

Determination of Some Plant Nutrients in Sunflower Waste Ashes

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Abstract: Since plants need various plant nutrients during their development process, these needs are met with synthetic and chemicals inputs. This increases the input cost considerably. However, such problems can be eliminated thanks to the inputs obtained from completely natural plant wastes. Ash obtained from sunflower plant wastes, especially those used as fuel, has the potential to be an important natural fertilizer with plant nutrient elements in its content. In this study, it was aimed to determine some plant nutrients (B, Mg, P, K) found in the ashes obtained from burning of different variety (Coral, Pioneer63F73, PioneerP64LL05, Pioneer64LC108, Goldsun, Şems, Aga1301, Duna, Bosfora ve PioneerPR64G46) of sunflower plant wastes. As a result of the study, the highest B and Mg content was obtained from Pioneer PR64G46, P and Ca content from Pioneer P64LL05 and K content from Pioneer 64LC108. Observations show that the ash of the sunflower wastes has a very high content of phosphorus and potassium, and that these ashes can be used as fertilizers, especially in phosphorous and potassium-poor soils.

Keywords: *Helianthus annuus* L, fertilizers, variety, potassium, phosphorus

Ayçiçeği Bitki Atık Küllerinin Bazı Bitki Besin Elementlerinin Belirlenmesi

Öz: Bitkiler gelişim süreçleri boyunca çeşitli bitki besin elementlerine ihtiyaç duyduklarından bu ihtiyaçları sentetik ve kimyasallar girdiler ile giderilmektedir. Bu da girdi maliyetini oldukça arttırmaktadır. Hâlbuki tamamen doğal bitki atıklarından elde edilen girdiler sayesinde bu tür sorunlar ortadan kalkacaktır. Özellikle yakacak olarak kullanılan ayçiçeği bitki atıklarından elde edilen kül, içeriğinde bulunan bitki besin elementleri ile önemli bir doğal gübre olma potansiyeline sahiptir. Bu çalışmada, farklı çeşitlere ait (Coral, Pioneer63F73, PioneerP64LL05, Pioneer64LC108, Goldsun, Şems, Aga1301, Duna, Bosfora ve PioneerPR64G46) ayçiçeği bitki atıklarının yanmasından elde edilen küllerinde bulunan bazı besin elementlerinin (B, Mg, P, K ve Ca) belirlenmesi amaçlanmıştır. Yapılan çalışma sonucunda, en yüksek B, Mg içeriği PioneerPR64G46 çeşidinden, P, Ca içeriği Pioneer P64LL05 çeşidinden ve K içeriği Pioneer64LC108 çeşidinden elde edilmiştir. Yapılan gözlemlerde, ayçiçeği atıklarının küllerinde oldukça yüksek fosfor ve potasyum içeriğinin mevcut olduğu, özellikle fosfor ve potasyumca fakir topraklarda gübre olarak kullanılabilmesi öngörülmektedir.

Anahtar Kelimeler: *Helianthus annuus* L., gübreler, çeşit, potasyum, fosfor

INTRODUCTION

In our country, the most cultivated oil-seed plant for vegetable oil production is sunflower. Thanks to its high adaptability and tolerance to all kinds of soil, it is possible to grow it in almost every region of our country except Eastern Black Sea. Especially, 58.82% of sunflower plants are grown in Thrace-Marmara Region, 18.49% in Central Anatolia Region, 10.92% in Black Sea Region and 11.76% in Çukurova Region (Anonymous, 2019). Both the sunflower's oil and its other parts (such as stalks, heads, seeds) can be utilized in many areas such as industry, cosmetics, paint industry and as pulp for animal feeding. The remains of the sunflower, cultivated particularly in many regions of Anatolia, such as stalks, heads, seed husks that are left after harvest, are used for heating, cooking and as fuel in tandoori oven rooms for pastries. Since the ashes obtained from the incineration have a high potassium content, it is possible to meet the potassium requirement of the soil in particular by sprinkling them onto the soil (Arioglu, 1999; Kaya et al., 2008).

According to the 2016 data of the Turkish Statistical Institute, the total harvested area of sunflower for snack and sunflower oil is 7.201.081 da and the annual amount of waste left in the field was calculated as 7.201.081x0.18 =

1.296.195 tons and the amount of usable waste was 1.296.195x0.5 = 648.097 tons by using the coefficients and usability rates determined by the California Energy Commission (CEC) (Sumer et al., 2016). Unfortunately, sunflower which has such high plant waste is not utilized as a natural fertilizer in agricultural production, but is wasted by being used as fuel or thrown directly into the landfills. It is clearly seen that sunflower ash, which is rich in plant nutrient elements, obtained from after being used as fuel especially in sunflower cultivation areas may be an important source for use as a natural fertilizer. After harvest, 400-1000 kg of stalks, leaves and heads waste is obtained in the sunflower production. These wastes are used for heating in winter and cooking purposes, and ash material with high potassium (40%) and phosphorus (40%) content is used as potassium fertilizer in the fields and vegetable gardens (Egilmez, 1977). Since there are important plant nutrients such as phosphorus, potassium, calcium, magnesium, zinc, copper, cobalt, manganese and iron in the ash obtained from plant wastes, it can be used

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as a fertilizer in plant nutrition (Suresh et al., 1998). Paleckiene et al. (2012) in the study they conducted in order to determine the physical and chemical properties of the fertilizer obtained by adding various additives (sugar factory lime, molasses, urea formaldehyde resin) to the ash obtained from sunflower residues found that as a result of turning sunflower waste ash and sugar factory lime mix into granules, a fertilizer containing 0.08% N, 5.94% P₂O₅, 12.97% K₂O, 24.27% CaO, 10.0% MgO, 0.03% Na₂O, 0.27% Fe, 0.02% Cu, 0.01% Zn, 0.04% Mn and 0.06% Mo and marketable appropriate parameters could be produced. Quaranta et al. (2011) in their study of using ash obtained by burning sunflower husks in the production of ceramics or its re-use as a soil additive, found 15.6% Mg, 7.9% Ca, 4.8% P and 4.6% K in the content of sunflower husk ash. In our country, plant residues are used to meet the plant nutrients needed for agricultural production and to minimize the input costs. Especially where sunflower wastes are used as fuel, the plant nutrients contained in the remaining ashes can be an alternative fertilizer for improving soil and reducing the input costs. This study was conducted to determine the plant nutrients in the content of the ash, where sunflower wastes are used as fuel, so that the remaining ash can be used as an alternative fertilizer instead of being wasted as garbage.

MATERIAL AND METHODS

Trial Land and Soil Characteristics

This study was conducted on a private property in the center of Kavak district of Samsun province in 2014-2015. Kavak, located on the Samsun-Ankara highway, is a district 51 km away from the province of Samsun. The district has an altitude of 600 meters and a forested and rugged terrain. Since it is located higher than sea level, continental climate is observed. Summers are warm and winters are cold. The maximum rainfall is experienced in spring. The area where the experiment was conducted has an altitude of 633 m. It is located between 41°04'35.0" north latitude, 36°02'51.3" east longitude degrees and there are settlements and woodland around it (Anonymous, 2018). Rainfall, temperature and relative humidity values of the experimental area are presented in Table 1.

The soil structure of the experimental area was determined to be clayey-loamy. Its pH values ranged from 7.73 to 7.54. According to this result, the soil structure was slightly alkaline. Lime ratios of the experimental soils ranged from 0.68%-0.20%, organic matter ratios ranged from 2.28%-2.63%, amount of phosphorus ranged from 11.93-13.87 kg da⁻¹ and potassium ranged from 154.8-109.8 kg da⁻¹. When the results of the analysis of soil samples obtained from the experimental area were compared with the evaluation

Table 1. Some climate data of Samsun-Kavak district for 2016 *

Months	Mean precipitation (mm)	Mean temperature (°C)	Mean relative humidity (%)
April	36.8	12.5	64.9
May	151.1	13.1	82.4
June	58.9	18.3	81.4
July	68.7	19.5	80.7
August	06.7	21.1	81.3
September	47.9	15.8	78.6
Total/Average	370.1	16.7	78.2

* The Prime Ministry State Meteorological Affairs General Directorate was taken from Meteorological Bulletin and Samsun Meteorological Regional Directorate's Annual Observatory

criteria given by Kacar (2009) it was determined that the lime ratio of the experimental area soils was low, the amount of organic matter was moderate, and the amount of phosphorus and potassium that are beneficial to plants was sufficient.

Experimental Details and Treatments

The materials used in the experiment were Pioneer63f73, Pioneer64LC108, PioneerP64LL05, Coral, Şems, PioneerPR64G46, Goldsun, Aga1301, Duna and Bosfora. Experiment was set up according to the "Randomized Blocks" experimental design with three repetitions (Yildiz and Bircan, 1991), and the interrow distance was 70 cm and the intrarow distance was 35 cm (Kara, 1986). The area of the experimental plots was 11.2 m², and with the plantation, 30 kg 20-20-0 compound fertilizer was given per decare of the land. The sunflower heads were harvested in order to obtain the plant nutrients from the ash of the remaining plant wastes (heads, stalks, leaves) after the harvest, one row from the edges and one plant from the head parts were considered to be affected by the edge effect, and ten plant wastes were harvested manually from the remaining 2 rows left in the center. Some plant nutrient elements (B, Mg, P, K and Ca) in ash samples obtained from each sample after burning were analyzed

Using inductive matching plasma (ICP) and mass spectrometry (MS) in Bayburt University Central Research Laboratory. As in Figure 1, sunflower waste ashes were obtained by burning plant wastes belonging to each type of harvest.

Statistical Analysis

The data obtained as a result of the study was statistically analyzed using the SPSS computer software, and the differences between the averages were checked by Duncan Multiple comparison test according to their significance levels (Turan, 1995).



Figure 1. Burning of sunflower wastes and the appearance of individual sizes of ash

RESULTS

Considering that the ashes of sunflower plant wastes may be used as an alternative fertilizer thanks to the plant nutrient content of the remaining plant wastes at the places where they are used as fuel, chemical analysis for plant nutrient contents of plant ashes obtained as a result of an adaptation study with ten different hybrid sunflower varieties was performed in Kavak district of Samsun province. The mean values of B, Mg, P, K and Ca elements obtained from each sample are given in Table 2 as \pm SD.

Since the ash obtained from burning sunflower plant wastes contains a high level of potassium element, it can also be used as a fertilizer. As a matter of fact, the highest plant nutrient value was obtained from potassium element as a result of the chemical analysis of sunflower waste ash samples. According to this result, the amount of potassium element varied between 37.69-23.35 g kg⁻¹. While the highest potassium value was obtained from Pioneer64LC108, the lowest potassium value was obtained from Duna variety.

The highest element concentration obtained from the sunflower waste ash samples after the potassium element

belonged to calcium and magnesium elements with 26.64-20.85 g kg⁻¹ and 17.27-8.56 g kg⁻¹, respectively. Phosphorus and boron elements followed these with 7.27-1.64 g kg⁻¹ and 0.25-0.12 g kg⁻¹, respectively. The highest boron and magnesium element concentrations were obtained from the PioneerPR64G46 variety, the highest phosphorus and calcium element concentration from the PioneerP64LL05 variety and the highest potassium element concentration was obtained from the Pioneer64LC108 variety when the waste ash from the varieties was evaluated. The lowest boron, phosphorus and potassium element concentrations were obtained from the Duna variety, the magnesium element concentration from the Şems variety and the calcium element concentration from the Pioneer 64LC108 variety.

DISCUSSION

Potassium is an important nutrient for plants after nitrogen, the most widely used plant nutrient by plants (Guzel et al., 2002). Potassium element plays an important role in the development of plant root system, seed maturation, ensuring that plants receive water regularly, chlorophyll

Table 2. Concentration of B, Mg, P, K and Ca in oil sunflower plant waste ash*

Varieties/Concentration	B	Mg	P	K	Ca
		g kg ⁻¹			
Coral	0.18±0.00	10.50±0.28	2.61±0.01	27.95±0.35	24.62±0.02
Pioneer63F73	0.15±0.00	10.20±0.06	6.22±0.00	29.16±0.27	22.55±0.03
PioneerP64LL05	0.20±0.00	12.34±0.13	7.27±0.02	24.83±33.1	26.64±0.02
Pioneer64LC108	0.15±0.00	13.93±0.03	3.14±0.02	37.69±33.3	20.85±0.02
Goldsun	0.17±0.00	15.36±0.01	3.17±0.02	36.33±0.00	24.96±0.01
Şems	0.15±0.01	08.56±0.03	1.87±0.02	26.13±0.12	23.06±0.02
Aga1301	0.18±0.00	13.22±0.03	2.16±0.00	31.14±0.21	22.08±0.02
Duna	0.12±0.00	09.18±0.01	1.64±0.00	23.35±0.18	21.09±0.02
Bosfora	0.14±0.00	09.84±0.03	2.74±0.00	32.84±0.15	24.99±0.06
PioneerPR64G46	0.25±0.00	17.27±0.03	2.17±0.00	27.72±0.00	26.13±0.06

*The data (values \pm SE) are the mean values of three measurements for the same sample

formation, which is important for photosynthesis, preventing the negative effects of excess nitrogen, plants resistance to diseases and as an activator for major enzymes (McCauley et al., 2009; Kacar and Katkat, 2010). Potassium deficiency causes decline in plant growth, leaves turn from dark yellow to dark brown and in extreme deficiency to black, and as the turgor press falls, plants become more water stressed and this increases their sensitivity to drought and frost (Bosgelmez et al., 2001). Plant nutrients such as nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg) and boron (B) are vital for plants to grow and develop (Kacar et al., 2002). Agricultural soils in Turkey are poor in terms of phosphorus which is beneficial for plants. For this reason, phosphorus fertilizers are used mostly in our country's soil (Kacar and Katkat, 1997). Phosphorus element plays an important role in ATP formation, which involves in energy transfer, in the formation of DNA, in cell division, in the formation of flowers and fruits, in the maturation of plants and in developing resistance against diseases and pests in plants. In the case of its deficiency, there are many negative effects such as slowing of growth in plants, shoot and bud formation in fruits and trees, weakening of root development and decline in plant's endurance against cold, frost and diseases (Bosgelmez et al., 2001; McCauley et al., 2009). Calcium element plays an important role in regulating the structure of plant cell wall, increasing the soil structure by increasing the soil granulation, adjusting the soil pH, increasing plant tissue resistance against freeze-thaw stress, protecting plants against diseases, protein formation and transporting carbohydrates in plants. In calcium-poor soils, the growth of meristem tissues, buds and roots of plants slow down, black and brown spots and resulting damage occur in young leaves, and yield decreases in the obtained crop (Cepel, 1996; Gardiner and Miller, 2008). The boron element is important for a number of processes such as the formation of cell walls and the rejuvenation of tissues, activation of certain enzymes, carbohydrate biosynthesis, nucleic acid and protein metabolism. Boron deficiency causes a number of adverse effects, such as yellowing and thickening in plant leaves, dying in buds, slowing in plant growth, damage to cell wall (Plaster, 1992; Kacar and Katkat, 2010). Since magnesium element is a building block of chlorophyll, phytin and pectin, it plays an important role in photosynthesis. In addition, it has important roles in ATP formation, carbon dioxide assimilation, the amount of sugar and starch, protein synthesis and enzyme activation. Since the amount of chlorophyll decreases in its deficiency, photosynthesis slows down, leaves become yellowish and the physiological activities in the plant declines (Aktas and Ates, 2005; Ozbek et al., 2001). Christopher et al. (2003) in their study to determine the effects of ash obtained as a result of incineration of biomass mixture found that, in the content of the sunflower plant waste ash, P_2O_5 compound constituted 14.2% of the ash, K_2O constituted 47.2%, MgO constituted

14% and CaO compound constituted 13.6% of the ash. Paleckiene et al. (2012) in their study on obtaining fertilizer from rapeseed plant waste ash and sugar factory wastes found that rapeseed plant waste ash consists of 6.2% phosphorus element, 20.7% potassium element, 23.2% calcium element and 2.1% magnesium element Paleckiene et al. (2012), in the study they conducted in order to determine the physical and chemical properties of the fertilizer obtained by adding various additives (sugar factory lime, molasses, urea formaldehyde resin) to the ash obtained from sunflower residues found that there were 10.94% P_2O_5 , 25.84% K_2O , 24.27% CaO, 19.07% MgO, 18.58% compounds in sunflower waste ash. Quaranta et al. (2016), in their study of using ash obtained by burning sunflower husks in the production of ceramics or its re-use as a soil additive, found 15.6% Mg, 7.9% Ca, 4.8% P and 4.6% K in the content of sunflower husk ash. In a study on rapeseed plants in Poland, the chemical composition of the rapeseed waste ash was determined to be containing 15.1 g kg^{-1} phosphorus element, 155.7 g kg^{-1} potassium element, 124.0 g kg^{-1} calcium element and 7.3 g kg^{-1} phosphorus element (Piekarczyk et al., 2011). Although the results we have found are lower than the results of other researchers, we have also concluded that the potassium element has the highest plant nutrient value in the chemical composition of oil plants waste ash like in other studies conducted. The data obtained as a result of the research showing a statistically significant difference from the data of other researchers is thought to be caused by the fact that the land where the sunflower experiment was set up was poor in terms of soil nutrients.

CONCLUSION

Potassium is one of the major plant nutrient elements that have an impact on the nutrition and quality of plants. There is no current data on the fact that sunflower plant receives more potassium from the soil, that high levels of potassium can be found in ash resulting from burning stalks and residues obtained after harvest and that it can be used as a fertilizer for the soils with potassium deficiency. In this context, when the chemical composition of sunflower waste ash is examined, the maximum amount of nutrient elements identified in the ash are potassium (37.69 g kg^{-1}), calcium (26.64 g kg^{-1}), magnesium (13.93 g kg^{-1}), phosphorus (7.27 g kg^{-1}) and boron (0.25 g kg^{-1}). While the highest amount of B and Mg elements were found in PioneerPR64G46, the highest amount of P and Ca elements were found in PioneerP64LL05 and the highest amount of P and CA elements were found in Pioneer64LC108 sunflower varieties.

In the light of the data obtained, sunflower plant waste ash can be used as a potential plant nutrient source in poor soils in terms of potassium and other nutrients (P, Mg, Ca and B), however, more extensive research is needed on this subject.

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