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Response of marigold (*Tagetes erecta* L.) to jeevamrit and humic acid under Prayagraj agro-climatic conditions

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Abstract
The present investigation "Response of marigold to jeevamrit and humic acid under prayagraj agro-climatic condition" was carried out in the Horticultural Research Field, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology And Sciences, Prayagraj, conducted during rabi season November, 2024- April, 2025 season at SHUATS, the study utilized a Randomized Block Design featuring eleven treatment combinations that included soil drenching and foliar applications of jeevamrit, humic acid, and various NPK levels. Among the treatments, T_6 (75% NPK + soil drenching of 5% jeevamrit) showed the most significant results, recording the tallest plants (68.0 cm), the widest spread (64.0 cm²), the highest number of branches (8), the earliest bud initiation (71 days), the maximum flower count (82 per plant). It also excelled in flower size (6.31 cm), average flower weight (8.21 g), shelf life (13 days), self-life (22 days), and the highest flower yield (1315 g per plant), the highest flower yield per hectare (64 t) and flowering duration (89 days). Economically, T_6 yielded the highest gross return (₹14,59,534 per hac), net return (₹11,28,096 per hac), and B:C ratio (3.4).

Keywords: Marigold, *Tagetes erecta* L, jeevamrit, humic acid, organic farming

Introduction

Flowers are considered some of the most remarkable creations of nature, providing joy, beauty, and emotional connections to human existence. They symbolize purity, love, peace, and integrity, and carry cultural, spiritual, and economic significance around the world. In India, flowers are vital in religious ceremonies, social functions, and ornamental gardening. Among these, the marigold (*Tagetes* spp.) is particularly distinguished as one of the most significant and widely cultivated flower crops. Marigold is classified under the Asteraceae family and is celebrated for its bright blooms, durability, and versatility. The genus *Tagetes* consists of about 33 species, including *Tagetes erecta* (African marigold), *T. patula* (French marigold), and others such as *T. tenuifolia, T. minuta,* and *T. lucida* (Rydberg, 1945) [13]. Of these, *T. erecta* and *T. patula* hold the most commercial importance, with *T. erecta* being widely cultivated throughout India. Marigold is esteemed not only for its decorative use in garlands, bouquets, and decorations but also for its therapeutic properties. The leaves of marigold have been traditionally employed to treat boils and skin infections, owing to the presence of antibacterial compounds like the flavonoid patulitrin (Rhama and Madhavan, 2011) [12]. In light of the urgent need for sustainable agricultural practices and increasing environmental concerns, it is essential to reduce reliance on chemical fertilizers.

Jeevamrit, a traditional Indian bio-stimulant, along with humic acid, an organic soil amendment, has garnered attention as sustainable alternatives. Jeevamrit is created using readily available farm inputs such as cow dung, cow urine, jaggery, pulse flour, and forest soil. It is rich in beneficial microorganisms (bacteria, actinomycetes, and fungi) and nutrients including nitrogen (1.97%), phosphorus (0.172%), potassium (0.29%), manganese (47 ppm), and copper (50 ppm) (Kumar *et al*., 2021) [3]. Furthermore, jeevamrit has the ability to alter soil pH, thereby increasing the bioavailability of nutrients, which renders it effective in both acidic and alkaline environments (Kulkarni, 2019) [7]. In a similar vein, humic acid constitutes a vital part of soil organic matter, recognized for its contribution to enhancing nutrient absorption, water retention, and root growth. It improves the cation exchange capacity of the soil and facilitates the availability of micronutrients, establishing it as a significant additive in organic and integrated agricultural practices.

Materials and Methods

A field experiment was conducted to assess the response of marigold to jeevamrit and humic acid under the agro-climatic conditions of Prayagraj. This study took place in the Horticultural Research Field, Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, from November, 2024 to April, 2025. The experimental design employed was a Randomized Block Design, comprising a total of eleven treatments. The treatments included a 100% inorganic fertilizer dose (30:20:20 g/m^2 NPK, Control, T_1), soil drenching with 5% jeevamrit at 15 day intervals (T_2), foliar application of 5% jeevamrit at 15 day intervals (T_3), 75% inorganic fertilizer dose combined with soil drenching of 2% humic acid at 15 day intervals (T_4), 75% inorganic fertilizer dose with foliar application of 2% humic acid at 15 day intervals (T_5), 75% inorganic fertilizer dose along with soil drenching of 5% jeevamrit at 15 day intervals (T_6), 75% inorganic fertilizer dose with foliar application of 5% jeevamrit at 15 day intervals (T_7), 50% inorganic fertilizer dose combined with soil drenching of 2% humic acid at 15 day intervals (T_8), 50% inorganic fertilizer dose of 2% humic acid (T_9), 50% inorganic fertilizer dose with soil drenching of 5% jeevamrit at 15 day intervals (T_{10}), and 50% inorganic fertilizer dose with foliar application of 5% jeevamrit at 15 day intervals (T_{11}), each replicated three times.

The experimental soil was loamy sand, known for its excellent drainage capabilities. The recommended fertilizer ratio was 30:20:20 g/m2. The entire quantity of phosphorus and potassium, along with half of the nitrogen, was applied as a basal dose during the field preparation, in the form of single super phosphate and muriate of potash, respectively. The other half of the nitrogen was applied 30 days after transplanting using the ring method. A total of thirty-three plots were established, each measuring 2 m x 2 m, with seedlings planted at a spacing of 45 cm x 45 cm.

Results and Discussion

Growth and Vegetative Parameters

The mean data on growth and vegetative parameters such as maximum plant height (cm), plant spread (cm^2) and number of primary branches are depicted in Table 1.

Plant height (cm)

At all stages of plant growth *i.e*., 15, 30, 45 and 60 days after planting, maximum plant height (24.2 cm, 42.4 cm, 58.4 cm and 68.0 cm, respectively) was observed in treatment T_6 *i.e*. 75% NPK + soil drenching with 5% jeevamrit at fifteen days interval whereas minimum plant height (13.1 cm, 23.1 cm, 33.1 cm and 41.8 cm) was recorded under T_1 (100% NPK).The increase in plant height might be due to the reason that drenching of jeevamrit acted as a tonic for soil health and promoted growth as it contains macronutrient, increased nutrient availability and microbial activity in rhizosphere. Similar results have been reported in Boston fern after drenching and foliar application at Jeevamrut alternatively at fifteen days intervals by Vanlalhruaii (2019) [14].

Plant spread (cm^2)

At all stages of plant growth i.e., 15, 30, 45 and 60 days after planting, maximum plant spread (24.1 cm^2, 38.9 cm^2, 55.3 cm^2 and 64.0 cm^2, respectively) was observed in treatment T_6 *i.e.* 75% NPK + soil drenching with 5% jeevamrit at fifteen days interval whereas minimum plant spread (13.2 cm^2, 27.5 cm^2, 31.2 cm^2 and 41.7 cm^2) was recorded under T_1 (100% NPK). The increase in plant spread might be due to increase in soil microbial activity, micronutrients in form of zince, copper, chlorine, cobalt, iron, magnesium, boron and macronutrients in form of nitrogen, phosphorus, potassium, magnesium, sulphur, leading to enhanced canopy expansion and overall plant growth. This result is consistent with the research conducted by Kaushal *et al.* (2024) [5].

Number of primary branches

Among the various treatments, maximum number of primary branches (8) was observed in T_6 (75% NPK + soil drenching with 5% jeevamrit) which was found to be at par with T_7 (75% NPK + foliar application of 5% jeevamrit, 7) whereas lesser number of primary branches (4) was observed in T_1 (100% NPK). The possible reason for increase in a number of primary branches might be due to increased nutrient uptake, improve photosynthesis, a better source sink relationship and efficient biochemical activities which stimulate cell division and elongation. This finding is in agreement with the conclusion drawn by Choudhary *et al.* (2021) [2].

Floral parameters

The mean data on floral parameters such as days to first bud initiation, days to first flowering, days to 50% flowering, number of flowers per plant, average flower weight (g), flower diameter (cm), flower duration (days), shelf life (days) and self-life (days) are depicted in Table 1.

The application of jeevamrit has significantly influenced various flowering attributes *viz.,* days to first bud initiation, days to first flowering, days to 50% flowering. The earliest first bud initiation (56), fewer days (89) taken for first flowering and lesser days for 50% flowering (91 days) was observed in T_1 (100% NPK). Whereas more number of days (71 days) for bud initiation, (102 days) taken for first flowering and for 50% flowering (104 days) was observed in T_6 (75% NPK + soil drenching with 5% jeevamrit). Early bud initiation, first flowering and 50% flowering might be due to increase of microbial activities in soil and convert the non-available form of nutrient into an available form which faster the vegetative growth and storing sufficient reserved food materials for differentiation of buds into flowers which ultimately resulted in earliest blooming. This result is consistent with the research conducted by Pansuriya and Kumari (2024) [9].

Among the different treatment, maximum number of flowers per plant (82), average flower weight (8.21 g), flower diameter (6.11 cm) and longer flowering duration (89 days) was obtained with the T_6 (75% NPK + soil drenching with 5% jeevamrit). The minimum number of flowers per plant (48), average flower weigth (5.31 g), flower diameter (4.28 cm) and shorter flowering duration (81 days) was recorded under T_1 (100% NPK). Increase in number of flowers per plant, average flower weight, flower diameter and longer flowering duration might be due to active and rapid multiplication of bacteria, especially in the rhizosphere, creating favourable conditions of nitrogen fixation and phosphorus solubilisation at higher rates and making it available to the plants leading to more uptake of nutrients and water. This in turn increase photosynthesis and enhances food accumulation and also diversion of photosynthesis towards sinks resulting in better growth and subsequently higher number flowers per plant and higher yield. This finding is in agreement with the conclusions drawn by Praveen *et al.* (2021) [11]. Among the various treatment, longer shelf life (13 days) and longer self-life (22 days) was obtained with the T_6 (75% NPK + soil drenching with 5% jeevamrit). Shorter shelf life (9 days) and shorter self-life (17 days) was recorded under T_1 (100% NPK). As photosynthesis increased in plant heaving jeevamrit as soil drench, their food accumulation might have increased by diversion of photosynthesis towards sink, providing higher amount of substrate for respiration thereby, increasing their shelf life and self-life Parmar *et al.* (2024) [10].

Yield parameters: The mean data on yield parameters such as maximum number of flower yield per plant (g) and flower yield per hectare (t) are depicted in Table 1.

The mean data presented in table 1, reveals that among the different treatment, maximum flower yield per plant (1315 g) and maximum flower yield per hectare (64 t) was obtained with the T_6 (75% NPK + soil drenching with 5% jeevamrit). The minimum flower yield per plant 428 g) and minimum flower yield per hectare (20 t) was recorded under T_1 (100% NPK). Increase in number of flower yield per plant and flower yield per hectare might be due to active and rapid multiplication of bacteria, especially in the rhizosphere, creating favourable conditions of nitrogen fixation and phosphorus solubilisation at higher rates and making it available to the plants leading to more uptake of nutrients and water. This in turn increase photosynthesis and enhances food accumulation and also diversion of photosynthesis towards sinks resulting in better growth and subsequently higher number flowers per plant and higher yield. This result is consistent with the research conducted by (Praveen *et al*. 2021) [11].

Table 1: Effect of jeevamrit and humic acid on different papamaters

Tr. No.	Plant height (cm)	Plant spread (cm^2)	Number of primary branches (days)	First bud initiation Days	First flowering Days	50% flowering Days	Number of flowers per plant	Average flower weight (g)	Flower diameter (cm)	Duration of flowering Days	Shelf life Days	Self life Days	Flower yield per plant (g)	Flower yield per hectare (t)
T_1	41.8	41.7	4	56	89	91	48	5.31	4.28	81	9	9	428	20
T_2	47.2	47.9	6	62	92	96	58	6.04	4.81	83	11	11	545	21
T_3	49.7	51.3	6	63	95	98	55	6.11	5.01	82	10	10	718	35
T_4	51.2	50.5	5	60	93	96	62	6.52	5.43	83	10	10	622	30
T_5	51.2	46.6	6	61	92	96	60	6.91	5.83	78	10	10	600	29
T_6	68.0	64.0	8	71	102	104	82	8.21	6.31	89	13	13	1315	64
T_7	59.3	61.2	7	68	97	100	61	7.91	6.11	84	12	12	777	38
T_8	53.5	57.5	5	62	94	95	61	7.46	5.97	81	10	10	670	33
T_9	48.4	49.9	5	63	92	94	64	7.02	6.04	81	9	9	590	29
T_{10}	52.7	56.5	5	61	94	96	60	7.41	4.44	82	9	9	582	28
T_{11}	54.3	52.0	6	61	90	94	57	7.02	5.29	83	10	10	530	26
F-Test	S	S	S	S	S	S	S	S	S	S	S	S	S	S
SE(d)±	2.968	6.673	0.540	2.504	1.931	1.163	7.896	0.169	0.246	1.982	0.678	0.678	50.536	4.528
$CD_{0.05}$	6.235	2.246	1.135	5.261	4.057	2.442	16.589	0.355	0.517	4.163	1.424	1.424	106.158	9.513
CV (%)	13.241	7.384	10.966	4.867	2.513	2.815	24.547	5.719	10.53	2.934	7.803	7.803	9.224	32.674

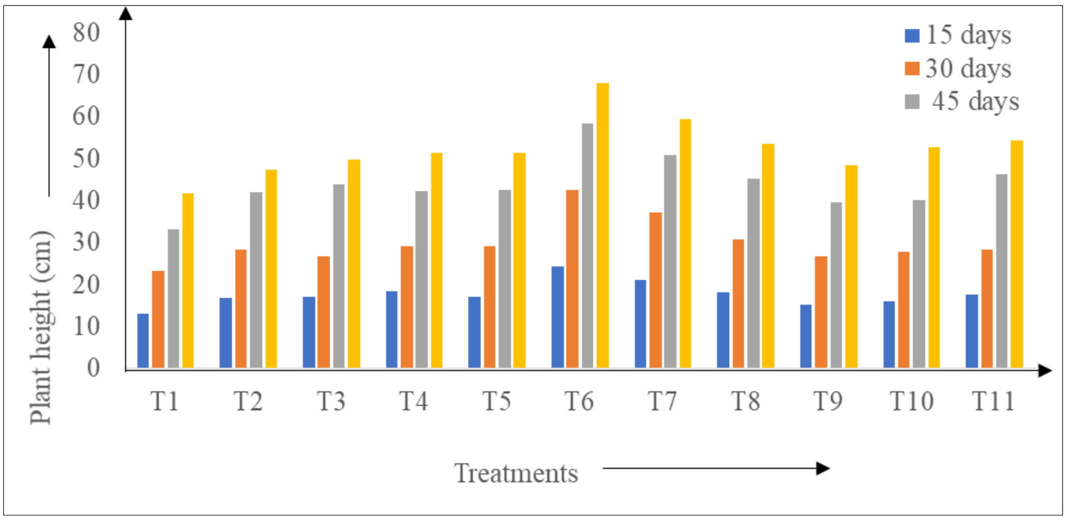

Fig 1: Effect of jeevamrit and humic acid on plant height of marigold

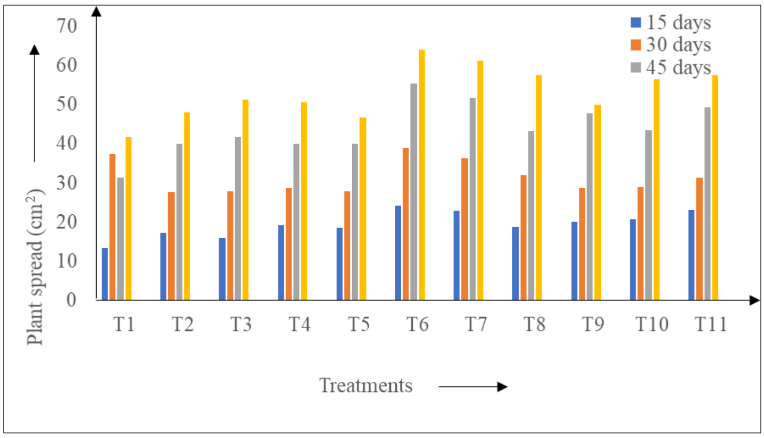

Fig 2: Effect of jeevamrit and humic acid on plant spread of marigold

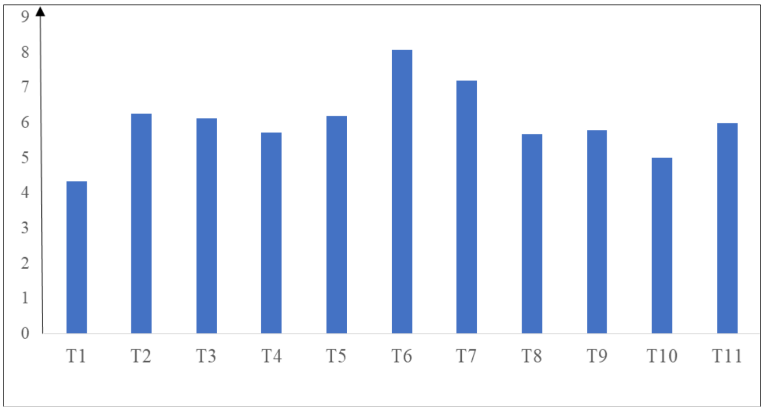

Fig 3: Effect of jeevamrit and humic acid on number of primary branches in marigold

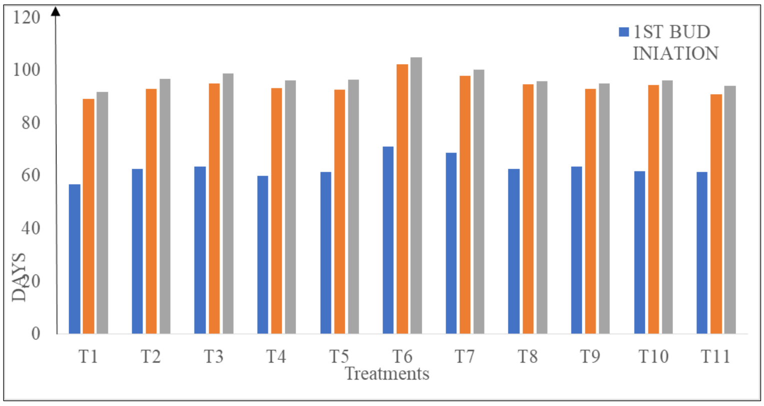

Fig 4: Effect of jeevamrit and humic acid on days to first bud initiation, first flowering, 50% flowering in marigold

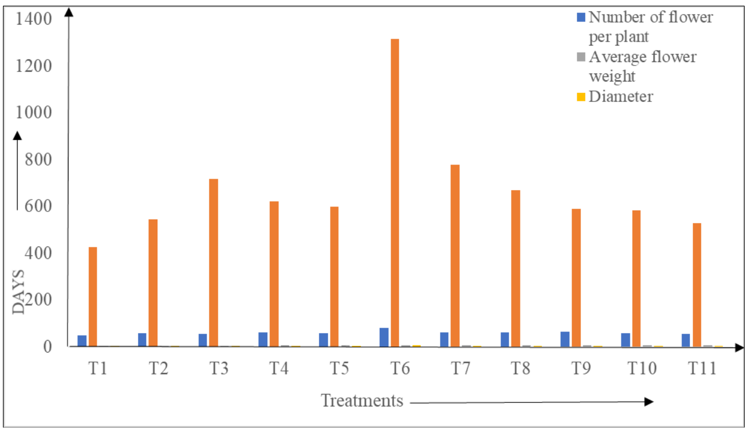

Fig 5: Effect of jeevamrit and humic acid on number of flowers per plant, average flower weight and flower diameter of marigold

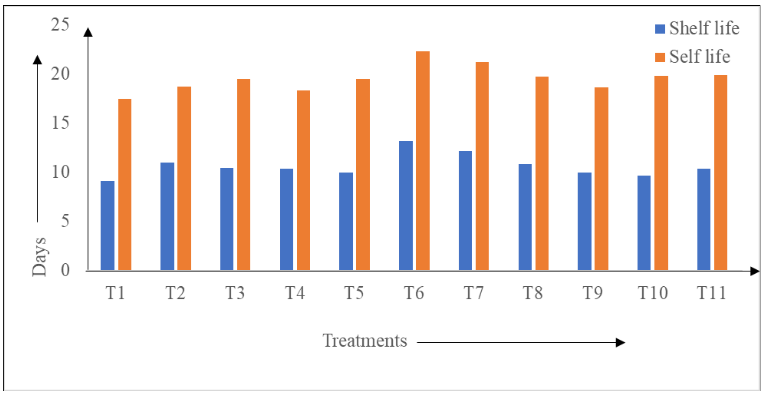

Fig 6: Effect of jeevamrit and humic acid on shelf life and self-life of marigold

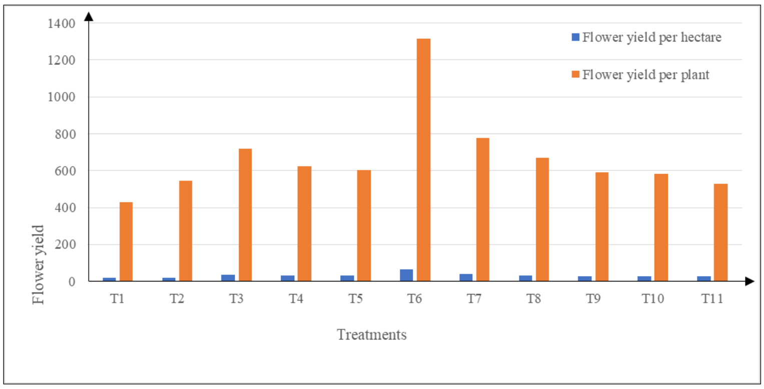

Fig 7: Effect of jeevamrit and humic acid on flower yield per plant and flower yield per hectare Of marigold

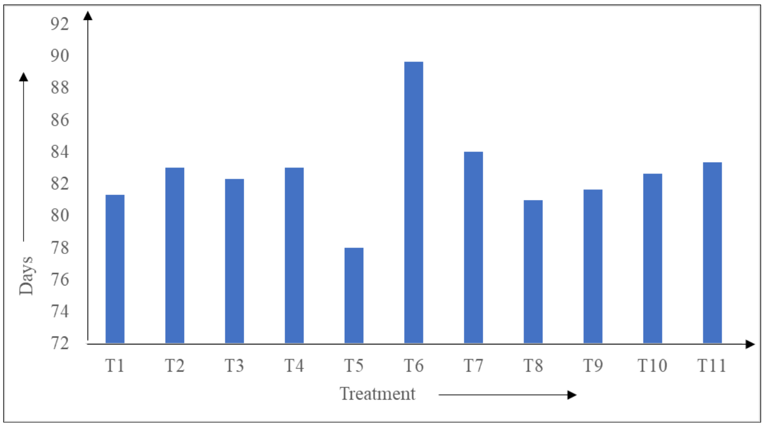

Fig 8: Effect of jeevamrit and humic acid on duration of flowering in marigold

Conclusion

It is concluded from the present investigation that using jeevamrit and humic acid, particularly with reduced amounts of chemical fertilizers, can boost the growth, flowering, yield, and shelf life of marigolds in the subtropical climate of Prayagraj. Out of the eleven treatments tested, T_6 (75% NPK + soil drenching with 5% jeevamrit) followed by T_7 (75% NPK + foliar application of 5% jeevamrit) stood out as the most effective for all the parameters viz. Plant height, plant spread, number of primary branches, first bud initiation, first flowering, 50% flowering, number of flower per plant, flower yield per plant, average flower weight, shelf life, self life, duration of flowering as well as highest B:C ratio of 3.4.

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