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STUDIES ON EFFECT OF BIO-ENZYMES ON GROWTH AND PHYSIOLOGICAL PARAMETERS OF AFRICAN MARIGOLD (*TAGETES ERECTA* L.) CV. BM 4

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ABSTRACT

A study was conducted to evaluate the effect of bio-enzymes on growth and physiological parameters of African Marigold (*Tagetes erecta* L.) cv. BM 4 at Sri Konda Laxman Telangana Horticultural University, Floricultural Research Station, Rajendranagar, Hyderabad. The experiment was carried out in Randomized Block Design (RBD) with seven treatments and three replications. The results revealed that among the seven treatments, T_2 (75% N+100% P_2O_5+ 100% K_2O + Moringa leaf extract @ 2ml/L) recorded highest plant height (54.13 cm), maximum plant spread in east-west direction (56.80 cm), maximum plant spread in north-south direction (54.10 cm) and maximum number of branches per plant (36.13). Similarly in physiological parameters recorded maximum leaf area (38.80 cm^2) and maximum chlorophyll content at harvesting stage (46.50 SPAD units). This study highlights the foliar application of bio-enzymes on growth and physiological parameters of African Marigold cv. BM 4.

Keywords **:** African Marigold cv. BM 4 (Bidhan Marigold 4), moringa leaf extract, fish amino acid, egg amino acid, growth parameters and physiological parameters.

Introduction

Marigold (*Tagetes erecta* L.) a member of the Asteraceae family, is an important commercial flower valued for its ornamental, medicinal, and economic uses (Panwar *et al*., 2013). African marigold (*Tagetes erecta*) is a hardy annual (90–100 cm) bearing large, round blooms in yellow to orange shades (Dikr and Belete, 2017). Marigold serves as a rich source of carotenoids and essential oils for pharmaceutical and nutraceutical applications (Gupta *et al*., 2022). It is also a major source of lutein, widely used as a natural colorant, supplement, and poultry feed additive (Verghese, 1998; Vernon-Carter, 1996; Sanghamitra *et al*., 2015). Bio-enzymes, developed from kitchen waste fermentation with jaggery which are eco-friendly formulations containing NPK and metabolites that act as natural fertilizers, pesticides, and plant growth enhancers (Sethi *et al*., 2021). Moringa leaf extract (MLE) is an eco-friendly plant growth enhancer rich in cyto-kinins, auxins, gibberellins, essential minerals, amino acids, and antioxidants. Foliar application of Moringa leaf extract improves nutrient uptake, photosynthesis, growth, produce quality, and post-harvest traits, making it a sustainable alternative to synthetic agrochemicals (Yuniati *et al*., 2022). Fish emulsions enhance seedling growth and fruit production (Aung and Flick, 1980) and support soil microbial activity (El Tarabily *et al*., 2003). Fish amino acid (FAA), made by fermenting fish by-products with jaggery, is applied as a foliar spray or soil drench in natural farming, promoting efficient nutrient absorption, nitrogen supply, chlorophyll synthesis, and overall plant health (Weinert *et al*., 2014). Egg amino acid (EAA), prepared from eggs, lemon, and jaggery,

is a biodegradable bio-fertilizer that boosts growth, yield, and soil fertility while correcting calcium deficiency, promoting sustainable farming (Shiyas, 2023).

Material and Methods

A field experiment was conducted during February to may in summer season of the year 2024-2025 at Floricultural Research Station, ARI, Rajendranagar, Hyderabad which is geographically located at an altitude of 542.3 m above mean sea level on 78.40° East longitude and 17.32° North latitude. The region falls under the semi-arid agroclimatic zone of Telangana. The soil is sandy loam in texture. The study was laid out in a Randomized Block Design (RBD) with seven treatments *viz.*, T_1 **(**100% N + 100% P_2O_5 + 100% K_2O (90 N + 90 P_2O_5 + 75 K_2O kg/ha) – Control), T_2 **(**75% N + 100% P_2O_5 + 100% K_2O + Moringa leaf extract (MLE) @ 2ml/L**),** T_3 **(**50%N + 100% P_2O_5 + 100% K_2O + Moringa leaf extract (MLE) @ 2ml/L**),** T_4 **(**75% N + 100% P_2O_5 + 100% K_2O + Fish amino acid (FAA) @ 1ml/L**),** T_5 **(**50% N + 100% P_2O_5 + 100% K_2O+ Fish amino acid (FAA) @ 1ml/L**),** T_6 **(**75% N + 100% P_2O_5 + 100% K_2O + Egg amino acid (EAA) @ 1ml/L**),** T_7 **(**50% N + 100% P_2O_5 + 100% K_2O + Egg amino acid (EAA) @ 1ml/L). Each treatment was replicated three times. Bidhan Marigold-4 is an African marigold cultivar that grows up to 75 cm tall with 9-10 primary branches. It produces orange -red, globular flowers, starts blooming 30 days after transplanting, yields about 104-110 flowers per plant, and gives 12-15 tons/acre**.** Seeds were collected from Floricultural Research Station, Rajendranagar, Hyderabad and sown in pro-trays filled with a 1:1 cocopeat–vermicompost mix, watered daily with a rose can. The healthy, uniform seedlings which are of 25 days old were transplanted into the main field at 45 cm x 45 cm spacing. Bio-enzymes were applied at fortnightly intervals after transplanting for five times during the crop duration. From each treatment and replication, five plants were randomly selected for observations. Data on plant height (cm), plant spread (E-W) (N-S) (cm^2), number of branches per plant, leaf area (cm^2) and chlorophyll content (SPAD units) were recorded. Data from the plants were averaged over three replications and analysed using ANOVA (Panse and Sukhatme, 1954). S.E (m) ± and CD at 5% level were calculated to test significance.

Results and Discussions

Plant height (cm)

Plant height was significantly influenced by foliar application of bio-enzymes, highest plant height was recorded in T_2 - (75% N + 100% P_2O_5 + 100% K_2O + Moringa leaf extract @ 2ml/L) (54.13 cm) which was statistically on par with T_4 **(**75% N+100% P_2O_5 + 100% K_2O + Fish amino acid @ 1ml/L) (53.43 cm). whereas lowest plant height was recorded in T_1 (100% N + 100% P_2O_5 + 100% K_2O) (43.56 cm). The combined application of inorganic fertilizer and moringa leaf extract exhibited a synergistic effect by improving nutrient availability and uptake, resulting in superior growth performance. Similar findings were reported by Culver *et al*. (2012) in tomato and Kanchani and Harris (2019) in okra.

Plant Spread E-W (cm)

Plant spread (E-W) was significantly influenced by foliar application of bio-enzymes, maximum plant spread in east-west direction was recorded in T_2 (75% N + 100% P_2O_5 + 100% K_2O + Moringa leaf extract @ 2ml/L) (56.80 cm) followed by T_4 (75% N + 100% P_2O_5 + 100% K_2O + Fish amino acid @ 1ml/L) (55.46 cm) while, minimum plant spread in east-west direction was recorded in T_1 (100% N + 100% P_2O_5 + 100% K_2O) (41.63 cm).

Plant Spread N-S (cm)

With regard to bio-enzymes foliar application, it can be clearly seen that bio-enzymes significantly influenced the plant spread in north-south direction. Maximum plant spread in north-south direction was recorded in T_2 (75% N + 100% P_2O_5 + 100% K_2O + Moringa leaf extract @ 2ml/L) (54.10 cm) followed by T_4 **(**75% N + 100% P_2O_5 + 100% K_2O + Fish amino acid @ 1ml/L) (51.51 cm) while, minimum plant spread in north - south direction was recorded in T_1 (100% N + 100% P_2O_5 + 100% K_2O) (42.82 cm). The foliar application of bio-enzymes notably enhanced plant spread in marigold, likely due to improved physiological processes such as cell elongation, nutrient uptake and metabolic activity.

Number of branches per plant

The data pertaining to number of branches per plant exhibited marked differences among the treatments. Treatment T_2 (75% N + 100% P_2O_5 + 100% K_2O + Moringa leaf extract @ 2ml/L) exhibited maximum number of branches (36.13), which was statistically on par with T_4 **(**75% N + 100% P_2O_5 + 100% K_2O + Fish amino acid @ 1ml/L) (32.26), whereas T_1 (100% N + 100% P_2O_5 + 100% K_2O) reflected the minimum number of branches per plant (24.13). Foliar application of moringa leaf extract increased the number of branches, which may be attributed to the supply of macro and micronutrients as well as growth hormones present in the extract. These

results are in accordance with the research findings of Kanchani and Harris (2019) reported in okra and Bashir *et al*. (2014) in tomato.

Leaf area (cm^2)

Effect on foliar application of bio-enzymes on leaf area showed significant variations among all the treatments. The data resulted that maximum leaf area was recorded in T_2 (75% N + 100% P_2O_5 + 100% K_2O + Moringa leaf extract @ 2ml/L) (38.80 cm^2), which was statistically on par with T_4 **(**75% N + 100% P_2O_5 + 100% K_2O + Fish amino acid @ 1ml/L) (34.31 cm^2) while, minimum leaf area was recorded in T_1 (100% N + 100% P_2O_5 + 100% K_2O) (28.90 cm^2).

Chlorophyll content (SPAD meter units) at harvesting stage

Data regarding chlorophyll content at harvesting stage varied significantly among all the treatments. The data revealed that the highest chlorophyll content was recorded in T_2 (75% N + 100% P_2O_5 + 100% K_2O + Moringa leaf extract @ 2ml/L) (46.5 SPAD units), which was statistically on par with T_4 **(**75% N +100% P_2O_5 + 100% K_2O + Fish amino acid @ 1ml/L) (41.05 SPAD units). In contrast, the lowest chlorophyll content was recorded in T_1 (100% N + 100% P_2O_5 + 100% K_2O) (31.1 SPAD units). The increased chlorophyll content may be attributed due to cyto-kinins induced by moringa leaf extract, stimulated the cell division and chloroplast development, leading to enhanced chlorophyll synthesis. Similar findings were reported in cabbage by Yaseen *et al*. (2023).

Conclusion

Based on the present study it can be concluded that the treatment T_2 (75% N+100% P_2O_5 +100% K_2O + Moringa leaf extract @ 2ml/L) had a beneficial impact on growth and physiological parameters of African Marigold cv. BM 4.

Fig 1: Measuring plant height (cm)

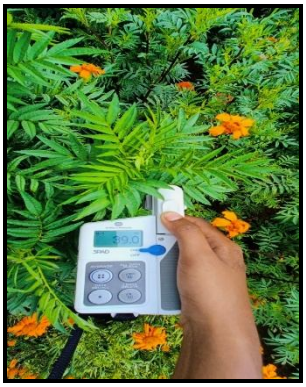

Fig 2: Measuring chlorophyll content (SPAD meter)

Table 1: Effect of Bio-enzymes on growth and physiological parameters in African Marigold cv. BM 4.

Treatments	Plant height (cm)	Plant spread (E-W) (cm)	Plant spread (N-S) (cm)	Number of branches per plant	Leaf area (cm^2)	Chlorophyll content (SPAD meter units) at harvesting stage
T_1 - 100% RDF - Control	43.56^{d}	41.63^{b}	42.82^{d}	24.13^{e}	28.90^{c}	31.10^{d}
T_2- 75% N +100% P_2O_5 + 100% K_2O + Moringa leaf extract @ 2 ml/L	54.13^{a}	56.80^{a}	54.10^{a}	36.13^{a}	38.80^{a}	46.50^{a}
T_3 - 50% N +100% P_2O_5 + 100% K_2O + Moringa leaf extract @ 2 ml/L	49.14^{abcd}	45.83^{b}	49.18^{bc}	30.33^{bc}	31.01^{bc}	37.71^{bc}
T_4 - 75% N +100% P_2O_5 + 100% K_2O + Fish amino acid @ 1ml/L	53.43^{ab}	55.46^{a}	51.51^{ab}	32.26^{b}	34.31^{ab}	41.05^{ab}
T_5 - 50% N +100% P_2O_5 + 100% K_2O + Fish amino acid @ 1ml/L	48.20^{bcd}	45.32^{b}	46.93^{c}	28.13^{cd}	29.00^{c}	34.84^{bcd}
T_6 - 75% N +100% P_2O_5 + 100% K_2O + Egg amino acid @ 1ml/L	51.10^{abc}	46.75^{b}	49.02^{bc}	31.00^{b}	33.63^{bc}	38.82^{bc}
T_7 - 50% N +100% P_2O_5 + 100% K_2O + Egg amino acid @ 1ml/L	46.58^{cd}	44.37^{b}	46.84^{c}	27.53^{d}	29.79^{bc}	32.87^{cd}
S.E (m) ±	1.88	2.14	1.21	0.88	1.52	2.03
CD @ 5%	5.81	6.59	3.74	2.73	4.7	6.27

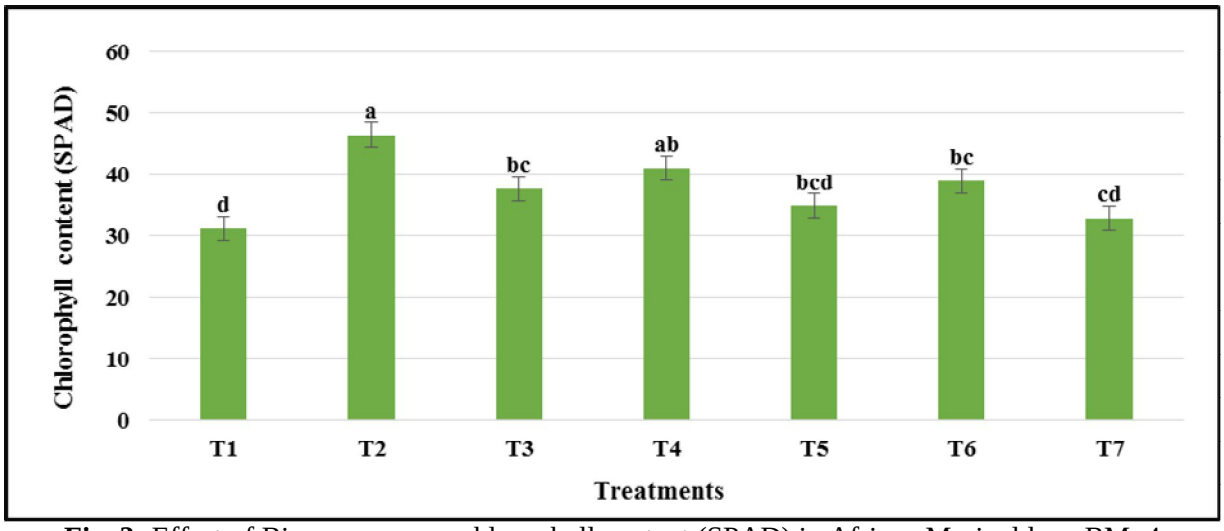

Fig. 3: Effect of Bio-enzymes on chlorophyll content (SPAD) in African Marigold cv. BM 4

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