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Influence of rate and method of phosphorus placement to Garlic (*Allium sativum* L.) in a Mediterranean environment

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Abstract

A trail was conducted to study the effect of rate and method of phosphate placement on the yield of garlic under semi-arid conditions of Mediterranean environment in north Jordan. Factorial experiment with four levels of phosphorus (0, 25.0, 50.0 and 75.0 kg P ha-1) and two methods of placement (banding and broadcast) with three replicates revealed high yields with P application (75 kg P ha-1) drilled with the garlic cloves after cultivation (banded) in comparison with that of lower rates of banded and all other doses applied as broadcast application.

Key words: Garlic, Allium sativum L., phosphorus, application rate, placement, Mediterranean climate

Introduction

Garlic (*Allium sativum* L.) is an important spice crop grown throughout the Mediterranean countries. The production of garlic under a particular set of environmental conditions is influenced by various agronomic factors. Among these, selection of cultivar, fertilizer rate and method of fertilizer placement are most important. This crop needs an ample supply of readily available nutrients for optimum growth and yield. Garlic crop can be reasonably responsive to P fertilization, particularly in low available P soils.

Phosphate deficiency is common in the calcareous soils, which encompass more than 50% of the total cultivated area of the Mediterranean region (Kassam, 1981). Field trials conducted on these soils have demonstrated significant and economic responses to phosphate fertilizers (Cooper, 1983; Harmsen, 1984).

Several points are considered to obtain profitable results in crop growth of which the amount, method and time of application. Turk and Tawaha (2002a), showed a significant effect of P placement method to onion. In Australia, phosphate is applied to the surface of the soil, although there have been few studies on the relative effectiveness of this method for crop and pasture species (Ozanne et al., 1976). The advantage of band application over broadcasting for lentil has been reported by Turk and Tawaha (2002b). However, the information on garlic very limited. Currently, most farmers using phosphate on garlic crop broadcast and incorporate the fertilizer prior to seeding. However, several authors have demonstrated that the method of placement could affect the phosphate recovery and yield.

Phosphorus application influences plant growth and this has been investigated in many crops under many soils and environmental conditions but information concerning calcareous soils in the Mediterranean region for garlic is still inadequate,

Table 1. Growth, yield and quality as affected by rates and methods phosphorus of application

Treatments	Plant height at 120 days of planting	Bulb Length (cm)	Bulb diameter (cm)	Clove breadth (cm)	Clove length (cm)	No of cloves/ bulb	Garlic dry weight g m^{-2}
P rate (kg ha^{-1})							
P0 (0)	51.0	3.05	2.80	2.60	3.15	12.0	540.0
P1 (35.0)	56.0	3.35	3.15	2.95	3.45	12.5	585.0
P2 (52.5)	62.0	3.40	3.45	3.25	3.50	12.5	681.5
P3 (70.0)	66.0	3.45	3.55	3.30	3.55	13.5	740.5
LSD (p= 0.05)	4.0	0.05	0.30	0.28	0.20	1.0	40.0
P placement method							
Band	56.3	3.20	3.13	2.90	3.30	12.0	612.3
Broadcast	61.3	3.42	3.35	3.15	3.53	13.25	661.3
LSD(p= 0.05)	3.9	0.11	0.20	0.21	0.30	1.1	43.0
Interaction	NS	NS	NS	NS	NS	NS	NS

NS, not significant

regardless of the fact that these soils inhabit a high proportion of the cultivated areas. The aim of the present investigation was to study the effect of rate and method of phosphate placement on the yield of garlic under Mediterranean environment.

Materials and methods

The trials were carried out at a field site of the Jordan University of Science and Technology campus (JUST) in northern Jordan (32o 34′ N latitude; 36o 01′ E longitude; and 520 m altitude), during 1999-2000 and 2000-2001 growing seasons. The JUST location typically experiences moderate to severe drought stress during the cropping season of garlic. It has Mediterranean climate (mild rainy in winter and dry hot in summer). The soils were shallow, and a silty caly, montmorillonitic, thermic, typic Chromoxerert. Qudah and Jaradat (1988) considered this soil to be at the dry end of xeric moisture regime. The pH was 8.1 and organic matter 0.96%. Available phosphorus ranged from 23 to 60 kg ha^{-1}, the available N was 1.1 g kg^{-1} soil, and K was 436.40 mg kg^{-1}. The experiment consisted of three replicates in a factorial design with four levels of phosphorus (0, 25.0, 50.0 and 75.0 kg P ha^{-1}) and two methods of application (banding and broadcast). Phosphorus was supplied in the form of superphosphate (21% P). The phosphate fertilizer was either broadcast, rotovated into the surface layer just before planting (broadcast) or drilled with the cloves after cultivation (banded). In band placement the fertilizer was applied in bands a little below and a two to three inches to one side of the cloves. Band placement was used due to relatively large spaces between the rows and soils in which there were chances of phosphate fixation which is common in the Jordanian calcareous soils.

Garlic cloves of a local variety were planted 8 cm deep spaced at 20 x 20 cm in the both years. Plots of 2.5 x 4.0 m separated by 0.5 m buffer area were planted with garlic cloves on Dececember 1, 1999, and December 9, 2000. Nitrogen fertilizer was applied uniformly by hand across all treatments [20 kg N ha^{-1} at planting in form of Urea (46 % N) and 40 kg N ha^{-1} top-dressed at 50 days after planting]. Weeds were controlled manually as and when needed. The measured variables included: plant height at 120 days of planting, bulb length (cm), bulb diameter (cm), clove length (cm), clove breadth (cm), number of cloves/ bulb, and garlic dry weight (g m^{-2}).

Collected data were subjected to analysis of variance (ANOVA) using the MSTAT statistical software developed by Michigan State University (1985). Means were separated using the least significant differences (LSD) test at $p \leq 0.05$.

Result and discussion

The main source of yield variation in Mediterranean region is variable rainfall. The trials were conducted under supplementary irrigation; thus, no significant interaction between seasons was noticed. Therefore, the presented results are means across the two growing seasons. Garlic (Allium sativum) responded well to P application. At low rates of applied P (P0 and P1) garlic exhibited some P deficiency symptoms which include dwarf growth and purpling of the leaves; such effects were absent at high P rates (P2 and P3). As compared with control, plant height at 120 days of planting, bulb length, bulb diameter, clove length, clove breadth; number of cloves per bulb and bulb dry weight were significantly increased with P application. It was superior at P3 than at either P0 or P1.

Clove length was not increased by P placement methods. On the other hand, plant height at 120 days of planting, bulb length, bulb diameter, clove breadth, number of cloves per bulb and bulb dry weight were significantly greater with band placement than with the broadcast methods of phosphorus application. The superiority of band placement was probably due to a combination of higher available soil moisture and a greater probability of roots being exposed to the fertilizer.

Most of the time, P application by band placement is more effective because it was more likely to be in contact with moist soil. Moreover, band placement increases the possibility of root contact, as roots have a tendency to grow downward in garlic.

Based on above results, it can be concluded that bulb yield of garlic can be significantly improved further with the addition of P to soils of medium available P status (10 mg Olsen's P kg^{-1} soil). It also showed a significant effect of P placement method (banded).

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