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ORIGINAL ARTICLE

The Effect Of Phosphorus on the Productivity of Feverfew (Tanacetum parthenium (L.)Schultz Bip).

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ABSTRACT

Field trials were carried out in a semi-arid climatic area in Iran through two successive seasons of 2004 and 2005 to determine the effect of phosphorus (P) on the productivity of feverfew (*Tanacetum parthenium* L.), an important medicinal plant. Phosphorus was band-placed at the rates of 0, 50, 100 and 150 Kg/ha at planting time. Results indicated that growth parameters and essential oil concentration increased with increasing the P levels. Application of 100 kg/ha P significantly increased the fresh and dry weights, plant height and flower numbers per plant. All P as compared with the control significantly enhanced the essential oil concentration. Moreover the role of phosphorus as a central and pivotal metabolic and regulatory nutrient element has been discussed.

Key words: Feverfew, phosphorus, essential oil, growth parameters.

Introduction

Feverfew is a perennial herbaceous plant belonging to the Asteraceae family. It is mainly used for the prevention and moderation of the frequency and severity of migraine headaches (Johnson *et al*., 1985) and as an anti-inflammatory in rheumatoid arthritis (Patrick *et al*., 1989). Feverfew has also been traditionally used for anaemia, earache, and indigestion; as an abortifacient and as a remedy to eliminate parasites from the intestines (Johnson *et al*., 1985, Chevallier, 2001). Since feverfew is an important medicinal plant, any study as related to the cultivation aspects of this plant is of prime interest. It is clear that environmental factors have a great impact on the productivity of this plant (Fonseca *et al*., 2006). In commercial medicinal plant production, the main objective is to produce high biomass yields per hectare with high levels of secondary metabolites. Nutritional requirements have a major effect on the yield and growth of all horticultural and agronomic crops (Default *et al*., 2003). On the other hand the level of secondary metabolites in medicinal plants may be positively or negatively affected by the kind and amount of nutrient elements. Phosphate plays a central, pivotal metabolic and regulatory role on the nexus of several physiological and biochemical processes in plants, including photosynthesis, energy conservation, inter- and intra-cellular co-ordination of carbohydrate metabolism (Abel, 2002) and in energy transfer (Harley, 1971).

Trivino and Johnson, (2000) have reported that total yield of volatile oil of (*Origanum majorana* L.) was increased by 50% as P was increased up to 3.0 mM in soil solution (Trivino and Johnson, 2000). Moreover, the fresh and dry weights were increased twofold by P treatment as compared to the control. Ichimura *et al*., (1995) observed that P significantly increased the fresh weight and essential oil concentration in Sweet basil (Ichimura *et al*., 1995). Similar results have been noted with black cumin (*Nigella sativa*) and coriander (*Corianderum sativum*) by several workers. (Das *et al*., 1991; Ughreja and Chundawat, 1992). The main objective of present study was to investigate the effects of different P levels on the yield and essential oil concentration of feverfew.

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Table 1: Some physical and chemical characteristics of the experimental soil

EC dS m^{-1}	pH	O.C[1] (%)	T.N (%)	P (mg kg^{-1})	K (mg kg^{-1})	Silt (%)	Sand (%)	Clay (%)
2.1	6.7	1.59	0.64	10.4	152	18	68	14

1-Organic matter 2-Total Nitrogen

Materials and Methods

Plant Material

The seeds of feverfew were provided by Zardband Pharmaceutical Company located in Tehran, Iran. This experiment was carried out at the Research Station, College of Agriculture, Tarbiat Modares University (TMU) in the suburb of Tehran, Iran. The station is located at 1215 m above sea level, latitude 35°, 48° north. Plants were grown in sandy loam, with good drainage. Some of physicochemical characteristics of the soil are shown in Table 1. The experiment was arranged as a randomized complete block design (RCBD) with three replications in 2004 and 2005. The treatment consisted of 4 P rates (0, 50, 100, 150 kg ha^{-1}) as triple super phosphate. Phosphorus was band-placed in two rows, 100 mm deep and 150 mm apart at each site. The seedlings of equal height and vigour were hand transplanted from the nursery bed to the field on April 15. Each plot was of 2 m^2. The seedlings were planted between the fertilizer bands in rows, 30 cm apart and there was 20 cm distance between every plant. All plots were furrow irrigated immediately after transferring the seedlings to the field. Irrigation was carried out every day for one week to establish the seedlings in soil. Hoeing and mechanical weeding were done as needed.

Plant height was measured at the full flowering stage. Large foliar mounds with flower stalks were harvested with a sharp knife, leaving about 5 cm above the ground surface and placed in a paper bag. The fresh weight and flower number were recorded. All samples were air dried. The dry weight of all samples was measured and the essential oil was extracted by subjecting flowers and leaves (40 g, 3 times) to hydro-distillation for 3 h using an all glass Clevenger-type apparatus, according to the method outlined by the European Pharmacopoeia (Anonymous, 1996). The concentration of oil expressed as percentage w/w in dry matter. Data were subjected to analysing variance and means were compared using Duncan's New Multiple Range Test (DNMRT).

Results and Discussion

Results

The combined statistical analysis of both years showed that plant height, flower numbers per plant, fresh and dry weights and essential oil concentration increased significantly by soil P application as compared to control ($p \leq 0.05$).

The data of both years demonstrated that soil P fertilization had a significant effect on the mean of plant height, flower numbers per plant, fresh weigh, dry weight and essential oil concentration with respect to control (Figures 1,2,3,4,5). However, dry weight significantly increased with increasing P level up to 100 kg /ha (Fig 4).

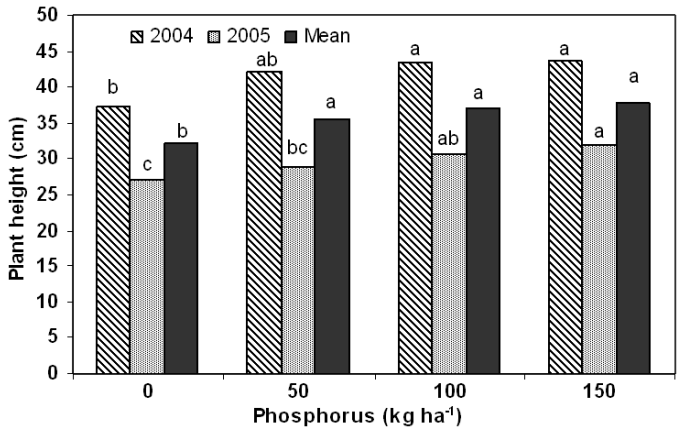

Fig. 1: Effect of phosphorus on the plant height of *Tanacetum parthenium* at $p \leq 0.05$ in 2004 and 2005. Means followed by the same letter are not significantly different, as indicated by DNMRT.

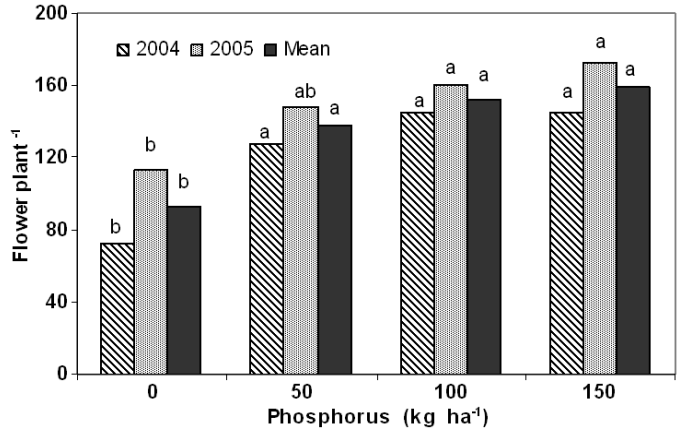

Fig. 2: Effect of phosphorus on the flower numbers of *Tanacetum parthenium* at $p \leq 0.05$ in 2004 and 2005. Means followed by the same letter are not significantly different, as indicated by DNMRT.

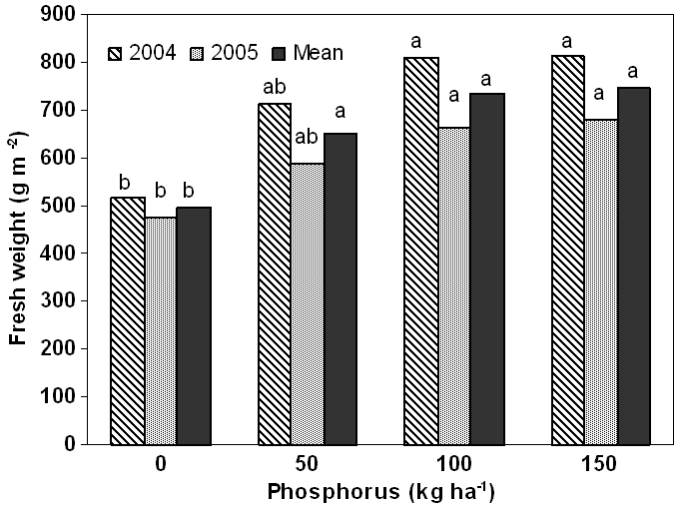

Fig. 3: Effect of phosphorus on the fresh weight of *Tanacetum parthenium* at $p \leq 0.05$ in 2004 and 2005. Means followed by the same letter are not significantly different, as indicated by DNMRT.

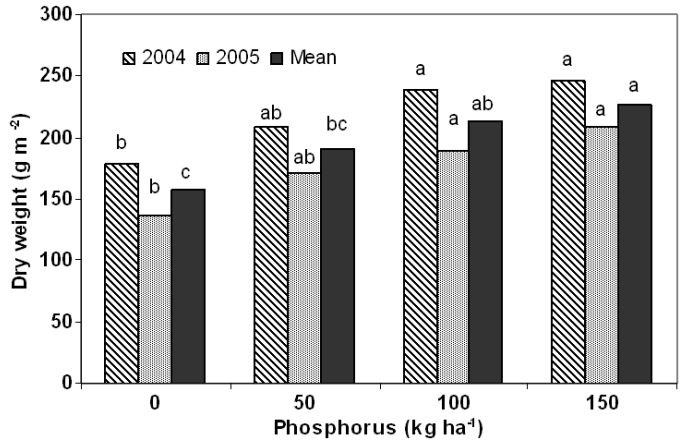

Fig. 4: Effect of phosphorus on the dry weight of *Tanacetum parthenium* at $p \leq 0.05$ in 2004 and 2005. Means followed by the same letter are not significantly different, as indicated by DNMRT.

No further response was obtained with higher P rate. In the present study, the lowest and highest amounts of essential oil was recorded with o and 150kg P/ha^{-1} respectively. However, there was no significant difference between 100 and 150 kg P/ha^{-1} on the essential oil concentration.

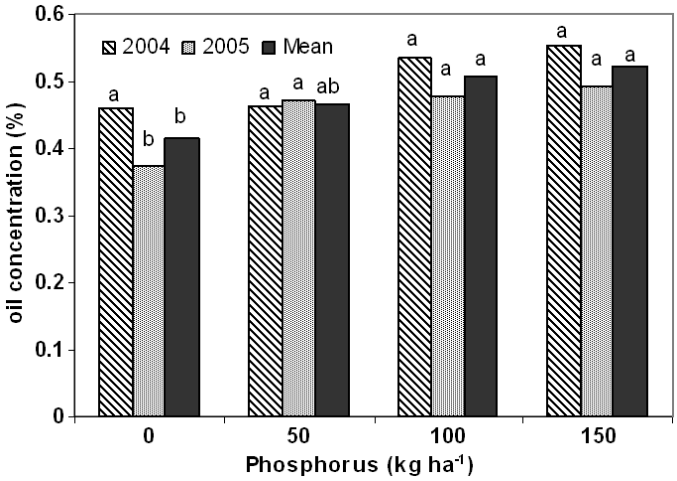

Fig. 5: Effect of phosphorus on the essential oil concentration of *Tanacetum parthenium* at $p \leq 0.05$ in 2004 and 2005. Means followed by the same letter are not significantly different, as indicated by DNMRT.

Discussion

The data of this investigation showed that all growth parameters were positively affected by phosphorus application. Phosphorus significantly increased fresh and dry matter, flower numbers, plant height and essential oil concentration. The total dry matter is an important criterion for crop production. The most effective P rate was 100 kg/ha and increasing the amount of phosphorous to 150 kg/ha did not significantly affect either the morphological characteristics or essential oil concentration in feverfew. These results are similar to those of Salardini *et al*., (1994) with pyrethrum (*Tanacetum cinerariifolium*) who reported that application of 100 kg P/ha significantly increased achenes and pyrethrin yield for this crop (Salardini *et al*., 1994). They are also in agreement with the data of Nikolova *et al*., (1999) who showed P fertilization increased the essential oil concentration of chamomile (Nikolova *et al*., 1999) and with Nilbe *et al*., (2005) who observed increasing biomass of chamomile (Nilbe *et al*., 2005). It is well documented that phosphorus is an essential element in reproductive and vegetative growth of plants (Marschner, 1986) and thus, the vegetative growth and flower numbers stimulation and increased by applied P was expected in our study. Phosphorus is also known to have multifarious cellular functions in plants, including: signalling and transmembrane metabolic flux and therefore, the secondary metabolism is modulated by these mechanisms (Ram *et al*., 2003). In conclusion, it appears that P is a crucial nutrient element for feverfew cultivation. Therefore, it is strongly recommended that on sites low in available P, the crop be supplied with adequate P. Furthermore, the authors suggest that the influence of P soil addition on the growth, chemical composition and biochemical indices of feverfew be thoroughly studied on locations with wide range of climatology, physical and chemical properties and mineralogical characteristics.

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