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Yerfıstığında Tohuma Fungusit Muamelesi ile Mikroelement ve Pix Uygulamalarının Verim ve Verim Bileşenleri Üzerine Etkileri

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Öne Çıkanlar:
- Yerfıstığında Pix uygulaması
- Yerfıtğında yaprak gübresi uygulaması
- Yerfıstığında Tohuma fungusit uygulaması

Anahtar Kelimeler:
- Mepiquat chloride
- Meyve verimi
- Tohum ilaçlaması
- Yaprak gübresi
- Yerfıstığı

ÖZET:

Yerfıstığında çiçeklenme öncesi ve çiçeklenme sonrası dönemlerde sıvı mikroelement ve Mepiquat Chloride uygulaması ile toprak zararlıları, toprak kökenli patojenik funguslara karşı tohum ilaçlaması yapılarak verimi artırmak amaçlanmıştır. Doğu Akdeniz Bölgesi'nde iki yıl süre ile yürütülen bu çalışmada ekim öncesi toprak zararlıları ve toprak kökenli patojen funguslara karşı tohum ilaçlaması, farklı gelişme dönemlerinde yapraktan mikro element ve bitki büyüme düzenleyicisi Pix (mepiquat chloride) uygulanmıştır. Ekim öncesi Vitavax (200 g/L Carboxin + 200 g/L Thiram) 400 g/L 100 tohum, Gaucho (600 g/L Imidacloprid) 800 g/L 100 kg tohum, Fertilon Combi (Fe, Zn, B, Mn, Cu, Mn ve Mo) 1000 g /ha and 150 cc /ha Pix dozlarından oluşan kombinasyon denenmiştir. Fungusit ve insektisit tohum ilaçlaması ekimden önce yapılmıştır. Mikroelement ve Pix kombinasyonları çiçeklenme başlangıcı, çiçeklenme sonrası ve çiçeklenme başlangıcı + çiçeklenme sonrası uygulanmıştır. Tohum iç oranı, 100 tohum ağırlığı ve meyve verimi bakımından en iyi sonuçlar Pix + Fertilon Combinin çiçeklenme sonrası yapraklara püskürtülerek yapılan uygulamadan elde edilmiştir. Bunu Goucho + Vitavax tohum ilaçlaması ve çiçeklenme sonrası yapraklara Pix püskürtülmesi uygulaması izlemiştir. Bu çalışmada ekim öncesi Goucho + Vitavax tohum ilaçlaması ve çiçeklenme öncesi, çiçeklenme sonrası ve çiçeklenme öncesi + çiçeklenme sonrası dönemlerde Pix, Fertilon Combi ve Pix + Fertilon Combi uygulamalarının genelde verim artışına katkı sağladığı görülmüştür.

Effect of Seed Fungicide Treatment, Microelement Fertilizer and Mepiquat Chloride Applications on Yield and Yield Components of Peanut

Highlights:
- Mepiquat chloride application in Peanut
- Foliar fertilizer application in Peanut
- Fungicide application to peanut seed

Keywords:
- Foliar fertilization
- Mepiquat chloride
- Peanut
- Pod yield
- Seed treatment

ABSTRACT:

Seed treatment against soil pests and soil-borne pathogenic fungi, foliar application of microelement and mepiquat chloride at flowering and after flowering periods promise to increase peanut (*Arachis hypogaea* L.) yield. A two-year field study was conducted to test this hypothesis by seed fungicide and insecticide treatment, foliar micronutrient and mepiquat chloride (Pix) applications at different combinations and different growth stages of peanut in the eastern Mediterranean region. The treatments were different combinations of Vitavax (200 g/L Carboxin + 200 g/L Thiram) 400 g/L 100 kg seed, Gaucho (600 g/L Imidacloprid) 800 g/L 100 kg seed, Fertilon Combi (Fe, Zn, B, Mn, Cu, Mn and Mo) 1000 g /ha and Pix (150 cc /ha mepiquat chloride). Peanut seeds were treated with fungicide and insecticide before planting. Microelement fertilizer and Pix combinations were applied at the beginning of flowering, after flowering and at the beginning of flowering + after flowering. The best results for seed kernel ratio, 100 seed weight and pod yield were obtained from Pix + Fertilon Combin treatment after flowering. This treatment was followed by Goucho + Vitavax seed treatment before planting + Pix application after flowering. In this study, it was observed that Goucho + Vitavax seed treatment and Pix, Fertilon Combi and Pix + Fertilon Combi applications at flowering, after flowering and at flowering + after flowering applications generally contributed pod yield increases.

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INTRODUCTION

Peanut (*Arachis hypogaea* L.) is a member of the Leguminosae family and subfamily Papilinoideae. Peanut is an annual oil seed crop that originated from South America, Mexico and Central America and is now cultivated throughout the tropical and warm temperate regions of the world (Yayock et al., 1998; Sharma and Mathur, 2006; Bertioli et al., 2011). World peanut production was approximately 47 million metric tons in 2020, with the largest production in the China, India, Nigeria, USA and Senegal (Anonymous, 2021). Peanut has rich source of oil (47%-53%) and protein (25%-36%) as well as minerals, antioxidants and vitamins (Jordan et al., 2017). Peanut is widely used to produce peanut butter, nut-based snacks and protein-rich foods in the food industry.

The microelements that the peanut needs in trace amounts play an important role in the metabolic processes. Peanut is highly sensitive to boron (B), zinc (Zn) and iron (Fe) copper (Cu), manganese (Mn), molybdenum (Mo) deficiencies (Murata, 2003; Zuo and Zhang, 2011). Although plants require small amount of microelements but they play crucial roles in growth and development. Soil is the main source of both macro and microelements that peanut require its growth and development. Some of the macro and microelements may not be available in proper amount in the soil due to numerous factors such as leaching and degradation, decomposition and insolubility. Therefore, essential plant nutrients must be supplied for adequate growth and development. Compared with macro elements, foliar application of microelements performs best on growth, development and yield of many crops. Foliar nutrient applications are more beneficial when the soil conditions decrease mobility and nutrient absorption. Foliar application of micronutrients is easily practiced to correct nutrient deficiencies. Foliar nutrient applications promote root absorption of plant nutrients by improving root growth (Meena et al., 2007). Foliar application of N, Mn, Cu, and B on peanut indicated beneficial effects on pod yield and quality (Hardy and Havelka, 1977).

Iron shortage in calcareous soils is one of the greatest challenges which farmers encounter while growing plants. The soils of Çukurova plain is quite rich in calcium bicarbonate and soluble calcium whose pH values are generally higher than 7. Therefore, iron fertilization for peanut has great importance for satisfactory yield. Since in calcareous soils, less than 10% of the iron is available to plants (Mortvedt, 1991). The foliar application of Fe fertilizer is effective to supply iron for peanut. Most of the foliar iron fertilizers are spread as chelated-Fe fertilizer, inorganic-Fe fertilizer, and organic-Fe fertilizer (Laurie et al., 1991). Iron is required for chlorophyll synthesis, energy transfer, nitrogen fixation and reduction, and in many metabolisms such as respiration and photosynthesis processes (O'Hara et al., 1988; Panhwar, 2005). Therefore, iron deficiency in peanut reduces the pod number per plant and pod yield seed yield to decrease (O'Hara et al., 1988). Iron fertilizer spraying increased peanut yield up to 42 % in alkaline and calcareous soils (Singh and Dayal, 1992). In Çukurova region, iron deficiency chlorosis is still common problem in NC-7 peanut cultivar producing areas. The common varieties of Fe fertilizers are inorganic-Fe fertilizer, chelated-Fe fertilizer, and organic-Fe fertilizer (Laurie et al., 1991).

Zinc is one of the most substantial nutrients required for peanut growth and development as well as chlorophyll production, pollen function and germination (Brown et al., 1993; Marschner, 1993; Fageria et al., 2002). Root nodulation, chlorophyll content and pod yield increases were recorded with the Zn application in the Zn deficient soils. Pod yield reduction varied between 13 and 20%, depending on the Zn deficiency level of the soil (Singh et al., 2004). Foliar application of Zn element could repair zinc shortage. Highest seed yield, oil and protein content were reported with the foliar application of

1000 mg/L as Zn sulphate (Darwish et al., 2002; Ali and Mowafy, 2003; El Habbasha et al., 2013; Irmak et al., 2016; Christopher et al., 2019).

Molybdenum is essential for nitrogen fixation and it was recommended for some legume crops but controversial findings on peanut yield were reported. Zheng et al. (2011) and Crusciol et al. (2019) reported yield increase with the application of molybdenum while Caires and Rosolem (1995) and Silva et al. (2009); Silva et al. (2012) reported any increase on peanut yield.

Boron is one of the highly mobile elements that quickly leaches from the soil. A typical boron deficient peanut has an internal nut damage known as hollow-heart, a boron-specific disorder that highly reduces the kernel quality and value up to 65% (Cox and Reid, 1964; Singh et al., 2004; 2007). Boron deficiency affects nitrogen fixation, which is the main source of nitrogen for peanut. When boron deficiency occurs yield loses up to 50 % can be seen (Singh et al., 2004; 2007).

Manganese is an essential element for peanut growth and development (Gascho and Davis, 1995), since it serves as a cofactor in kinase and transferase enzymatic reactions (Horst, 1986). Manganese deficiency occurs only on soil with high pH levels (Gascho and Davis, 1995). In the manganese deficient soil, the interveinal chlorosis is a typical deficiency symptom. Manganese deficiency can be corrected more rapidly with the foliar manganese application. Peanut yield increase was recorded with application of manganese (Parker and Walker, 1986). Copper is a micronutrient that is very rarely applied to agronomic crops as a nutrient, since it becomes toxic at high concentrations (Ali et al., 2015). In general, copper fertilization is not applied to peanut and yield increase has not been reported yet.

Plant growth regulators can control or modify growth and development of peanut (Khan et al., 2011). Mepiquat chloride (Pix), which is a gibberellin acid inhibitor, inhibits cell elongation and limits overgrowth in plants. It also decreases the length of internodes and partially leaf area in plants and increases the concentration of chlorophyll in plant leaves. The use of growth regulators such as Pix to decrease plant height alters plant morphology and can alter assimilate partitioning in favor of seed growth by increasing radiation utilization efficiency. On the other hand, many PGR substances are also widely utilized in cereals and oilseed crops to facilitate harvesting and increase yield and quality. For this reason, they are thought to have high potential in many plants (Daniels et al., 1982).

The objectives of the study were to investigate the effects of seed fungicide treatment, foliar micronutrient and mepiquat chloride (Pix) application on yield and yield components of peanut in the eastern Mediterranean type of environment.

MATERIALS AND METHODS

A 2-years field experiment was conducted at the East Mediterranean Agricultural Research Institute (36°48' N and 35°17' E, 7 m msl) in Adana, Turkey during 2000 and 2001. Soil samples were taken before planting in a depth of 0-30 cm to determine the physical and chemical properties of the soil. The pH of the soil was measured using a pH meter (Model: HANNA HI 8520) after mixing with distilled water a ratio of 1:2.5. Electrical conductivity was measured in triplicate using a conductivity meter (Model: HANNA HI 9812-5) after mixing with the ratio 1:2.5 soil to distilled water. The $CaCo_3$ content was determined volumetrically by Scheibler calcimeter method (Carter, 1993). Soil texture of the soil was determined with the hydrometer method (Gee and Bauder, 1986). The soil at the experimental area was alkaline-calcareous with fine textured silty clay loam in nature and low in organic matter (about 1%), calcium carbonate (30.31- 31.30 %) and electrical conductivity (1.12, 1.733 dS m^{-1}), low in available P_2O_5 (0.23- 3.10 ppm) and K_2O (38.51 -123.18 ppm) (Table 1).

Table 1. Some Physical and Chemical Properties of The Experimental Soil

Soil depth (cm)	Sand (%)	Silt (%)	Clay (%)	Soil texture	$CaCo_3$ (%)	pH	Ece dS m^{-1}	Total salt (%)	Available (ppm)	
									P_2O_5	K_2O
0-30	16.1	39.6	44.3	*SiC	31.50	7.6	1.33	0.055	3.10	123.18
30-60	10.5	48.0	41.5	SiC	30.64	7.9	1.12	0.044	0.23	43.24
60-90	10.8	55.2	34.0	**SiCL	30.49	7.8	1.21	0.051	0.31	38.51
90-120	35.7	42.1	22.2	***L	30.31	7.6	1.18	0.039	0.39	40.74

*SiC: Silty-Clay; **SiCL: Silty-Clay-Loam; ***L: Loam

The experimental site has a typical Mediterranean climate characterized by hot and drought summer. The average temperature for the May to September was 25 °C, the average sunshine duration was 10 h, and the average relative humidity was 66%.

The experiment was laid out in a randomized complete block with three replicates in each year. The experimental field was fertilized with 50 kg /ha N, 20 kg /ha P before planting. The seeds were planted in rows 0.7 m apart, with 0.25 m between plants in each row. Plots consisted of four 6-m rows that were end-trimmed to of 5 m prior to harvest. The peanut crop was harvested at 85% pod maturity according to shell out method. All plots were irrigated with furrow irrigation approximately every 2 weeks, starting from the flowering stage. At harvest, peanut yield was determined by harvesting two rows from the center of each four-row plot. Yields were adjusted to kg /ha at 12% moisture level. In plots, pods were separated from the plant by hand and the pods were shelled after one-week air drying then shelling rate (%), 100 seed weight (g) and Pod weight (kg /ha) were determined.

Virginia type peanut cultivar NC-7 was used as plant material. Cultivar NC-7 has large seeds and pods, semi spreading growth habit, alternating pairs of reproductive axes on the branches. The peanut seeds were treated with Vitavax 200 FF (200 g/L Carboxin + 200 g/L Thiram) and with 600 g/L Gaucho FS (600 g/L Imidacloprid) 600 insecticide before planting. Fertilon Combi (B 1.5%, Cu EDTA chelate 0.6%, Fe EDTA chelate 4%, Mn EDTA chelate 3%, Mo EDTA chelate 0.05%, Zn EDTA chelate 4%) was used as foliar fertilizer. The application doses of Goucho fungicide was 800 g 100 k/g seed, Vitavax, insecticide was 400 g 100 k/g seed, Pix 150 cc /ha 100 L^{-1} water and Fertilon Combi was 1000 g /ha 1000 L^{-1} water. Microelements and Pix were applied at three different stages; beginning of the flowering, after flowering, beginning of the flowering + after flowering. The applied 13 treatments were given below.

T_1- Control (Water spray)
T_2 – Goucho + Vitavax seed treatment (100 kg seed 800 /g Goucho + 400 g Vitavax)
T_3 – Goucho + Vitavax, Pix application at the beginning of the flowering
T_4 – Goucho + Vitavax, Pix application after flowering
T_5 – Goucho + Vitavax, Pix application at the beginning of the flowering and after flowering
T_6 – Goucho + Vitavax, Pix + Fertilon Combi application at the beginning of the flowering
T_7 – Goucho + Vitavax, Pix + Fertilon Combi application after flowering
T_8 - Pix application at the beginning of the flowering
T_9 - Pix application after flowering
T_{10} - Pix application at the beginning of the flowering and after flowering
T_{11} – Pix + Fertilon Combi application at the beginning of the flowering
T_{12} – Pix + Fertilon Combi application after flowering
T_{13} – Pix + Fertilon Combi application at the beginning of the flowering and after flowering

The investigated plant parameters were analyzed using a standard analysis of variance in randomized block experimental design using the general linear model (SAS Institute, 1996). Means were separated using by LSD.

RESULTS AND DISCUSSION

The fungicide treatment of seed, micro-element and mepiquat chloride (Pix) applications on shelling rate, 100 seed weight and pod weight were given in Table 2.

Table 2. Effect of Seed Treatment with Fungicide and Foliar Application of Micro-Element and Mepiquat Chloride (Pix) on Shelling Rate, 100 Seed Weight and Pod Weight

	Shelling rate (%)			100 seed weight (g)			Pod yield (kg /ha)		
Treat-ment	2000	2001	Mean	2000	2001	Mean	2000	2001	Mean
T_1	67.2	64.4	65.8 AB	87.1	80.0	83.6 C	5190.0 BCD	2529.0 I	3859.6 E
T_2	71.1	58.9	65.0 ABC	93.5	93.3	93.4 ABC	5948.1 AB	4139.7 EFG	5044.5 AB
T_3	70.1	61.7	65.9 AB	88.1	106.3	97.2 AB	5333.3 BC	4300.3 EFG	4816.5 AB
T_4	70.9	63.9	67.4 A	94.4	100.0	97.2 AB	5890.5AB	4490.1 DEF	5190.6 A
T_5	68.3	64.9	66.6 AB	86.6	97.0	91.8 ABC	5784.8AB	3564.4 GH	4674.7 ABC
T_6	70.0	61.9	66.0 AB	83.6	110.0	96.8 AB	5108.5 BCD	3925.2 FGH	4517.8 BCD
T_7	69.0	62.4	65.7 AB	84.0	94.7	89.3 BC	5620.0 ABC	3762.8 FGH	4691.0 ABC
T_8	68.2	64.9	66.5 AB	81.0	94.7	87.8 BC	4842.2 CDE	3180.2 HI	4014.2 DE
T_9	68.0	59.3	63.7 BC	84.2	101.0	92.6 ABC	5225.6 BCD	2761.6 I	3993.0 DE
T_{10}	66.8	57.2	62.0 C	88.1	87.0	87.6 BC	5648.4 ABC	3274.7 HI	4461.1 BCD
T_{11}	69.9	61.8	65.8 AB	86.3	102.3	94.3 ABC	5655.2 ABC	3982.7 FGH	4818.9 AB
T_{12}	69.9	65.2	67.6 A	92.4	115.0	103.7 A	6179.8 A	3868.7 FGH	5023.3 AB
T_{13}	69.4	60.1	64.7 ABC	88.4	106.0	97.2 AB	5710.1 AB	2695.2 I	4203.1 CDE
Mean	69.1 A	62.0 B		87.5 B	99.0 A		5540.9	3570.5	
LSD 0.05	Year:1.17-Treat.: 2.98 Y x T: N.S..			Year:4.152- Treat.:10.59 Y x T: N.S..			Yıl:199.9- Treat.:509.6 Y x T: 720.07		
C.V. (%)	3.91			9.78			9.62		

*Means followed by the same letter within a column are not significantly differed at P≥0.01 based on the LSD test

The result in the above table indicates that shelling percentage among the treatments was not significant in the first and second year of the experiment (Table 2). The highest shelling percentage was obtained from treatment T_2 with 71.1% and the lowest was obtained from treatment T_{10} with 66.8% in the first year of the study. In the second year of the study, application of Pix + Fertilon Combi application after flowering (T 12) had the highest shelling rate at 65.2%, and the treatment T 10 (Pix application at the beginning of the flowering and after flowering) had the lowest shelling rate with 57.2%. The shelling percentage of peanut genotypes was increased with the addition of plant nutrients (Williams 1987; Hartmond et al., 1996). When mean shelling percentage was considered, year and treatment were significant while year x treatment interaction was not significant. The mean shelling percentage varied between 62.0 and 67.6%. The highest mean shelling percentage was obtained from Goucho + Vitavax, Pix application after flowering (T_4), while the lowest was obtained from Pix + Fertilon Combi application after flowering (T_{12}), while the lowest was obtained from treatment Pix application at the beginning of the flowering, and after flowering (T_{10}). Application of Pix and Fertilon Combin at different growth stages of the plant did not had a significant effect on shelling percentages, but spraying on leaves after flowering seemed more appropriate. A balanced mineral fertilization for peanut would be a strategy to improve crop growth, plant yield (Chianu and Mairura, 2012; Shaban et al., 2012; Vanlauwe et al., 2015; Almeida et al., 2015).

In terms of 100 seed weight, the differences between years and treatments was found significant at the 5% level, and the year x treatment interaction was not significant. The 100 seed weight varied between 81.0 and 94.4 g in the first years, and 80.0 and 115 g in the second year. However, the 100 seed weight differences were not significant among the treatments. The mean 100 seed weight variation was significant among the treatments. The mean 100 seed weight varied between 83.6 and 103.7 g among the treatments. The highest and the lowest mean 100 seed weight was obtained from treatment T_{12} and the T_1 (control treatment), respectively. Haliloglu (2010) reported 100 seed weight increase in cotton with the pix application.

Significantly higher pod yield was obtained among treatments in both years of the study. The highest pod yield was obtained from treatment T_{12} with 6179.8 kg /ha and the lowest was obtained from treatment T_8 with 4842.2 kg /ha in the first year. When pod yield in the second year was in consideration, the highest and the lowest pod yield was obtained from treatment T_4 and Treatment T_1 with 4490.1 and 2529.0 kg /ha, respectively. Foliar application of micronutrients increased seed yield by influencing amount of seeds per plant and seed weight of peanut (Walker et al., 1982; Halevy et al., 1987; Singh et al. 1995; Hänsch and Mendel, 2009). This is in agreement with our results that application of micronutrient increased peanut biomass and consequently increased seed yield when compared to the control treatment. The year treatment interaction was significant. The significant interaction was resulted from treatment T_{12} and T_{13}, since both treatments had higher pod yields in the second year of the study. The mean pod yield was varied between 3859.6 and 5190.6 kg /ha, the lowest and the highest mean pod yield were obtained from treatment T_1 and T_4, respectively. The application of Pix and Fertilon Combin at different growth stages of the plant had a positive effect on pod yield. Compared to the control (T_1), Goucho + Vitavax seed treatment resulted in an average of 11.85% increase in 100 seed weight and an average of 30.68% increase in pod yield. Similarly, Jeyakumar and Thangaraj (1996) reported that Pix (125 ppm mepiquat chloride) application at 35 days after sowing significantly increased number of flowers and pod yield. Foliar micronutrient applications could be recommended to avoid the depletion of these nutrients in peanut. The yield improvement with the micronutrient applications could be attributed to amendment of poor nutrient uptake from the soil and translocation of these elements into the developing pods. As an application period, treatments applied after flowering gave the better results. Similar findings were reported by Haliloglu (2010); Gulluoglu (2011), Arioglu et al., (2013) that Pix increased pod yield. Our findings are also consistent with the findings of Arslantas (1988) and Avinasha et al., (2019) that application of micronutrient increased pod yield in peanuts.

CONCLUSION

Seed fungicide treatment, foliar micronutrient and mepiquat chloride (Pix) applications at the flowering, after flowering and at flowering + after flowering increased shelling percentage, 100 seed weight and pod yield of peanut. In terms of shelling percentage, 100 seed weight and pod yield, the best results were obtained from the application of Pix + Fertilon Combi after flowering. Compared to the control treatment, the highest pod yield increase (19%) was obtained from Pix + Fertilon Combi after flowering (T_{12}) in the first year, and 78% increase in the second year from Goucho + Vitavax seed treatment and Pix application after flowering (T_4). Goucho + Vitavax seed treatment alone did not have much effect on shelling percentage in peanut. However, it had a positive effect on 100 seed weight and pod yield.

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Conflict of Interest

The article authors declare that there is no conflict of interest between them.

Author's Contributions

The authors declare that they have contributed equally to the article.

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