OUAT, Bhubaneswar during the period 2011-12 and 2012-13.The experiment was laid out in randomized block design with pooled over the season with three replications. Fifteen treatments combinations comprising Recommended dose of fertilizer (RDF), Vermicompost (VC), Poultrymanure (PM) and Biofertilizer (BF) were used in the experiment. The detail of the treatments are : T_1 - Control, T_2 - RDF, T_3 - PM(25% RDN) +75% RD'NP' , T_4 -VC(25% RDN) +75% RD'NP' , T_5 - BF + 75% RD'NP', T_6 - PM (50% RDN) +50% RD'NP' , T_7 - VC (50% RDN) +50% RD'NP' , T_8 – VC (25% RDN) +BF + 75% RD'NP' , T_9 - PM (25% RDN) + BF+75% RD'NP' , T_{10} - PM(12.5% RDN) +VC (12.5% RDN) +75% RD'NP' , T_{11} - PM(12.5% RDN) +VC (12.5% RDN)+ BF+75% RD'NP' , T_{12} - PM (50% RDN) + BF +50% RD'NP' , T_{13} – VC(50% RDN) + BF+50% RD'NP' , T_{14} - PM(25% RDN) +VC(25% RDN) +50% RD'NP' , T_{15} - PM (25% RDN) +VC (25% RDN)+ BF +50% RD'NP'.

For kharif, rabi and summer crops healthy, strong seedlings of marigold cv. Sirakole were transplanted in the month of August, November and February respectively. Well decomposed farm yard manure (FYM) @ 25t / ha was thoroughly incorporated in all the experimental plots during the final land preparation. Vermicompost and Poultry manure were applied at 20 days prior to transplanting and biofertilizers like *Azospirillum* and phosphate solubilizing bacteria were applied at 10 kg/ha at the time of transplanting after well decomposed with FYM as per the treatment .The recommended dose of chemical fertilizers at the rate of 200 kg N and 200 kg P2O5 per hectare were also applied as per the treatment schedule along with a common dose of 200 kg K2O to all the experimental plot except T1. Out of total chemical fertilizers half nitrogen along with full phosphate and potash were applied as basal dose at the time of transplanting while rest half nitrogen was applied at the time of first earthing up operation i.e. after one month of transplanting. Different intercultural operation like gap filling, irrigation, weeding, plant protection measures and pinching performed at required time. The plant samples for NPK analysis were collected at 90 DAT. Leaves, stem, flowers and roots were collected separately at both the stages and washed thoroughly with distilled water and the water was blotted out. The plant parts were then kept in paper bags and dried in hot air oven at 70 ^{0}C for 48 hours. The dried plant parts were finely ground in a 'Willey Mill' to afine powder. This fine powder was again dried in oven at 60 ^{0}C for a couple of hours and stored in desiccators till the sample was used for chemical analysis. The uptake of nutrients was calculated using the formula suggested by Piper (1996) and was expressed in kg/ ha.

$$\text{Uptake of nutrient} = \frac{\text{Nutrient content (\%) x Dry matter production (kg/ha)}}{100}$$

Result and Discussion

The dry matter accumulation (g/plant) showed a significant difference amongst various treatments (table 1). Significantly higher dry matter accumulation in leaf, stem and flower was recorded in T_{11} (poultry manure+ biofertilizer + vermicompost + 75% RD'NP') compared to others. Dry matter production in general is indicative of the efficiency of variety and different sources of nutrients. For instances, if the leaf dry matter is more, it is evident that photosynthetic system is efficient. Treatments again clearly showed the beneficial effects of poultry manure, vermicompost and biofertilizer. The increase in dry matter may be due to luxurious vegetative growth in terms of plant height, number of leaves, leaf area, stem girth and number of branches. Beneficial effect of biofertilizers like *Azospirillum* may be attributed to the increased availability and influence of nitrogen, the chief constituent of protein – essential for formation of protoplasm, which enhances cell division and cell enlargement. Moreover, nitrogen is an important component of amino acids and co-enzymes, which are of considerable biological importance. The mechanisms by which PSB augment plant growth is through phosphate dissolution and in the biosynthesis of auxin (Sattar and Gaur, 1987) [10] and IAA (Bareae *et al*., 1976) [1]. The increase in dry weight due to availability of nitrogen, which enhanced more leaf area resulting in a higher photo assimilates and there by resulted in more dry matter accumulation.

These findings are similar with the results reported in tuberose (Swaminathan *et al.,* 1999) [9], marigold (Chandrikapure *et al.,* 1999) [4], chrysanthemum (Hemavathi, 1997) [6] and gundumalli (Bhavanisanker and Vanagamudi; 1999) [3].

From the table 2, it was observed Treatment replacing 25% recommended dose of nitrogen with organic sources (poultry manure, vermicompost and biofertilizer) performed higher uptake than treatment replacing 50% recommended dose of nitrogen with organic sources. So T_{11} (75% RD'NP') appeared to be optimal dose than T_{15} (50%RD'NP'). Due to cut down of recommended dose of fertilizer by 50 percent, N supply was disrupted, so during the cropping period crop could not uptake or utilize more N, P, K nutrient from the plot treated with more organic fertilizer. However, presence of organic manure was found to play significant role in nutrient uptake as it was evident from the performance under treatment receiving only recommended dose of fertilizers (RDF) which recorded significantly less uptake of NPK. It might be due to the fact that in spite of using the recommended dose of chemical fertilizer, available nitrogen was low, which was due to leaching and volatilization losses, whereas in case of organic manure applied soil, the organic manure held the nutrients and retained losses (Prativa and Bhattarai, 2011) [8]. Similarly in the absence of organic manure and biofertilizer the uptake of P was low due to less solubility and reduction in availability of phosphate. Decrease in K uptake in sole chemical fertilization as compared to INM practices was reported by Bahadur *et al*. (2004) [2].

Uptake of NPK by marigold plants was influenced by the growing season. It was observed that nutrient uptake was maximum in rabi season followed by kharif season while it was lowest during summer season. Among several factors influencing nutrient uptake by plants, soil water content is considered as one of the important factors. Plants obtained most of the nutrients and water from soil through their root system. Any factor resists root growth and activity has the potential to resist nutrient availability. This is not because nutrients are not available in the soil but because the ability of the crop to take up the nutrients is restricted. Soil water content is critical not only to supply the water needs of the crop but also to dissolve nutrients and make them available to plants. Excess water in the soil depletes oxygen and builds up the carbon dioxide level while oxygen is needed by roots to grow and take up nutrients, high CO_2 level is toxic (Fernandez and Hoeft, 2012) [5]. In the present study the uptake of nutrients was observed to be minimum in summer season, which might be due to limited availability of soil moisture. Good soil moisture improves nutrient uptake. If moisture is a limiting factor, fertilizer is not used efficiently. In rainy season availability of excess water in soil might have restricted root growth and activity due to depletion of oxygen which in turn might have resulted in less uptake of nutrients. Further light intensity is low in cloudy days during rainy season. Low light intensity reduces photosynthetic rate and nutrient uptake by the crop since low light intensity sometimes occurs when soils are over saturated with water. Cloud cover can exacerbate the capacity of the crop to take nutrients. On the other hand, during rabi season due to availability of good soil moisture and light intensity the nutrient uptake was higher as compared to other two seasons.

Interaction of nutrient treatments with season was not significant with respect to nutrient uptake by plants. However, plants under the treatment comprising poultry manure (12.5%

RDN) +vermicompost (12.5% RDN) + biofertilizer +75% RD'NP' in rabi season recorded maximum nitrogen, phosphorus and potash uptake as compared to other combinations. The plants under control plot exhibited lowest uptake of the three nutrients in summer season.

From the present study it has been concluded that application of 75% RD'NP' i.e. 150 kg N,150 kg P/ha in combination with 200 kg K/ha, poultry manure (12 % RDN), vermicompost (12.5 % RDN), FYM (25 t/ha) and bio fertilizers @ 10 kg/ha (*Azospirillum* and PSB at 1:1 ratio) resulted in maximum uptake of nutrients in rabi season, which can be recommended to the flower growers as a healthy nutrient management practices in marigold for getting higher return without deteriorating the soil health.

Table 1: Effect of different sources of nutrition on dry matter accumulation (g) in stem, leave and flower per plant of marigold in three seasons

		Dry matter accumulation in stem (g)				Dry matter accumulation in leave (g)				Dry matter accumulation in flower (g)			
Treatments		**Kharif**	**Rabi**	**Summer**	**Mean**	**Kharif**	**Rabi**	**Summer**	**Mean**	**Kharif**	**Rabi**	**Summer**	**Mean**
T_1	Control	31.25	28.26	21.34	26.95	19.54	17.43	12.45	16.47	14.54	19.43	11.34	15.10
T_2	Recommended dose of fertilizer	33.16	29.17	22.52	28.28	21.51	18.92	12.82	17.75	16.87	20.65	12.36	16.63
T_3	Poultry manure (25% RDN) + 75% RD'NP'	41.58	31.82	25.32	32.91	27.82	22.81	14.91	21.85	19.83	22.53	15.41	19.26
T_4	Vermicompost (25% RDN) + 75% RD'NP'	40.27	31.32	24.53	32.04	27.26	22.42	13.71	21.13	19.24	22.18	15.02	18.81
T_5	Biofertilizer + 75% RD'NP'	33.82	29.83	22.87	28.84	22.17	19.02	12.82	18.00	16.53	20.91	12.92	16.79
T_6	Poultry manure (50% RDN) + 50% RD'NP'	37.26	30.65	23.03	30.31	23.42	20.32	13.28	19.01	17.82	21.36	13.91	17.70
T_7	Vermicompost (50% RDN) + 50% RD'NP'	35.92	30.28	22.93	29.71	22.92	19.27	12.92	18.37	17.32	21.17	13.26	17.25
T_8	Vermicompost (25% RDN) + Biofertilizer + 75% RD'NP'	48.82	39.82	31.17	39.94	36.16	28.50	18.03	27.56	25.32	30.28	20.27	25.29
T_9	Poultry manure (25% RDN) + Biofertilizer + 75% RD'NP'	49.25	40.51	31.43	40.40	36.81	29.43	18.32	28.19	25.93	31.48	20.93	26.11
T_{10}	Poultry manure (12.5% RDN) + Vermicompot (12.5% RDN) + 75% RD'NP'	47.23	37.45	30.45	38.38	35.92	27.23	17.54	26.90	24.20	28.51	19.81	24.17
T_{11}	Poultry manure (12.5% RDN) + Vermicompost (12.5% RDN) + Biofertilizer + 75% RD'NP'	51.67	42.91	33.26	42.61	39.80	31.24	19.52	30.19	27.50	33.54	22.94	27.99
T_{12}	Poultry manure (50% RDN) + Biofertilizer + 50% RD'NP'	43.28	33.92	28.19	35.13	31.50	23.85	15.32	23.56	21.83	25.28	17.83	21.65
T_{13}	Vermicompost (50% RDN) + Biofertilizer + 50% RD'NP'	43.07	33.28	27.43	34.59	29.32	23.41	15.19	22.64	21.28	24.92	17.32	21.17
T_{14}	Poultry manure (25% RDN) + Vermicompost (25% RDN) + 50% RD'NP'	39.54	30.91	23.08	31.18	25.87	21.52	13.54	20.31	18.37	21.52	14.86	18.25
T_{15}	Poultry manure (25% RDN) + Vermicompost (25% RDN) + Biofertilizer + 50% RD'NP'	45.32	35.28	28.54	36.38	33.24	25.92	16.27	25.14	23.19	26.38	19.43	23.00
	Mean	41.43	33.69	26.41		28.88	23.42	15.11		20.65	24.68	16.51	
	SEm ±	3.32	2.86	3.31		4.34	2.80	2.99		2.66	3.00	2.45	
	CD (5%)	9.64	8.29	9.60		12.58	8.11	8.68		7.73	8.71	7.11	
	Pooled	Season	Treat	Tr x S		Season	Treat	Tr x S		Season	Treat	Tr x S	
	SEm ±	0.94	1.83	3.17		0.59	1.99	3.45		0.59	1.57	2.72	
	CD (5%)	3.25	5.15	NS		2.05	5.60	NS		2.06	4.41	NS	

NB: RDN – Recommended dose of nitrogen, RDNP –Rrecommended dose of nitrogen and phosporus

Table 2: Effect of different sources of nutrition on nitrogen (N, Phosphorus (P) and Potash (K) uptake (kg/ha) of marigold in three seasons

		Nitrogen (N) uptake				Phosphorus (P) uptake				Potash (K) uptake			
Treatments		**Kharif**	**Rabi**	**Summer**	**Mean**	**Kharif**	**Rabi**	**Summer**	**Mean**	**Kharif**	**Rabi**	**Summer**	**Mean**
T_1	Control	38.34	42.85	26.43	35.87	8.31	9.60	6.83	8.25	39.12	43.32	28.32	36.92
T_2	Recommended dose of fertilizer	43.59	49.32	30.82	41.24	10.42	12.35	8.24	10.34	42.32	49.15	31.52	41.00
T_3	Poultry manure (25% RDN) + 75% RD'NP'	53.23	54.87	37.59	48.56	12.34	15.54	10.34	12.74	52.62	54.62	41.31	49.52
T_4	Vermicompost (25% RDN) + 75% RD'NP'	52.58	53.29	36.92	47.60	12.19	14.34	10.35	12.29	51.35	54.53	39.45	48.44
T_5	Biofertilizer + 75% RD'NP'	44.53	50.42	32.49	42.48	10.10	13.35	9.62	11.02	43.25	50.63	33.53	42.47
T_6	Poultry manure (50% RDN) + 50% RD'NP'	47.38	51.61	34.38	44.46	11.19	14.32	9.45	11.65	46.31	51.43	35.69	44.48
T_7	Vermicompost (50% RDN) + 50% RD'NP'	46.28	51.28	33.81	43.79	11.21	13.29	9.52	11.34	45.35	51.13	36.72	44.40
T_8	Vermicompost (25% RDN) + Biofertilizer + 75% RD'NP'	63.47	67.41	47.41	59.43	16.19	17.19	13.32	15.57	62.29	65.52	46.13	57.98
T_9	Poultry manure (25% RDN) + Biofertilizer + 75% RD'NP'	65.39	69.27	48.42	61.03	16.23	18.15	13.42	15.93	62.17	64.56	46.32	57.68
T_{10}	Poultry manure (12.5% RDN) + Vermicompot (12.5% RDN) + 75% RD'NP'	60.27	64.29	44.29	56.28	15.35	17.29	12.29	14.98	60.15	61.34	44.35	55.28
T_{11}	Poultry manure (12.5% RDN) + Vermicompost (12.5% RDN) + Biofertilizer + 75% RD'NP'	68.39	72.61	51.26	64.09	18.23	20.32	14.13	17.56	65.32	69.12	49.52	61.32
T_{12}	Poultry manure (50% RDN) + Biofertilizer + 50% RD'NP'	57.43	58.51	41.29	52.41	13.29	16.35	11.15	13.60	46.34	58.15	42.31	48.93
T_{13}	Vermicompost (50% RDN) + Biofertilizer + 50% RD'NP'	56.21	57.39	39.37	50.99	13.31	15.32	11.31	13.31	55.12	56.64	41.29	51.02
T_{14}	Poultry manure (25% RDN) + Vermicompost (25% RDN) + 50% RD'NP'	50.83	52.48	35.82	46.38	11.35	14.19	10.62	12.05	49.52	52.35	31.52	44.46
T_{15}	Poultry manure (25% RDN) + Vermicompost (25% RDN) + Biofertilizer + 50% RD'NP'	59.47	62.49	43.91	55.29	14.32	16.15	12.59	14.35	58.39	60.52	44.31	54.41
	Mean	53.83	57.21	38.95		12.94	15.18	10.88		51.97	56.20	39.49	
	SEm ±	4.03	3.14	3.00		2.10	1.61	1.88		2.74	2.97	3.00	
	CD (5%)	11.69	9.11	8.71		6.09	4.66	5.46		7.94	8.61	8.69	
	Pooled	Season	Treat	Tr x S		Season	Treat	Tr x S		Season	Treat	Tr x S	
	SEm ±	0.78	1.98	3.42		0.47	1.08	1.87		0.59	1.67	2.90	
	CD (5%)	2.69	5.56	NS		1.64	3.05	NS		2.05	4.72	NS	

NB: RDN – Recommended dose of nitrogen, RDNP –Recommended dose of nitrogen and phosporus

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