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Effect of inoculation with VAM fungi at different P levels on flowering parameters of *Tagetes erecta* L.

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ABSTRACT

In this experiment the VAM fungi viz., *Glomus fasciculatum* (Thaxter) Gerd. and Trappe, *Glomus mossea* (Nicol. and Gerd.) Gerd. and Trappe, *Glomus intraradices* Schenck and Smith. with an un-inoculated control was maintained and three P levels viz., 60, 90, 120 kg ha^{-1} were tried. The results brought out that marigold responded well to VAM inoculation under field conditions. The least days taken to first flowering was recorded with the inoculation of *G. fasciculatum* and given P at 60 kg/ ha (30.47 days) as compared to other species of *Glomus* fungi, the least days taken to 50% flowering was recorded with the inoculation of *G. fasciculatum* and given P at 90 kg/ ha (48.73 days) as compared to the other species of *Glomus* fungi and uninoculated control plants with given P at 120 kg/ ha and the maximum flowering duration was recorded with the inoculation of *G. fasciculatum* and given P at 90 kg/ ha (66.60 days) and it was closely followed by *G. mosseae* (66.00 days) at the same level as compared to the other species of *Glomus* fungi and uninoculated control plants.

Keywords: Marigold, VAM, phosphorus, Glomus fasciculatum, G. mosseae, G. Intraradices, flowering duration, flower bud initiation .

I. INTRODUCTION

Marigold (*Tagetes erecta* L.) belongs to the family Asteraceae and genus *Tagetes*. The two main popularly grown species in marigold are *Tagetes erecta* L. and *Tagetes patula* L. which have their origin in Mexico and South Africa, respectively. *Tagetes erecta* L. is popularly known as "African marigold" while *Tagetes patula* L. as "French marigold". There are several other important species *viz.*, *Tagetes tenuifolia* L. (the striped marigold), *Tagetes lucida* L. (the sweet scented marigold), *Tagetes minuta* L. and *Tagetes lacera* L.

Compared to any other flowering annuals, marigold is easily adaptable to various conditions of growing and has fairly good keeping quality. It is propagated by seeds and comes up well in all types of soil. The flowers of these species are generally large in size with bright shades, ranging from yellow to orange and are the best for combination in any flower arrangement. Marigold is grown for cut flowers, making garlands, decoration during pooja and several religious functions, besides its use in landscape gardening. Apart from its significance in ornamental horticulture, it has been valued for other purposes too. The aromatic oil extracted from marigold, is called as "tagetes oil". It is used in preparation of high grade perfumes and also as an insect fly repellant..

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Mycorrhiza literally means 'fungus root'. The fungus obtains photosynthesis from plant, while the plant is able to utilize the network of fungal hyphae, (which effectively act as an extended root system). The uptake of inorganic nutrients by plants is influenced by microorganisms in the rhizosphere. Symbiotic endophytes such as mycorrhizae are examples of microorganisms that are involved in the uptake of vital plant nutrient element, phosphorus.

Phosphorus is an important plant macronutrient, making up about 0.2 % of a plant's dry weight. Mycorrhizae are important for plant P acquisition, since fungal hyphae greatly increase the volume of soil that plant roots explore (Smith and Read, 1997). In certain plant species, root clusters (proteoid roots) are formed in response to P limitations. These specialized roots exude high amounts of organic acids (up to 23 % of net photosynthesis), which acidify the soil and chelate metal ions around the roots, resulting in the mobilization of P and some micronutrients (Marschner, 1995).

Considering its importance as commercial flower crop, the study on effect of VAM fungi on marigold at different phosphorus levels was initiated.

II. MATERIALS AND METHODS

A factorial experiment was laid out in Randomised Block Design. There were 12 treatment combinations each three replications. In the present experiment VAM fungi (*Glomus fasciculatum, G. mosseae, G. intraradices* with an uninoculated control) and three levels of phosphorus (60, 90, 120 kg ha^{-1}) were tried in all possible combinations.

Treatment details are as follows,

Factor I = Mycorrhizal species

M_1- *Glomus fasciculatum* (Thaxter) Gerd. and Trappe.

M_2- *Glomus mossea* (Nicol. and Gerd.) Gerd. and Trappe.

M_3- *Glomus intraradices* Schenck and Smith.

M_o- Uninoculated control

Factor II = Phosphorus levels : 3

(225kg N + 60kg K_2O as constant)

P_1- 60 kg P_2O_5 ha^{-1}

P_2- 90 kg P_2O_5 ha^{-1}

P_3- 120 kg P_2O_5 ha^{-1}

2.1. Treatment Combination

Treatment No.	Treatment	Combination
T_1	M_0P_1	Uninoculation + 60 kg P_2O_5 ha^{-1}
T_2	M_0P_2	Uninoculation + 90 kg P_2O_5 ha^{-1}
T_3	M_0P_3	Uninoculation + 120 kg P_2O_5 ha^{-1}

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T_4	M_1P_1	*G. fasciculatum* + 60 kg P_2O_5 ha $^{-1}$
T_5	M_1P_2	*G. fasciculatum* + 90 kg P_2O_5 ha $^{-1}$
T_6	M_1P_3	*G. fasciculatum* + 120 kg P_2O_5 ha $^{-1}$
T_7	M_2P_1	*G. mosseae* + 60 kg P_2O_5 ha $^{-1}$
T_8	M_2P_2	*G. mosseae* + 90 kg P_2O_5 ha $^{-1}$
T_9	M_2P_3	*G. mosseae* + 120 kg P_2O_5 ha $^{-1}$
T_{10}	M_3P_1	*G. intraradices*+ 60 kg P_2O_5 ha $^{-1}$
T_{11}	M_3P_2	*G. intraradices* + 90 kg P_2O_5 ha $^{-1}$
T_{12}	M_3P_3	*G. intraradices* + 120 kg P_2O_5 ha $^{-1}$

2.2 Data collection

2.2.1. Days to flower bud initiation

The number of days taken from the date of transplanting to the date of appearance of first flower bud was counted as days to flower bud initiation

2.2.2 Days to 50% of flowering (days)

The number of days required for 50 per cent of the plants to produce first flower in each plot was recorded by counting the days from the date of sowing.

2.2.3 Flowering duration (Days)

The total number of flowering days was counted from the day of flower bud initiation to the complete cessation of flowering in the plant.

III. RESULTS AND DISCUSSION

The data on days to flower bud initiation, Days to 50% of flowering and Flowering duration as influenced by inoculation of *Glomus* fungi at different levels of P is presented in the Table 1.

3.1 Result

The interaction effect of inoculation of *Glomus* fungi and P-fertilization was found to be non-significant on days to flower bud initiation. It was decreased with the increase in P level at 120 kg/ ha in uninoculated control. However, the inoculated plants flowered earlier with given P at 90 kg/ ha. The least days taken to first flowering was recorded with the inoculation of *G. fasciculatum* and given P at 60 kg/ ha (30.47 days) as compared to other species of *Glomus* fungi and the uninoculated control plants applied with P at 120 kg/ ha and more days were found to be observed in uninoculated control plants with given P at 60kg/ ha (44.80 days)

The interaction effect of inoculation of *Glomus* fungi and P-fertilization was found to be significant in days to 50% of flowering. It was decreased with the increase in P levels up to 120 kg/ ha uninoculated control. However, the inoculated plants flowered earlier with the given P at 90 kg/ ha. However, the least days taken to 50% flowering was recorded with the inoculation of *G. fasciculatum* and given P at 90 kg/ ha (48.73 days) as

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compared to the other species of *Glomus* fungi and uninoculated control plants with given P at 120 kg/ ha and more days were observed in control plants with given P at 120 kg/ ha (57.20 days).

The interaction effect of inoculation of *Glomus* fungi and P-fertilization was found to be significant on flowering duration. It was increased with the increase in P levels up to 120kg/ ha in uninoculated control. However, the inoculated plants had maximum flowering duration with the given P at 90 kg/ha. The maximum flowering duration was recorded with the inoculation of *G. fasciculatum* and given P at 90 kg/ ha (66.60 days) and it was closely followed by *G. mosseae* (66.00 days) at the same level as compared to the other species of *Glomus* fungi and uninoculated control plants. The minimum flower duration was observed in uninoculated control plants with given P at 60 kg/ ha (50.53 days).

3.2 Discussion

Glomus fungi influenced the days to flower bud initiation and flowering duration in the inoculated plants. In the present study the plants inoculated with *G. fasciculatum* flowered significantly earlier and has maximum flowering duration as compared to other species of *Glomus* fungi and uninoculated control (Figure 1). The same trend was observed in the plants inoculated with *G. fasciculatum* and given P at 90 kg/ ha (48.73 days and 66.60 days, respectively) as compared to uninoculated control plants applied with P at 120 kg/ ha (57.20 days and 61.47 days, respectively). Kandasamy *et al*., (1986), observed that the inoculated plants flowered early by 7-10 days. A similar trend was observed by Daft and Okusanya (1973) in petunia.

Phosphorus induced early flowering in marigold *i. e.*, lesser number of days to 50 per cent flowering. Delay in flowering due to phosphorus deficiency was observed by Bose and Das (1996) in aster, zinnia and salvia

Table 1: Effect of inoculation with VAM fungi at different P levels on flowering parameters of *Tagetes erecta* L.

Treatment	Days to flower bud initiation	Days to 50% of flowering	Flowering duration (days)
Mycorrhiza			
M_0 - Uninoculated control	41.96	56.13	57.16
M_1 - *Glomus fasciculatum*	35.38	50.80	60.64
M_2 - *Glomus mosseae*	40.71	52.47	59.62
M_3 - *Glomus intraradices*	44.40	55.29	52.67
S.Em ±	NS	0.03	0.05
C.D. (P=0.05)	NS	0.10	0.14
Phosphorus levels (kg/ha)			
P_1 - 60	30.53	39.76	39.50
P_2 - 90	29.64	39.31	46.11
P_3 - 120	31.21	41.69	43.81

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S.Em ±	NS	0.03	0.03
C.D. (P=0.05)	NS	0.07	0.10
Interaction (MXP)			
M_0P_1 - Uninoculated control + P @ 60	44.80	54.80	50.53
M_0P_2 - Uninoculated control + P @ 90	40.73	56.40	59.47
M_0P_3 - Uninoculated control + P @ 120	40.40	57.20	61.47
M_1P_1 - *Glomus fasciculatum* + P @ 60	30.47	50.93	52.33
M_1P_2 - *Glomus fasciculatum* + P @ *90*	36.73	48.73	66.60
M_1P_3 - *Glomus fasciculatum* + P @ 120	38.93	52.73	63.00
M_2P_1 - *Glomus mosseae* + P @ 60	42.80	52.40	55.13
M_2P_2 - *Glomus mosseae* + P @ 90	37.40	49.40	66.00
M_2P_3 - *Glomus mosseae* + P @ 120	41.93	55.60	57.73
M_3P_1 - *Glomus intraradices* + P @ 60	44.73	53.93	52.67
M_3P_2 - *Glomus intraradices* + P @ 90	43.20	55.13	53.87
M_3P_3 - *Glomus intraradices* + P @ 120	45.20	56.80	51.47
S.Em ±	NS	0.10	0.14
C.D. (P=0.05)	NS	0.30	0.41

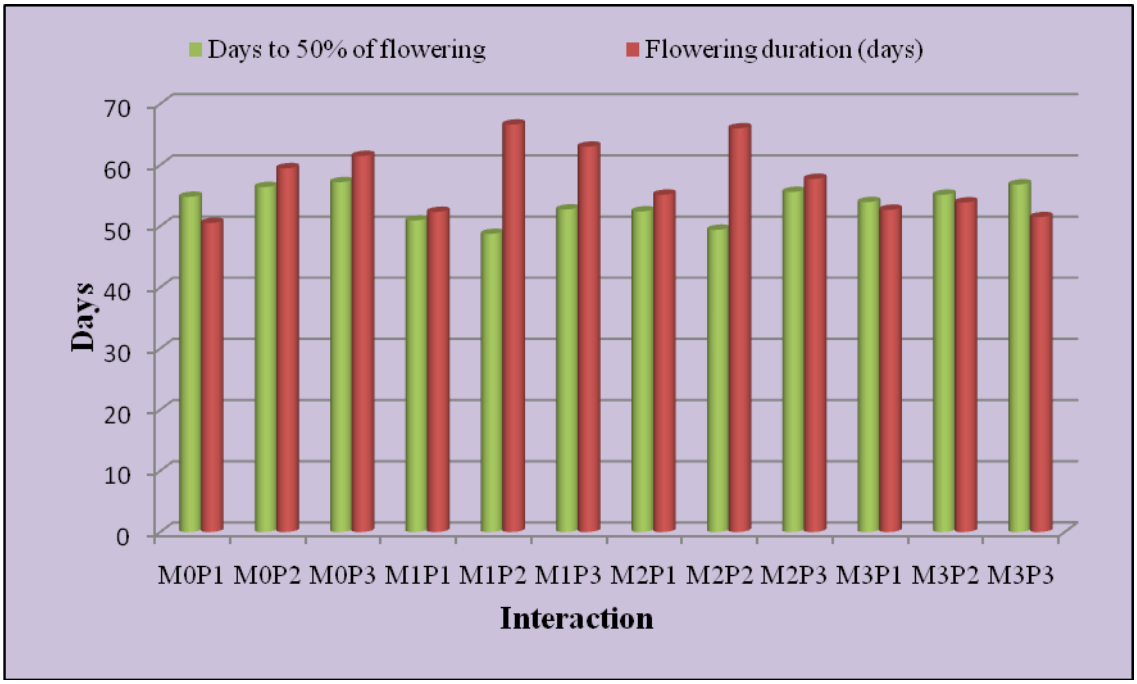

Figure 1: Effect of inoculation with VAMfungi at different P levels on flowering parameters of *Tagetes erecta* L.

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M_0 - Uninoculated control

M_1 - *Glomus fasciculatum*

M_2 - *Glomus mossae*

M_3 - *Glomus intraradices*

P_1 – 60 kg P_2O_5 ha $^{-1}$

P_2 – 90 kg P_2O_5 ha $^{-1}$

P_3 – 120 kg P_2O_5 ha $^{-1}$

IV.CONCLUSION

The least days taken to first flowering, the least days taken to 50% flowering and maximum flowering duration were recorded with the inoculation of *G. fasciculatum* and given P at 90 kg/ ha (36.73, 48.73, 66.60 days, respectively) as compared to uninoculated plants supplied with P at 120 kg ha^{-1}. This indicates the possibility of reducing P fertilizer application by 25 % of the recommended dose to marigold by inoculation with a suitable strain of VAM fungi, i. e., *G. fasciculatum* and *G. mosseae*.

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