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Research Article

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The Effect of Humic Acid and Potassium Applications on The Yield and Yield Components in Chickpea (*Cicer arietinum* L.)

Abstract
The study was conducted to determine effects of different levels of humic acid and potassium on the yield and some yield components in chickpea in 2017 in Mardin city. The experiment was laid out in a factorial randomised block design with three replications. The doses were used potassium (0, 10 and 20 kg da^{-1}) and humic acid (0, 30 and 60 kg da^{-1}) in this study. In the study were investigated the plant height, first pod height, branch number per plant, pod, seed number and per plant, biological yield, seed yield per unit, harvest index, 100-seed weight, protein ratio and potassium content in seed. The results of the study indicated that humic acid and potassium applications increased significantly the seed yield and yield components. The highest seed yield was obtained from 20 kg phosphorus da^{-1} + 60 kg humic acid da^{-1} application as 286.9 kg da^{-1}.

In general, fallow lands (53702 decares) occupy an important place in the agricultural lands in Mardin, as in the agriculture of the country (TUIK, 2019). Narrowing down fallow lands and increasing agricultural production is seen as an important target in our country's agriculture. Chickpea is a plant suitable for planting rotations with cereals in fallow lands, due to its resistance to low temperatures (-8 -10^{0}C) and its small vegetative component, so it consumes less water. Identifying varieties that adapt to the ecological conditions of the regions where it is grown in order to increase productivity in chickpea production is a very important factor. The variety characteristics of chickpeas are more related to the genetic structure of the variety. Another important feature to increase the grain yield per unit area in chickpea farming is to meet the nutrient requirement of the plant correctly. The fact that the nutrient in the soil is below the limit values is one of the important reasons that reduces the yield and quality.

Potassium, a macronutrient element, has an important effect on the high yield and protein ratio in legumes. In addition, potassium has important effects on plant metabolism. Since legume plants need more potassium than other plants, it is economical to apply potassium fertilizers even in soils containing high amounts of potassium. It is known that potassium has positive effects not only on yield and quality, but also on nodule formation, nitrogen fixation and plant growth.

Leonardite plant nutrients comprising a substantial portion of the work done to date in Turkey, low pollutant content, the existing content on the occasion of humic acid is more than the potential for use as soil conditioner. Studies continue in areas such as the effect of Leonardite on plant yield, evaluation of organic nutrient content and humic substance content (Engin et al., 2012). Humic substances known as fulvates with low molecular weights within the body of leonardite are related to chemical reactions affecting the structural activities of plants, while high molecular weight humic substances called humate change the physical characteristics of the soil. According to the results of many scientific studies, it has been reported that the usefulness of macro nutrients increases due to the chemical reactions of humic substances and humic substances in the soil and that both micro and nutrient absorption by plants are adjusted (Karaman et al., 2012).

This study was carried out in order to investigate the effects of humic acid and potassium fertilization in different doses applied to chickpea plant on yield, some yield elements and quality.

MATERIAL and METHODS

In the study, Diyar-95 chickpea variety registered by GAP International Agricultural Research and Training Center was used. This variety; It is 50-75 cm long, 33-42 cm first pod height and its average yield is 150-200 kg. As a source of humic acid, leonardite containing 50% humic acid and potassium sulfate fertilizer were used as a source of potassium.

This study was carried out in the spring of 2017 growing season in Mardin province. The province of Mardin, where the research was conducted, is located in the Southeastern Anatolia Region and the altitude of the province is 1150 m, located at 37^{0} 18 'north latitude and 40^{0} 44' east longitude. In the region where the study was conducted, the total annual precipitation for the LTA in the months corresponding to that growing season is 229.0 mm, the average temperature amount is 19.26 °C and the average relative humidity level is 42.2%. The amount of rainfall recorded in the 2017 growing season was 271.4 mm and the average temperature in the same period was 20.42 ^{0}C and the average relative humidity amount was 41.06%, while the total rainfall and average temperature data for the growing season were higher than the LTA data, the relative humidity was below the long-term average (TSMS, 2019).

It is seen that the soil samples obtained from the experimental area are clayey, slightly alkaline reaction, low organic matter content, high calcareous, salt-free, potassium content sufficient, and phosphorus content is determined as low.

The experiment was laid out in a factorial randomised block design with three replications. There are a total of twenty-seven parcels in the study and the parcels consist of five rows. In the study, the parcel area was planned to be 5 meters' x 1.5 meters = 7.5 m^2 by setting the distance between the blocks and parcels as 2 m and the distance between the rows as 30 cm. The sowing norm is set to 60 plants per square meter according to Sepetoğlu (1996).

In the study, 3 potassium doses (0, 10 and 20 kg da^{-1}) in the form of potassium sulfate and 3 different humic acid doses corresponding to 0, 30 and 60 kg da^{-1} were used as fertilizers. 14 kg da^{-1} DAP fertilizer was laid at the sowing time. All the operations were carried out on 0.9 m x 4 m = 3.6 m^2 by excluding the plants within fifty cm of each row and row heads from the five rows that make up the parcel as edge effect. It was made by hand by opening lines with a marker on October 27, 2017. In the experimental area, weed control was done with hoe twice before and after flowering. Irrigation was not carried out as the study was aimed at research in dry farming areas. The trial was hand-harvested on 11.07.2017. Measurement, counting and blending processes of the harvested plants were performed and their average values were obtained. The protein ratio in the grain was determined by the Kjeldahl method (Kacar, 1984), the potassium contents of the plant samples were determined by A.S.S. (Atomic Absorption Spectrophotometer) (Lindsay and Norwell, 1978).

In determining the difference between different potassium and humic acid doses in terms of yield and yield components in chickpea, factorial trial design in random blocks was used by the variance analysis method, while in determining different groups, Duncan (5%) Multiple Comparison Test (Düzgüneş et al., 1987) and Costat package program was used.

RESULTS and DISCUSSION

The average plant height in chickpeas of different doses of potassium fertilizer applications varied between 48.9-51.5 cm. The highest value for plant height was determined from the control application with 51.5 cm, and the lowest value was determined from the potassium application with 10 kg da^{-1} with 48.9 cm. Boulbaba et al. (2005) stated that high amount of K application on chickpea growth caused depressive effect, while Asghar Ali et al. (2007) stated that the effect of increasing potassium doses on growth is important.

Table 1. Average of different humic acid and potassium dosage applications in chickpeas and Duncan Groups

Plant features	Potassium Doses			Humic Acid Doses		
	0 kg da^{-1}	10 kg da^{-1}	20 kg da^{-1}	0 kg da^{-1}	30 kg da^{-1}	60 kg da^{-1}
Plant height	51.5 A	48.9 C	49.8 B	47.3 B	51.2 A	51.7 A
First pod height	34.24 A	31.61 B	30.73 C	32.20 AB	31.80 B	32.58 A
Num. of branc	5.06	4.93	4.88	4.58 C	5.3 A	5.0 B
Num. of pod per plant	27.40 B	28.03 B	29.55 A	23.00 C	30.50 B	31.48 A
Num. of seed per plant	28.6 B	28.8 B	32.2 A	24.2 C	31.9 B	33.4 A
Grain yield	227.1 C	244.1 B	276.6 A	235.1 C	249.1 B	263.4 A
Harvest index	28.6 C	30.9 B	32.3 A	29.9 B	30.6 AB	31.3 A
100 seed weight	33.43 B	33.97 B	36.38 A	31.90 B	36.20 A	35.60 A
Protein ratio	17.96 C	18.71 B	19.04 A	18.19 C	18.52 B	18.99 A
Potassium contents	798.24 C	817.77 B	836.41 A	807.86 B	818.81AB	825.75 A

When the effect of humic acid doses on the plant height of chickpea plant was examined, the highest plant height was obtained from 51.7 cm with 60 kg da^{-1} humic acid application, and the lowest plant height was obtained as 47.3 cm from 0 kg da^{-1}humic acid application. Shaaban et al., (2009) and Kahraman et al. (2017) reported that humic acid applications increase plant size.

As can be seen in Table 2, potassium doses varied between 30.73-34.24 cm in terms of first pod height, and the highest value was taken from control plots where no potassium was applied. The lowest value was obtained from 20 kg da^{-1} potassium application. It is seen that potassium application does not have a positive effect on first pod height. When the table is examined in terms of humic acid doses, it is seen that the highest value is 32.58 cm and 60 kg da^{-1} humic acid application and the lowest value is 31.80 cm and 30 kg da^{-1}, but the difference between control application and 60 kg da^{-1} humic acid application is not significant. In legumes, it is desirable that the first legume should be formed from high in terms of suitability for machine harvesting. It is very important to develop varieties and breeding technologies for this. In this study, it is seen that the variety used is suitable for this feature and does not require extra fertilization.

Although the number of branches in the average plant in potassium applications varied between 4.88-5.06, the effect of this application on the number of branches was found to be statistically insignificant. The average number of branches in the plant of humic acid doses ranged from 4.58 to 5.30, the highest value was determined from 5.30 units of 30 kg da^{-1} humic acid dose, and the lowest value was determined with 4.58 in control plots without humic acid. Elkatmış and Toğay (2017) stated that humic acid applications increase the number of branches in the plant.

When the effect of potassium doses on the number of pods per plant in chickpea plant is examined, it is seen that the highest value is obtained from the potassium dose of 29.55 units and 20 kg da^{-1}, and the least number of pods in the plant is 27.40 and 0 kg da^{-1} potassium dose applications. Erman et al. (2012) stated that potassium fertilization provides an increase in all the properties examined, Asghar Ali et al. (2007) stated that the effect of increasing potassium doses on growth is important, but the difference between the control application in the number of pods per plant and the application of 25 kg da^{-1} potassium is insignificant. When the effect of humic acid applications on the number of pods per plant was examined, the highest number of pods per plant was obtained from the humic acid dose of 31.48 and 60 kg da^{-1}, and the lowest number of pods per plant was obtained from the control plot as 23.00. Ünsal (2007), Saadati and Baghi (2014), Elkatmış and Toğay (2017) and Kahraman (2017) report that the application of humic acid in chickpeas increases the number of pods.

When the effect of potassium doses on the number of grains per plant in chickpeas is examined, the highest value is 32.2 units plant^{-1} with 20 kg da^{-1} potassium, the lowest number of seeds in the plant is obtained from parcels without potassium applied with 28.6 units plant^{-1}, but the same as 10 kg da^{-1} potassium application. took place in the group (Table 1.) The number of grains per plant; It is affected by both varieties and agricultural practices. It is understood from the results that potassium applications increase the number of seeds per plant parallel to the number of pods per plant. When the effect of humic acid doses on the number of grains per plant was examined, the highest value was obtained with the amount of humic acid dose of 33.4 units plant^{-1} and 60 kg ha^{-1}, and the value of the minimum number of grains per plant was obtained from control plots without humic acid application with 24.2 units plant^{-1}. Ünsal (2007) and Elkatmış and Toğay (2017) reported that humic acid applications have a positive effect on the number of grains per plant in chickpeas.

As can be seen from Table 1. The average grain yield per unit area of different potassium fertilizer applications varied between 227.1-276.6 kg da^{-1} and the maximum value was determined from 20 kg da^{-1} potassium application and the minimum value was determined from 0 kg da^{-1} potassium (control) application. Singh et al. (1994), Tomar et al. (2001), Asghar Ali et al. (2007) and Erman et al. (2012) knew that potassium fertilizer applications increase grain yield. In addition, Asghar Ali et al. (2007) stated that the highest benefit in potassium fertilizer doses applied to chickpeas was obtained from potassium application of 15 kg da^{-1}. The results recorded in the trial are consistent with the results of the researchers. When the efficiency effect of humic acid fertilizer at different doses per decare was examined, the highest value was obtained from 263.4 kg da^{-1} and 60 kg da^{-1} humic acid dose, while the lowest value was determined from 235.1 kg da^{-1} humic acid application. Ünsal (2007), Saadati and Baghi (2014), Elkatmış and Toğay (2017) and Kahraman (2017) stated that the application of humic acid increased the grain yield per unit area.

Considering the data in Table 1 in terms of potassium doses, the maximum harvest index average was obtained from 20 kg da^{-1} potassium application with 32.3%, and the minimum harvest index average was obtained with 28.6% and 0 kg da^{-1} potassium application. Erman et al. (2012) reported that potassium fertilizer applications increased the harvest index compared to the control. When the effect of humic acid doses in terms of harvest index was examined, the highest value was found as 31.3% from the amount of humic acid dose of 60 kg da^{-1}, while the lowest value was obtained from the parcels without humic acid with 29.9%.

The average weight of 100 grains obtained from potassium doses was between 33.43-36.38 g. While the highest 100 grain weight value was obtained from 20 kg da^{-1} potassium application, the lowest 100 grain weight was determined from the parcels without potassium application. Tomar et al. (2001) and Kumar et al. (2005) stated that increasing doses of potassium significantly increased the weight of 100 grains. While the average weight of 100 grains of different humic acid doses varied between 31.90-36.20 g, the highest value was obtained from 30 kg da^{-1} humic acid dose, but the difference between 60 kg da^{-1} humic acid application was not significant. The lowest value was obtained from 0 kg da^{-1} humic acid application.

When the potassium doses applied in terms of protein ratio in the grain were examined, the highest protein ratio was obtained from potassium application with 19.04% and 20 kg da^{-1}, while the lowest protein ratio was obtained from control plots with 17.96%. Tomar et al. (2001) and Asghar Ali et al. (2007) stated that potassium fertilization in chickpeas increases the protein content in the grain. The researchers' reports support the results of this study. The average protein ratio of humic acids in different doses applied to chickpea plant varied between 18.19-18.99%. While the highest protein ratio in the grain was obtained from 60 kg da^{-1} humic acid application, the lowest ratio was found in 0 kg da^{-1} humic acid application. Saadati and Baghi (2014) and Elkatmış and Toğay (2017) reported that as the humic acid doses increased, the protein ratio in chickpeas increased.

The average potassium content of the grain obtained from different potassium fertilization doses varied between 798.24-836.41 mg. The highest potassium content was recorded from 20 kg da^{-1} potassium administration and the lowest value was recorded from 0 kg da^{-1} potassium administration. Tomar et al. (2001) reported that increased potassium application in chickpea plant significantly increased the potassium content in the grain. The findings obtained in this study are in agreement with the findings of the researcher. The average potassium content of the grain taken from humic acid applications varied between 807.86 and 825.75 mg. While the highest potassium content was obtained from 60 kg da^{-1} humic acid application, the difference between 30 kg da^{-1} humic acid application was not significant. The lowest potassium content was obtained from 0 kg da^{-1} humic acid application. Unsal (2007), Sarwar et al. (2013) stated that humic acid fertilization increases potassium intake in chickpeas, while Alak and Müftüoğlu (2014) investigated the effect of humic acid applications on available potassium in corn plant, and that the amount of potassium that can be taken by the plant increased numerically as the amount of humic acid increased, but this increase was statistically significant. They stated that it was not.

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The study is part of the master's thesis.

CONCLUSION

The highest unit area yield, 286.9 kg da^{-1} with 20 kg da^{-1}. It was obtained from potassium + 60 kg humic acid da^{-1} application. Single seed control plots at the lowest value in terms of yield of 197.3 kg^{-1} Turkey and is as found values are significantly above the world average.

Although potassium was seen at a sufficient level in the soil analysis results in the area where the study was conducted, it was observed that all features except the first pod height, plant height and branch number were positively affected by potassium applications. It has been observed that chickpea, which is a legume plant, requires more potassium than other plants like other legumes, and the application of potassium fertilizers even in soils containing high amounts of potassium brings positive results. It has also been determined that fertilizer applications with sufficient levels of humic acid provide significant increases in the yield and characteristics closely related to the chickpea yield. As a result, 20 kg of chickpeas in and around da^{-1} potassium + 60 kg humic acid da^{-1} dose application can be recommended.

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