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INTEGRATED NUTRIENT MANAGEMENT ON GROWTH AND YIELD OF AFRICAN MARIGOLD (*TAGETES ERECTA L.*) HYBRID L 3 GROWN AS AN INTERCROP IN GRAND NAINE BANANA

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ABSTRACT

Investigations were undertaken to standardize the integrated nutrient management for the growth and yield of african marigold (*Tagetes erecta* L.) hybrid L3 grown as an intercrop in Grand Naine banana. The experiment was conducted in open field condition in a randomized block design with 12 treatments and replicated thrice. Application of major nutrients *viz.,* Nitrogen, Phosphorus and potassium in four splits at basal, 20, 35 and 50 DAT, and also bio- fertilizers *viz.*, *Azospirillum*, *Phosphobacteria*, VAM and bio control agents *viz.*, *Trichoderma viride* and *Pseudomonas fluorescens* were applied during at the time of transplanting. The bio- stimulants *viz.,* panchkavya and humic acid were applied as foliar spray in four times at 30, 45, 60 and 75 days after transplanting. All treatments contains macronutrients, bio-fertilizers, bio-control agents and bio- stimulants along with the absolute control as pure banana crop with nematicide and a control treatment without marigold and nematicide, thus constituting twelve treatments. Observations were recorded on marigold growth and yield parameters. The growth parameters *viz.*, plant height, plant spread, number of branches per plant, number of leaves and yield parameters, precocious flowering, lesser days for 50% flowering, flower diameter, individual flower weight, number, of flowers per plant and cost benefit ratio were recorded higher in treatment which received combined soil application of recommended dose of fertilizers (25t FYM ha^{-1} + 150:100:125 kg NPK ha^{-1}) + *Azospirillum* (2.5 kg ha^{-1}) + *Phosphobacteria* (2.5 kg ha^{-1}) + VAM (10 kg ha^{-1}) + *Trichoderma viride* (2 kg ha^{-1}) + *Pseudomonas fluorescens* (2 kg ha^{-1}) and foliar spray of humic acid (0.2%) to marigold without nematicide to banana.

KEY WORDS: intercrop, bio-fertilizers, bio-control agents, bio-stimulants, marigold.

INTRODUCTION

Marigold, a member of the family Asteraceae or Compositae, is a potential commercial flower that is gaining popularity on account of its easy culture, wide adaptability, and increasing demand in the subcontinent (Asif, 2008). Marigold is one of commercially exploited flower crop. Marigold is grown for cut flowers, gardands, decoration besides used in landscape gardening. It is also valued for extraction of aromatic oil and dried flower petals are used as poultry feed. In marigold the spacing has greater importance in manipulating growth, flowering behaviour and flower and yield. It is also a heavy feeder of nutrients, at present the nutrients are supplied through chemical fertilizers. Indiscriminate and continuous use of chemical fertilizer in intensive cropping system has led to an imbalance of nutrients in soil which has an adverse effect on soil health and also affecting seed yield. Commercial exploitation of the flowers for xanthophyll extraction has made this flower crop much more popular among the flower growers and industrialists. To reduce the fertilizer cost to safeguard the soil health and to control the nematode which affects the banana crop an intercropping trial with african marigold in Grand Naine banana was taken up using integrated nutrients such as FYM, macronutrients, bio fertilizers, bio control agents and bio stimulants with the objective of increasing the growth, yield and quality of african marigold hybrid L3 and to manage the nematode population which affects banana crop.

MATERIALS & METHODS

The experiment was conducted in open field condition at Sathyamangalam, Erode District, Tamil Nadu during the year 2010-2011, in a clay loam soil which having low available N (112.34 kg ha^{-1}), low P (13.45 kg ha^{-1}) and high K (471.12 kg ha^{-1}) and pH 7.9 with 0.65 EC (dS m^{-1}). 16 days old L 3 hybrid marigold seedlings were transplanted in ridges and furrows with a spacing of 90 cm x 22.5 cm between banana rows. There are twelve treatments and replicated thrice (Table- 1). All treatments contain macronutrients, biofertilizers, biocontrol agents and biostimulants along with the control as pure banana crop without marigold and nematicide.

TABLE 1. Treatment details

T_1	:	Soil application of recommended dose of fertilizers (25t FYM ha^{-1} + 150:100:125 kg NPK ha^{-1}) to marigold with nematicide to banana
T_2	:	Soil application of recommended dose of fertilizers (25t FYM ha^{-1} + 150:100:125 kg NPK ha^{-1}) to marigold without nematicide to banana
T_3	:	T_2 + *Azospirillum* (2.5 kg ha^{-1}) + *Phosphobacteria* (2.5 kg ha^{-1}) + VAM (10 kg ha^{-1}) + *Trichoderma viride* (2 kg ha^{-1}) + *Pseudomonas fluorescens* (2 kg ha^{-1}) and foliar spray of panchakavya (3%) to marigold
T_4	:	Soil application of 75% recommended dose of fertilizers + *Azospirillum* (2.5 kg ha^{-1}) + *Phosphobacteria* (2.5 kg ha^{-1}) + VAM (10 kg ha^{-1}) + *Trichoderma viride* (2 kg ha^{-1}) + *Pseudomonas fluorescens* (2 kg ha^{-1}) and foliar spray of panchakavya (3%) to marigold without nematicide to banana
T_5	:	Soil application of 50% recommended dose of fertilizers + *Azospirillum* (2.5 kg ha^{-1}) + *Phosphobacteria* (2.5 kg ha^{-1}) + VAM (10 kg ha^{-1}) + *Trichoderma viride* (2 kg ha^{-1}) + *Pseudomonas fluorescens* (2 kg ha^{-1}) and foliar spray of panchakavya (3%) to marigold without nematicide to banana
T_6	:	T_2+ *Azospirillum* (2.5 kg ha^{-1}) + *Phosphobacteria* (2.5 kg ha^{-1}) + VAM (10 kg ha^{-1}) + *Trichoderma viride* (2 kg ha^{-1}) + *Pseudomonas fluorescens* (2 kg ha^{-1}) and foliar spray of humic acid (0.2%) to marigold
T_7	:	Soil application of 75% recommended dose of fertilizers + *Azospirillum* (2.5 kg ha^{-1}) + *Phosphobacteria* (2.5 kg ha^{-1}) + VAM (10 kg ha^{-1}) + *Trichoderma viride* (2 kg ha^{-1}) + *Pseudomonas fluorescens* (2 kg ha^{-1}) and foliar spray of humic acid (0.2%) to marigold without nematicide to banana
T_8	:	Soil application of 50% recommended dose of fertilizers + *Azospirillum* (2.5 kg ha^{-1}) + *Phosphobacteria* (2.5 kg ha^{-1}) + VAM (10 kg ha^{-1}) + *Trichoderma viride* (2 kg ha^{-1}) + *Pseudomonas fluorescens* (2 kg ha^{-1}) and foliar spray of humic acid (0.2%) to marigold without nematicide to banana
T_9	:	T_2 + foliar spray of panchakavya (3%) only
T_{10}	:	T_2 + foliar spray of humic acid (0.2%) only
T_{11}	:	Banana without marigold and nematicide (control)
T_{12}	:	Banana with nematicide (absolute control)

At the time of transplanting, bio fertilizers *viz.*, *Azospirillum* (2.5 kg ha^{-1}), *Phosphobacteria* (2.5 kg ha^{-1}) and VAM (10 kg ha^{-1}) and biocontrol agents *viz.*, *Trichoderma viride* (2 kg ha^{-1}) and *Pseudomonas fluorescens* (2 kg ha^{-1}) were mixed with FYM and applied around the root zone of marigold plants and covered with soil. The bio-stimulants *viz*., panchakavya and humic acid were sprayed at 30, 45, 60 and 75 DAT at given concentrations and the calculated quantities of NPK fertilizers are applied in four split doses *viz.* Basal, 20 DAT, 35 DAT and50 DAT. Observations were recorded on marigold growth and yield parameters.

RESULTS & DISCUSSION

All the growth parameters were influenced significantly by application of different dose of macro nutrients, bio control agents, bio fertilizers and bio stimulants. The growth parameters *viz.*, plant height (102.77 cm), plant spread (1177.78 cm^2), number of branches per plant (32.46), number of leaves (143.21) were found higher in treatment which received soil application of recommended dose of fertilizers (25t FYM ha^{-1} + 150:100:125 kg NPK ha^{-1}) + *Azospirillum* (2.5 kg ha^{-1}) + *Phosphobacteria* (2.5 kg ha^{-1})+ VAM (10 kgha^{-1}) + *Trichoderma viride* (2 kg ha^{-1}) + *Pseudomonas fluorescens* (2 kg ha^{-1}) and foliar spray of humic acid (0.2%) to marigold without nematicide to banana respectively (Table 2).

TABLE 2. Response of integrated nutrient management on growth parameters in African marigold hybrid L3 grown as an intercrop in Grand Naine banana

Treatments	Plant height(cm)	Number of branches (No.)	Plant spread (cm^2)	Number of leaves (No.)
T_1	85.36	804.75	18.87	84.40
T_2	83.34	829.25	19.41	101.96
T_3	99.14	1162.75	26.42	102.10
T_4	86.10	935.66	24.13	101.35
T_5	89.33	901.78	23.84	97.00
T_6	102.77	1177.78	32.46	143.21
T_7	86.09	1089.80	28.12	87.30
T_8	83.95	907.33	22.64	84.53
T_9	88.43	892.95	22.24	92.07
T_{10}	86.96	908.67	24.78	90.40
T_{11}	___	___	___	___
T_{12}	___	___	___	___
CD. (P=0.05)				

Improvement in growth characters might be due to the pronounced effect of the treatments. Sufficient supply of plant nutrients might have shown stimulatory action in terms of cell elongation and thus resulting in increased plant height. Better availability of nutrients would have helped in protein synthesis resulting in production of taller plants with larger leaves and more number of branches (Neary *et al.*, 1995). The pronounced effects of these parameters are due to application of nitrogen and phosphorus (Sindhu and Yamdagni, 1992). Application of N significantly enhanced the plant growth parameters in african marigold (Avari and Patel, 1991). Phosphorus is associated with phosphorylation and is constituent of energy rich compounds like ATP, ADP, NADH and NADPH. Potassium is an activator of many enzymes that are essential for photosynthesis and respiration, and it also activates enzymes needed to form starch and proteins. The biofertilizers also synthesizes and secretes thiamin, riboflavin pyridoxine, nicotinic acid, indole acetic acid (IAA) and gibberellins like substances in addition to the production of antifungal antibiotics by the bacteria, which inhibit harmful fungi (Kapulnik *et al.*, 1985). It also increases water uptake by plants which eventually increased the growth of the marigold plant. Phosphorus solubilizing bacteria improved all these growth parameters which might be due to enhanced availability of phosphors due to presence of PSB in rhizosphere which stimulates the root system
through efficient translocation of certain growth stimulating compounds formed in the plants, which further enhances the absorption of nutrients thus resulting in a vigorous growth of marigold. Similar experimental findings were also observed by Yadav *et al.* (2005) in tuberose. Significant increase in plant height and spread due to combined application of Azospirillum, phosphorus solublizing bacteria (PSB) and inorganic fertilizers has been reported earlier in crossandra (Narashima Raju and Haripriya, 2001) and gundumalli (Manonmani, 1992). The yield parameters *viz*., precocious flowering (26.11 DAT), lesser days for 50% flowering (44.43 days), flower diameter (9.96 cm) individual flower weight (18.81g), number of flowers per plant (54.66) and cost benefit ratio(4.13) were higher in soil application of recommended dose of fertilizers (25t FYM ha-1+150:100:125 kg NPK ha-1) +Azospirillum (2.5 kg ha-1)+Phosphobacteria (2.5 kg ha-1) +VAM (10 kg ha-1) +Trichoderma viride (2 kg ha-1)+ Pseudomonas fluorescens (2 kgha-1) and foliar spray of humic acid (0.2%) to marigold without nematicide to banana respectively (Table 3). The earliness of bud initiation in biofertilizer-inoculated plants may be ascribed to easy uptake of nutrients and simultaneous transport of growth promoting substances like cytokinin to the axillary buds, resulting in breakage of apical dominance. Ultimately, this has resulted in a better sink for faster mobilization of photosynthates and early transformation of plant parts from vegetative to reproductive phase. The higher production of auxin and growth substances by humic acid at early phase of growth would have contributed to early flowering. This could also be attributed to the gibberellin like activity of humic acid. A positive significant effect was observed on the number of

days taken for fifty percent flowering and number of flowers that remained open at a time due to the application of 0.2 per cent humic acid spray. The earliness in 50% flowering may be due to continuous supply of nutrients from the soil by the soil microbes and un interrupted supply of water to the plant system would have transformed the vegetative phase to reproductive phase much earlier. The results are in line with the findings of Vasanthi, (1994) in jasmine, marigold by Chandrikapure *et al*. (1999), crossandra (Narasimha Raju and Haripriya, 2001), Limonium (Gayathri *et al*., 2004), who have endorsed the effect of N and P along with biofertilizers in the advancement of flowering. Humic acid contain cytokinin and auxin that might have increased the flower diameter as inferred by Cacco and Agnola (1984). Increase in flower diameter and weight could be due to the increased photosynthetic activity which, in turn, might have favoured an increased accumulation of dry matter and also efficient partitioning of photosynthates towards the sink. It might be attributed to the nature of interaction of physiological and growth parameters by way of increased dry matter production which is in conformity with finding of Obreza and Vavrina (1995) in capsicum and Veeranna (2000) in chilli. Increases in yield contributing characters directly influence the crop yield. Increased flower yield per plant and total yield of flowers per hectare is due to increase in available levels of nutrients by the combined effect of organic + inorganic + bio fertilizers + biocontrol agents+ bio stimulant application. The increase in yield was due to the performance of all crop growth and yield attributing characters due to better availability of soil moisture, environment and availability of plant nutrients throughout the crop growth period due to the beneficial soil microbes which mobilized the minerals from soil to root tips which is easily trans located into the plant system.

In a holistic point of view, it was perceived that, the combined soil application of recommended dose of fertilizers (25t FYM ha^{-1}+150:100:125 kg NPK ha^{-1})+ *Azospirillum* (2.5 kg ha^{-1}) + *Phosphobacteria* (2.5 kg ha^{-1}) + VAM (10 kg ha^{-1}) +*Trichoderma viride* (2 $kgha^{-1}$) + *Pseudomonas fluorescens* (2kg ha^{-1}) and foliar spray of humic acid (0.2%) to marigold without nematicide to banana improved the overall growth and yield content in african marigold hybrid 'L 3' grown as an intercrop with Grand Naine banana. It also improved the yield parameters of banana (bunch yield and yield per ha.) by protecting the banana roots from nematode damage.

TABLE 3. Response of integrated nutrient management on yield parameters in African marigold hybrid L 3 grown as an intercrop in Grand Naine banana

Treatments	Days taken for first flowering (days)	Days to fifty per cent flowering (days)	Flower diameter (cm)	Individual flower weight(g)	Number of flowers per plant	Flower Yield (kg/ plot ($12m^2$))	Estimated flower yield (tones/ha)	Final Nematode population (No.)
T_1	29.89	50.46	7.94	14.98	40.66	19.05	15.87	28.00
T_2	29.64	50.33	7.74	14.83	41.02	19.08	15.90	31.30
T_3	27.93	46.22	8.46	16.84	50.04	20.30	16.91	29.66
T_4	28.75	48.66	8.32	15.41	45.06	19.95	16.62	29.33
T_5	29.32	48.73	8.29	15.02	48.37	19.38	16.15	34.00
T_6	26.11	44.43	9.96	18.81	54.66	21.60	18.00	23.20
T_7	28.37	47.24	8.35	16.74	49.54	20.02	16.68	31.00
T_8	29.34	49.31	8.42	15.01	46.44	19.93	16.60	25.66
T_9	30.33	48.56	8.32	15.34	47.32	19.53	16.27	48.30
T_{10}	29.46	48.24	8.21	15.32	49.24	19.86	16.55	47.72
T_{11}	___	___	___	___	___	___	___	129.34
T_{12}	___	___	___	___	___	___	___	22.34
CD. (P=0.05)	1.77	1.07	1.45	1.93	4.56	1.28	0.83	9.93

REFERENCES

Asif, M. (2008) Effect of Various NPK Levels on Growth, Yield and Xanthophyll Contents of Marigold. MSc Thesis. Inst of Hort Sci., Univ of Agric, Faisalabad, Pakistan, p. 95.

Avari, A.F. and Patel, B.M. (1991) Effect of spacing and nitrogen levels on growth, flowering and yield of African marigold (*Tagetes erecta* L.) cv. Lemon. M.Sc. Thesis abstracts, Chaudhry Charan Singh Haryana Agricultural University, Hissar, India. Vol. XIX. No.1. March 1993.

Bhavanisanker, K. & Vanagamudi, K. (1999) Integrated nutrient management in gundimalli (*Jasmonium sambac* L.). South Indian Hort., 47 (1-6): 111-114.

Cacco, G. and Agnola, G.D. (1984) Plant growth regulator activity of soluble humic substances. Can. J. Soil. Sci., 64:225-228.

Chandrikapure, K.R., Sadawarte, K.T., Panchabh, D.M. and Shelke, B.D. (1999) Effect of bioinoculants and graded doses of nitrogen on growth and flower yield of marigold (*Tagetes erecta* L.). Orissa Journal of Horticulture, 27 (2): 31- 34.

Gayathri, H.N., Jayaprasad, K.V. and Narayanaswamy, P., (2004) Response of biofertilizers and their combined application with different levels of inorganic fertilizers in statice (*Limonium caspia*). Journal of Ornamental Horticulture, 7 (1): 70-74.

Kapulnik, Y., Gafni, Y. & Okon, Y. (1985) Effect of Azospirillum inoculation on root development and NO_3 uptake in wheat in hydrophonics systems. Can. J. Microbiol., 31: 881-887.

Manonmani, R. (1992) Effect of soil inoculation of azospirillum and Phosphobacteria and graded doses of

nitrogen and phosphorus fertilizers on growth and yield of Jasminum sambac cv. Gundumalli, M.Sc. (Hort.) Thesis, Tamil Nadu Agricultural University, Coimbatore, India.

Narasimha Raju, S. & Haripriya, K. (2001) Integrated nutrient management in crossandra (*Crossandra infundibuliformis* L.) cv. Dindigul local. South Indian Horticulture, 49: 181-184.

Neary, P.E., Starlie, C.A. & Paterson, J.W. (1995) Fertilization requirements for drip irrigation bell pepper grown on loamy sand soils. Proc. Fifth International microirrigation congress, April 2-6, Florida: 187-193.

Obreza, T.A. & Vavrina, C.S. (1995) Fertilization scheduling for improved nutrient use efficiency of micro-irrigated bell pepper in sandy soil. Proc. Dahha Greidinger International symposium on fertigation, March 26-April – 1, Israel: 247-256.

Sindhu, S.S. & Yamdagni, R. (1992) Influence of different combination of nitrogen, phosphorus and potassium on vegetative growth parameters of Hybrid Tea rose cv. Super Star. Haryana J. Hort. Sci., 21(3-4): 146 - 151.

Vasanthi, K. (1994) Studies on the effect of nitrogen, potassium in combination with *Azospirillum* and *Phosphobacterium* on the growth, yield and quality of jathimalli (*Jasminum grandiflorum* L.) cv. Co 1. M.Sc. (Hort.) Thesis, Tamil Nadu Agricultural University, Coimbatore, India.

Veeranna, H.K. (2000) Effect of fertigation, irrigation and potassium levels on the productivity of chilli (*Capsicum annuum* L.). Ph.D. Thesis, Univ. Agri. Sci., Bangalore.

Yadav, B.S., Gupta, A.K. and Singh, Sukhbir (2005) Studies on the effect of nitrogen, plant spacing and biofertilizers on growth parameters in tuberose cv. double. Haryana J. Hort. Sci. 34: 78-80.