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The Investigation of Olive Mill Pomace Effect on Second Crop Hybrid Corn Cultivation

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Abstract:

In this study that the effects of olive mill pomace (0, 1 and 2 tons/da) and pure nitrogen fertilizing (0, 12.5 and 25 kg da^{-1}) on hybrid corns (DKC 5783 and P 3394) was investigated. The research was carried out in Kahramanmaraş conditions during second crop growing seasons in 2007 and 2008. Split-split plot experimental design was used with four replications. The olive mill pomaces (omp) for first ear height, ear length, grain yield per ear and 1000 grain weight, and nitrogen doses for steam diameter, ear length, grain yield per ear and 1000 grain weight were significant. Varieties were showed significant differences in terms of first ear height, stem diameter, plant height, ear number per plant and grain yield. Years were reported that investigated all traits had differences significant, except for ear number per plant and 1000 grain weight of corn. The olive mill pomaces for grain yield was not significant. The grain yield of 0 tons/da of olive mill pomace treatment was 916.52 kg da^{-1}, 2 tons/da of olive mill pomace application was 837.91 kg da^{-1}. Grain yield for 0, 12.5 and 25 kg da^{-1}nitrogen (N) dose treatments were 692.42, 875.24 and 1055.40 kg da^{-1} respectively. The olive mill pomace and nitrogen doses for protein content had no significant effect. P. 3394 hybrid variety with 920.81 kg da^{-1} had higher grain yield than DKC 5783 hybrid variety (827.81 kg da^{-1}).

Key words: corn varieties, nitrogen rate, olive mill pomace.

İkinci Ürün Hibrid Mısır Tarımında Pirinanın Etkisinin Araştırılması

Özet

Bu çalışmada, prinanın (0, 1 ve 2 ton/da) ve azot gübre (0, 12.5 ve 25 kg da^{-1}) dozları ikinci ürün hibrit mısır (DKC 5783 ve P 3394) bitkisi üzerindeki etkisi araştırılmıştır. Araştırma, Kahramanmaraş koşullarında 2007 ve 2008 yıllarında ikinci ürün mısır yetişme sezonunda yürütülmüştür. Bölünen bölünmüş parseller deneme desenine göre dört tekerrürlü yürütülmüştür. Pirina dozlarının mısırın ilk koçan yüksekliğine, koçan uzunluğuna, tek koçan verimine ve bin tane ağırlığına, azot dozlarının sap çapına, koçan uzunluğuna, tek koçan ağırlığına ve bin tane ağırlığına etkisi önemli olmuştur. Çeşitler ilk koçan yüksekliği, sap çapı, bitki boyu, bitkideki koçan sayısına ve tane verimi yönünden kendi aralarında önemli farklılıklar göstermiştir. Mısır bitkisinin incelenen özelliklerden bitkide koçan sayısı ve bin tane ağırlığı hariç, diğer özelliklerin yıllara göre önemli derecede farklılıklar gösterdiği kaydedilmiştir. Pirina dozlarının tane verime etkisi önemsiz olmuştur. Tane verimi 0 ton/da pirina uygulamasında 916.52 kg da^{-1}, 2 ton /da pirina uygulamasında 837.91 kg da^{-1} olarak gerçekleşmiştir. Tane verim 0, 12.5 ve 25 kg da^{-1} azot (N) doz uygulamalarında sırasıyla 692.42, 875.24 ve 1055.40 kg da^{-1} olmuştur. Pirina ve azot dozların protein içeriğine etkisi olmamıştır. P. 3394 çeşidi 920.81 kg da^{-1} tane verimi ile DKC 5783 (827.81 kg da^{-1}) çeşidinden daha yüksek verim vermiştir.

Anahtar kelimeler: Mısır çeşitleri, pirina ve azot dozları

Introduction

Cereals are the most widely utilized crop group as human food and for livestock feed. Maize is the third most widely cultivated cereal crop which ranks after wheat and rice. In addition to being used as cereal, maize is also used in many areas in industry, which has stimulated maize cultivation and various studies about it. Maize is known, in cereal family, as having a relatively short growing period and giving more yields. It is selective about soil, which means that it needs a soil rich in plant nutrient and with a good drainage. The best growth level and maximum yield level can be achieved in deep and warm soil rich in available nutrients and with a good drainage and aeration (Kün 1994).

As the world population expands, it creates pressure on the soil on which people live. That is, as the resources get scarce, people start to use intensive farming methods and more chemical fertilizers, which increase misuses. Such chemicals which are used to improve the yield and quality of the farming crops are not only detrimental for sustainability of agriculture but also cause economic loss. Therefore, the studies carried out to improve quality standards should also include the use of present resources in accordance with the sustainable agricultural criteria. The main point for these criteria is conservation of water and soil quality and to cultivate by getting maximum benefit from environment and all these require a series of studies enhancing soil and plant productivity.

In order to increase organic matter content of soil and meet plant's nutrient needs barnyard manure and plant wastes are utilized. Therefore, using low-cost and environmentally friendly organic based alternative fertilizers is vital for our country to achieve sustainable productivity in farming (Tuna et al. 2012). One of the best examples of alternative fertilizer source is the plant waste obtained from the processing of agricultural products in industry. Olive processing waste and olive mill waste water which are obtained from the processing of olive are low-cost and environmentally friendly organic based alternative fertilizers (Cabrera et al. 1996).

Nitrogen is a vital plant nutrient and a major yield determining factor required for maize production. Maize plant, which is capable of giving high dry matter under irrigated conditions and has hairy roots, needs high rates of N for a good yield. When a large amount of N-fertilizer is used in irrigated farming, plants cannot use all the fertilizer due to leaching (Campbell et al. 1984). As a result of the leaching, some N-fertilizer may penetrate ground water supplies leading contamination and environmental degradation. The previously made studies suggest that the amount of N should be 8-25 kg da^{-1} for maize (Hills et al. 1983, Eck 1984, Soltner 1990, Kırtok 1998). However, optimum amount of N may differ depending on the maize cultivars and environmental conditions (Kececi et al. 1987, Sencar 1998, Sezer and Yanbeyi 1997).

This study was conducted to establish the benefits of utilizing by-products of olive mills as fertilizer in maize farming, to increase the use of low-cost, organic based alternative fertilizers in both conventional and organic farming, to prevent environmental pollution by decreasing, at least partially, heavy reliance on chemical fertilizers and to shed light on the following researches.

Materials and Method

The study site and plan

The study was carried out in Kahramanmaraş conditions during second crop growing season for two years (2007 and 2008) with split-split plot experimental design with four replications. Soil properties of the study site before sowing and climate conditions during growing season are indicated in Table 1 and Table 2 respectively.

Table 1. Soil properties of experiment place in 0-20 cm depth

Properties	2007	2008	Olive processing waste
Saturation (ml)	41.2	42.3	-
Ph	7.52	7.14	6
Salt (%)	0.05	0.04	-
Lime (%)	23.4	25.77	-
Organic matter (%)	1.2	1.89	67
Phosphorous (ppm)	6.68	8.98	-
Potassium (ppm)	144.01	159.02	-

(Bouyoucous 1951; Knudsen et al 1982; Olsen and Sommers, 1982; Nelson and Sommers, 1996; Rhodes, 1996).

Table 2. Average maximum and minimum temperature and relative humidity (%) parameters belongs to second crop corn growing season at Kahramanmaraş in 2007 and 2008.

	Years	June	July	August	September	October	November
Maximum	2007	34.9	38.7	37.5	34.6	27.2	16.3
˚C	2008	34.1	37.8	38.3	32.3	26	18.6
Minimum	2007	21	23.8	23.5	19.1	14.2	7.4
˚C	2008	20.7	23.8	23.8	19.3	13.2	8.3
Humidity	2007	49.8	46	62.8	54.5	54.2	65.9
(%)	2008	49.8	58.3	59.7	61.4	54.6	64.1

The study site was prepared for the sowing with disc harrow, rotary tiller and land roller just after previous crop harvest. Previous plan is wheat. It was given 16 kg da^{-1} nitrogen fertilizer. DKC 5783 and P 3394 hybrids cultivars were used as second crop maize plant. During the study 0, 1 and 2 tons/da olive will pomace were mixed to main plots and 0, 12.5 and 25 kg da^{-1} pure N(Urea) fertilizer were applied to sub-plots in two stages. The crop was planted with 70 cm x 20 cm interval in four lines with 5 m length (in $14m^2$ plots) in split-split plot.

Field study and data collection

Second crop maize sowing was made in the first week of July in 2007 and in the last week of June in 2008 by means of planter. In both years, the study was conducted in the same site like fixed plot. The previous crop plant was wheat in both years. Olive mill pomace was applied to the soil in the main plots by hand and then the site was harrowed. While P fertilizer was applied with sowing machine (10 kg da^{-1} P_2O_5), the first half of pure N (urea) fertilizer was applied to the rows by hand. The other half of N fertilizer was applied to the rows by hand just before the tassel flowering. All treatments were weeded twice a year to effectively control the weeds but insecticide was applied once in 2007 and twice in 2008. As for irrigation, it was applied seven and eight times in 2007 and 2008 respectively. Even though the crops reached to enough maturity at the end of October, they were harvested in the first week of December due to precipitation.

In this study, tassel flowering period, first ear height, plant height, stem diameter, number of ear per plant, ear length, number of grain per ear, grain yield per ear, 1000 grain weight, protein content and grain yield parameters were examined (Ülger 1986). All the data were analyzed using SAS (Anon, 1997) statistical program and the treatment means were assessed according to LSD test.

The properties of the soil prior to planting are shown in Table 1 . The soil of the study site was loamy, pH was neutral and slightly alkali, had no salinity problem, rich in the point of lime and potassium, had a moderate level of organic matter and phosphor. Olive processing waste was examined only in terms of organic matter content and it was detected to be rich in organic matter (67%). The soil sample was air-dried and passed through a 2-mm sieve before analysis. The soil pH was determined by glass electrode on saturated soil samples. Electrical conductivity of the soil was measured in saturation paste extract (Rhodes, 1996). Lime content of the soil was measured by the Scheibler calcimeter. Organic matter content of the soil was determined by the modified Walkley-Black wet oxidation procedure described by Nelson and Sommers (1996). The soil potassium content including exchangeable potassium was determined using the methods described in Knudsen et al. (1982). The soil texture was determined by the hydrometer method (Bouyoucous, 1951). The phosphorus content of the samples was determined by spectrophotometer, Jenway 6100, using the sodium bicarbonate method (Olsen and Sommers, 1982).

It is shown in Table 2 that the lowest and the highest temperatures in July and August, when maize continues to its vegetative development, were 20.7 ˚C and 38.7 ˚C respectively. The lowest and the highest temperature were recorded as 13.2 ˚C and 34.6 ˚C respectively in September and October, when generative development continues. During the second crop growth season, relative humidity changed in the range of 46.0-65.9 % (Anon, 2008).

Results and Discussion

Tassel flowering period (TFP), first ear height (FEH), plant height (PH), stem diameter (SD), number of ear per plant (NEPP), ear length (EL), number of grain per ear (NGPE), grain yield per ear (GYPE), 1000 grain weight (1000 GW), protein rate (PR) and grain yield (GY) parameters of the second crop maize cultivars and the interactions which formed significant varieties are indicated in Table 3 and 4.

Years

The research was carried out in the same place for both years. In other words, Plots of trial were been fixed. It is shown in Table 3 and 4 that the years had significant effect on the traits except for the NEPP and 1000 GW characteristics of corn investigated in the study. The plants cannot benefit from organic matter immediately. Firstly it must be broken by micro-organisms. So after a while, the plant can be taken as nutrient. Thus, the effect of organic matter was observed later (Montemurro et al., 2006).

While the TEP was measured as 55.56 days in 2007, it was observed to be three days earlier (52.59 days) in the second year. FEH were 64.81 cm and 74.03 cm in 2007 and 2008 respectively. PH was 182.12 cm in 2007 and 171.51 cm in 2008. SD were recorded as 23.13 mm and 20.34 mm in 2007 and 2008 respectively. EL was 18.39 cm in first year and 19.39 cm in second year. The NGPE per ear were recorded as 591.38 units and 687.18 units 2007 and 2008 respectively. While GYPE was 229.27 g in the first year, it was recorded as 245.32 g in the following year. PR was 7.11 % in 2007 and it was 8.04 % in 2008. GY values were detected as 756.37 kg da^{-1} and 992.34 kg da^{-1} in 2007 and 2008 respectively (Table 3 and 4.).

The findings of Turgut (1998) that maize cultivars showed differences depending on year supports our own findings. We found that the increase in LE, GYPE, NGPE, PR (%) and GY in the second year might have been caused by soil-improving effect of the olive mill pomace applied during the experiment. Our findings were also consistent with the statement of Pineiro et al. (2008) that positive effects of olive mill pomace could be observed in the following two years and with the findings of İlay et al. (2008) that olive mill pomace would be beneficial when it is applied a few months earlier than the date of plantation. Jawa (2006) suggested that if the leaves of plants mixed and integrated with the soil, it would double the grain yield. Kimetu et al. (2006) noted that when urea application in maize cultivation was compared to organic fertilizer application, penetrating of urea to lower soil layers by leaching was more than that of in organic fertilizer application. Kavdir and Killi (2008) reported that olive mill pomace stabilized all the properties of soil in clayed and sandy soils. The finding of İlay et al. (2008) that direct application of oil processing waste to sunflower and bean plants would have a negative effect on stem diameter and plant height is consistent with our findings. The three-day-earlier tassel flowering period in the second year could be attributed to the fact that the maize plants were planted earlier and benefited from longer day length in the second year. Similarly, the plants exploited day length more quickly and the plant height was measured as 11 cm shorter than that of the previous year.

Oil mill pomace rates

In the study; 0, 1 and 2 tons/da oil mill pomace doses were applied to the study site and it was observed that these varied doses had no statistically significant effects on TFP, PH, SD, NEPP, NGPE, PR and GY parameters of the maize cultivars. When compared to 1 and 2 ton/da treatments (868.48 kg da^{-1} and 837.91 kg da^{-1} grain yield respectively) with 0 ton/da olive mill pomace treatment. 0 ton/da treatment had the highest GY value with 916.52 kg da^{-1}. We found that there was no statistically significant difference between 0 ton/da and 2 tons/da olive mill pomace treatments in terms of GY. Increasing of olive mill pomace treatment caused decreasing of corn grain yield. This situation is due to the dissolve of organic matter, unable necessary nutrients for plant, unpredictability of application time and the amount. This findings is supported by following researchers. Verma ve Sharma (2008) found that the positive impact could be seen on plant and soil by the fact that the application nitrogen, phosphorus and potassium fertilizers with organic material. The possible slight increased leaching of dissolved organic chemicals complexes would be counterbalanced by the fact that the application of fresh or composted to be an extremely effective contribution to increasing crop yields and to maintaining or improving soil fertility if properly mixed and incorporated at acceptable loading rates of olive oil production waste (Cabrera. 2007). if the organic composts were mature and stable, the application of such products, even at sowing time, do not necessarily have a negative effect on early growth, in accordance with Murillo et al. (1997). Tejada and Gonzales (2003) explained that a temporary immobilization of soil mineral nitrogen, and consequently yield reduction, due to the deficiency of plant N uptake as a consequence of the high C/N ratio of organic waste. For this reason 0 ton/da olive mill pomace treatment had the highest GY. It was determined that the varied rates of olive mill pomace (0,1 and 2 ton/da) had no effect on grain protein content because we recorded the protein rates as 7.59, 7.55 and 7.58 % in 0, 1 and 2 ton/da treatments respectively (Table 3).

FEH, EL, GYPE and 1000 GW values of the maize plant statistically varied depending on the rates of olive mill pomace applied to the field. While the highest FEH was measured as 72.56 cm in 0 ton/da treatment, the lowest one was recorded as 66.61 cm in 2 tons/da treatment, which was followed by 69.08 cm value in 1 ton/da treatment. The lengthiest EL was recorded 19.50 cm in 0 ton/da treatment, and the shortest was determined 18.17 cm 2 ton/da treatment. While the highest GYPE was measured as 247.03 g in 0 ton/da application, the lowest one was recorded as 225.97 g in 2 tons/da application, which was followed by 238.89 g value in 1 ton/da treatment. While the highest 1000 GY was measured as 360.91 g in 0 ton/da treatment, which was followed by 355.75 g in 1 ton/da treatment and the lowest value was recorded as 340.67 g in 2 tons/da treatment. It was determined that as the doses of olive mill pomace increased, FEH, EL, GYPE and 1000 GW (Table 3 and 4).

Table 3. Average data belongs to tassel flowering period (TFP), first ear height (FEH), plant height (PH), stem diameter (SD), number of ear per plant (NEPP), ear length (EL) parameters of the second crop maize in Kahramanmaraş conditions in 2007 and 2008 years.

	TFP (day)	FEH (cm)	PH (cm)	SD (mm)	NEPP (unit)	EL (cm)
Years (A)	**	**	*	**	ns	**
2007	55.56	64.81	182.12	23.12	0.93	18.39
2008	52.59	74.03	171.51	20.34	1	19.39
Olive mill pomace (B)	ns	**	ns	ns	ns	*
0 kg da^{-1}	55.1	72.56	180.52	22.43	0.94	19.5
1 ton kg da^{-1}	53.04	69.08	181.16	21.77	0.98	18.99
2 ton kg da^{-1}	54.1	66.61	168.77	21	0.98	18.17
Nitrogen rates (C)	ns	ns	ns	**	ns	*
0 (kg da^{-1})	54.75	67.51	172.13	20.15	0.92	18.29
12.5 (kg da^{-1})	54.43	69.82	179.21	22.3	0.98	18.89
25 (kg da^{-1})	53.06	70.93	179.11	22.75	0.99	19.49
Varieties (D)	ns	**	*	*	**	ns
DKC 5783	54.94	64.63	171.58	21.24	1.02	18.82
P 3394	53.62	74.21	182.05	22.24	0.91	18.96

*, ** Significant at 0.05 and 0.01 level respectively. ns : non-significant at 0.05.

Table 4. Average data belongs to number of grain per ear (NGPE) grain yield per ear (GYPE), 1000 grain weight (TGW), protein rate (PR) and grain yield (GY) parameters of the second crop maize in Kahramanmaraş conditions in 2007 and 2008 years.

	NGPE (unit)	GYPE (g)	TGW (g)	PR (%)	GY (kg da^{-1})
Years (A)	**	**	ns	**	**
2007	591.38	229.27	352.54	7.11	756.37
2008	687.18	245.32	352.34	8.04	992.34
Olive mill pomace (B)	ns	*	*	ns	ns
0 kg da^{-1}	656.01	247.03	360.91	7.59	916.52
1 ton kg da^{-1}	629.32	238.89	355.75	7.55	868.48
2 ton kg da^{-1}	632.51	225.97	340.67	7.58	837.91
Nitrogen rates (C)	ns	*	**	ns	**
0 (kg da^{-1})	654.6	228.86	345.63	7.54	692.42
12.5 (kg da^{-1})	623.03	234.04	345.37	7.62	875.24
25 (kg da^{-1})	640.21	248.98	366.31	7.57	1055.4
Varieties (D)	ns	ns	ns	ns	**
DKC 5783	654.04	234.17	354.88	7.72	827.81
P 3394	624.52	240.42	350	7.43	920.81

*, ** Significant at 0.05 and 0.01 level respectively. ns : non-significant at 0.05.

The fact that FEH values increased in response to the increase in olive mill pomace in the second year might have been caused by fixed plot method and olive mill pomace application in previous year (Jawa, 2006; İlay et al., 2008; Pineiro et al., 2008).

The findings of Killi (2008) that as the rate of olive mill pomace increased, the plant growth was adversely affected and decreased and findings of İlay et al. (2008) that olive mill pomace had a negative effect on plant height, dry weight and stem diameter of sunflower and bean plants are highly consistent with our own findings. Since C/N rate increases as a result of increase in organic matter in soil and the forms of nutrients are not suitable for plant intake, plant growth will be inhibited. Therefore, as the amount of oil mill pomace increased, statistically significant and insignificant decreases were recorded in terms of all features investigated. The finding of Gachengo et al. (1999) that due to imbalance in nutrients in organic and mineral fertilizer combination, a regular and consistent relation could not be achieved and they could not obtain positive results supports our findings. Daudu et al. (2006) suggested that organic materials could be classified into two groups as high nutrient rate-low N rate and high N rate-low nutrient rate and determining an optimum N-nutrient combination could enhance maize yield. Nziguheba et al. (2002) stated that like Tithonia, organic waste had a more long-lasting enhancing effect on maize yield than mineral fertilizers and as the rate of organic waste increased in N- nutrient combination, maize yield increased. Kimetu (2002) stated that organic fertilizers had positive effects on maize yield but there were not sufficient details about N- nutrient combination rate. It was explained that combination of organic and inorganic fertilizers had a more positive effect on maize cultivars than each single fertilizer. Sangakkara et al. (2008) reported that the effect of organic fertilizer application on maize yield was greater in dry seasons.

Nitrogen rates

It was noted that while N rates had no statistically significant effect on TFP, FEH, PH, NEPP, NGPE and PR of the maize plants, its effect on GY, SD, EL, 1000 GW and GYPE was statistically significant. We recorded stem diameters as 20.15 mm, 22.30 mm and 22.75 mm in 0 kg da^{-1}, 12.5 kg da^{-1} and 25 kg da^{-1} N rate application respectively. EL also were determined as 18.29 cm, 18.89 cm and 19.49 cm in 0 kg da^{-1}, 12.5 kg da^{-1} and 25 kg da^{-1} N rate application respectively. The highest GYPE was measured as 248.98 g in 25 kg da^{-1} N application and it was followed by 234.04 g and 228 g grain yield per ear in 12.5 kg da^{-1} and 0 kg da^{-1} N applications respectively. The highest 1000 GW was recorded at 25 kg da^{-1} N rate application with 366.31 g. Whereas 1000 GW was measured 345.63 g and 345.37 g at 0 kg da^{-1} N and 12.5 kg da^{-1} N rates applications respectively, and there was no statistically significant difference between them in terms of 1000 GW. The lowest GY was measured as 692.42 kg da^{-1} in 0 kg da^{-1} N application, which was followed by 875.24 kg da^{-1} in 12.5 kg da^{-1} N application. The highest GY value was obtained as 1055.40 kg da^{-1} in 25 kg da^{-1} N application. It was found out that increasing amount of N resulted in substantial increase in maize yield. SD, EL, GYPE and GY increased in parallel with increase in N-dose (Table 3 and 4).

Higher doses of N treatment had no significant effect on TFP, FEH and PH. These three properties affect each other and they vary greatly in case of temperature, light and soil humidity variations (Yürürdurmaz 2007). There was a great variation in stem diameter of the N-fertilizer-applied maize plant compared to the maize plant in which no N was applied. This result is consistent with the findings of Budaklı Carpıcı et al. (2010) that stem diameter increased in response to increasing N rate. Also, İdikut and Kara (2011) reported that 1000 grain weight increased depending on nitrogen rates increases. We observed that ear length was varied by treatments (Saruhan and Şireli 2005; Koca et al. 2010) It is concluded from the results that grain yield per ear and grain yield increased in parallel with the increase in N rates. Starcevic et al. (2005) stated that there was a significant relation between the years and type of fertilizer, and maximum grain yield was measured from 300-350 kg da^{-1} N application, but the optimum economic grain yield, depending on the cost of nitrogen in grain, was obtained to 179-286 kg da^{-1} N treatment. Eck (1984) reported that N had a significant impact on grain weight and this impact was greater in case of limited. Dahmardeh (2011) reported that in response to the increase in N rate, grain yield increased and the highest grain yield was achieved in 350 kg/ha N application. Okalebo et al. (1999), Idikut and Kara (2011) suggested that higher grain yield could be achieved through application of organic and inorganic inputs to soil.

Cultivars

In our two-year-study, there was no statistically significant difference between the hybrid maize cultivars DKC 5783 and P 3394 in terms of TFP, GYPE and N rate in grain (Özsisli et al., 2009). However, there were statistically significant differences between the maize cultivars in terms of FEH, PH, SD, NEPP and GY. P 3394 maize cultivar (74.21 cm) had a higher PEH value than DKC 5783 cultivar (64.63 cm). While PH was recorded as 182.05 cm in P 3394 maize cultivar, it was measured as 171.58 cm in DKC 5783 cultivar. The SD value of P 3394 cultivar (22.24 mm) was detected to be higher than that of DKC 5783 cultivar (21.24 mm). The cultivar DKC 5783 had a higher (1.02) NEPP than P 3394 cultivar (0.91). In terms of GY, P 3394 cultivar (920.81 kg da^{-1}) gave more yield than DKC 5783 cultivar (827.81 kg da^{-1}) (Table 3). The finding of Cesurer (1995) that there were great differences between maize types in terms of first ear height, plant height and grain yield values supports our finding. While the two maize cultivars had no statistically significant difference in terms of TFP, GWPE and PR, P 3394 maize cultivar had greater values in terms of all the features except TFP and PR (%).

The fact that DKC 5783 and P 3394 maize cultivars used in this study are in the same group in terms of tassel flowering period shows that they are in the same group in terms of growing day degree, too. The maize cultivars which have the same growing day degree and treated similarly will not show difference in terms of protein rate. This view is supported by the findings of Vartanlı and Emeklier (2007). In the study carried out by Ozsisli et al. (2009), great differences were observed between the maize cultivars in terms of protein rate due to the fact that the maize cultivars had different growing day degree. The grain yield differences between the two maize cultivars was 93 kg da^{-1}. The differences was caused by the genetic constitution of the cultivars (Vartanlı and Emeklier, 2007). Similarly, P 3394 cultivar had greater values than DCK 5783 type in terms of first ear height (10 cm), plant height (11 cm) and stem diameter (1.0 mm). This was caused by the genetic constitution of the cultivars (Tekkanat and Soylu, 2005).

Interactions

In this study, in which the effect of olive mill pomace and N rate on maize cultivars, year x maize cultivar interaction had a significant effect on FEH, SD and NEPP. Olive mill pomace x maize cultivar interaction affected NGPE significantly. Furthermore, year x nitrogen rate and year x maize cultivar interactions on GYPE ear had significant effect. In addition, olive mill pomace x nitrogen rate interaction affected PR (%). These significant interactions are shown in Figure 1, 2, 3, 4, 5, 6 and 7.

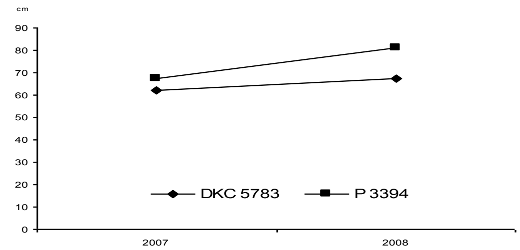

Figure 1 The effect of year x variety interaction on the first ear height

It can be seen from Figure 1 that while P3394 maize cultivar had a lower FEH value in the first year (67.53 cm) than in the second year (80.88 cm), the first ear heights of DKC 5783 maize cultivar were 62.08 cm and 67.18 cm in the first and second year respectively. This indicates that the effect of years on DKC 5783 maize cultivar was less than that of on P 3394 cultivar. In other words, DKC is a more stable maize cultivar in terms of FEH.

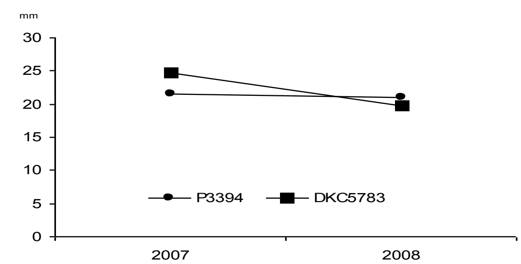

Figure 2 The effect of year x variety interaction on the stem diameter

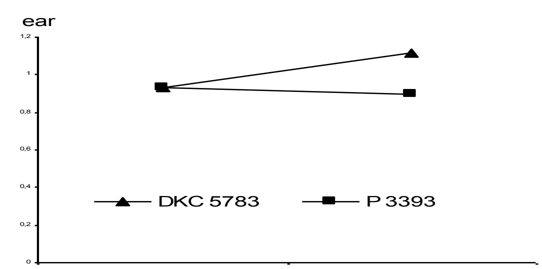

Figure 3 The effect of year x variety interaction on ear number per plant

Figure 2 indicates that while there was no significant difference between the SD values of the first (21.46 mm) and second year (21.00 mm) in P 3394 maize cultivar, DKC 5783 maize cultivar had a higher SD in the first year (24.79 mm) compared to the second year (19.68 mm). This suggests that P 3394 cultivar was more stable in terms of SD but DKC 5783 cultivar gave a more notable response to the years. The NEPP of DKC 5783 cultivar was higher in second year (1.11 ears) than that of the first year. Whereas, P 3394 cultivar had 0.93 ears NEPP in first year, it had 0.89 ears in second year, and showed a behavior unlike the other variety. Cultivars showed different reaction in terms of the NEPP according to the years (Fig. 3). While DKC 5783 hybrid corn had 643.33 NGPE with 0 kg da^{-1} oil mill pomace treatment, it was 621.79 grains and 696.99 grains with 1 ton/da and 2 ton/da oil mill pomace treatment respectively. The NGEP of P 3394 hybrid corn was showed decrease (668.67, 636.84 and 568.03) when rates of oil mill pomace were increase (0, 1 and 2 ton/da treatment). Hybrid corns showed different reaction in terms of the NGPE according to the oil mill pomace rates (Fig.4).

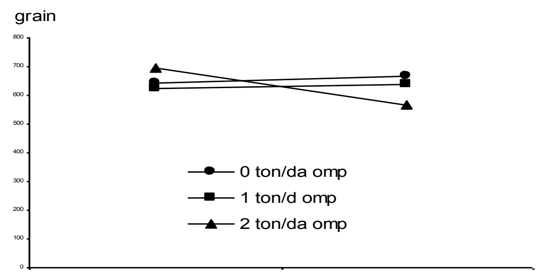

Figure 4 The effect of variety x olive mill pomace (omp) interaction on the grain number per ear

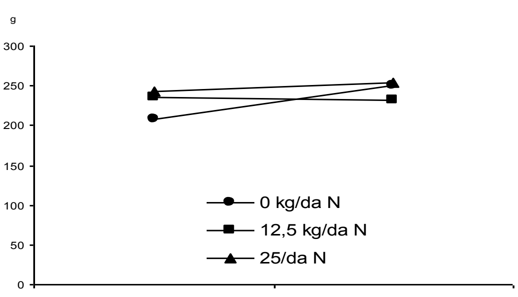

Figure 5 The effect of year x nitrogen rate interaction on the grain yield per ear

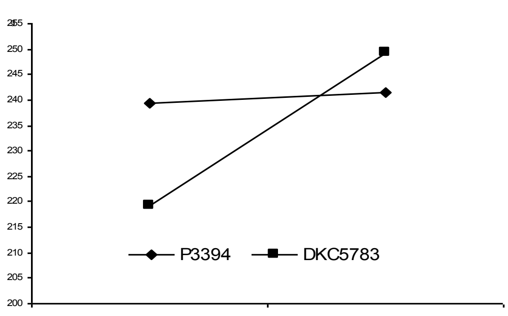

Figure 6 The effect of year x variety interaction on the grain yield per ear

The data from Figure 5 shows that in year x N rate interaction, 0 kg da^{-1} N treatment gave a more GYPE ear in the second year (229.79 g/ear) than in the first year (207.93 g ear^{-1}). The GYPE values in 12.5 kg da^{-1} and 25 kg da^{-1} N treatments were 236.47 g and 243.41 g in the first year; 231.61 g and 254.55 g in the second year respectively. It can be seen from the diagram that there was a slight decrease in grain yield per ear in 12.5 kg da^{-1} N treatment while there was an increase of 11 g in 25 kg da^{-1} N treatment. Previous studies indicated that upper fertilizer made a contribution to maize growth in certain growth periods (Eck, 1984; Oner, 2003; Celebi et al., 2010; Karadavut et al., 2010; Özkan and Ülger, 2011). The substantial increase in 0 kg da^{-1} N treatment in the second year might have been caused by the positive contribution of olive mill pomace and fixed plot method (Jawa, 2006; Ilay et al., 2008; Pineiro et al., 2008; Yolcu, 2011). P 3394 maize cultivar showed a stable manner and had only a slight difference of 2 g in terms of the GYPE between the first year (239.34 g) and the second year (241.49 g) in year x maize cultivar interaction (Fig. 6). DKC 5783 cultivar was determined to be variable in terms of GYPE depending on the year as it had a significant difference between the GYPE value of the first year (219.23 g) and that of the second year (249.14 g). As N rate(0, 12.5 and 25 kg da^{-1}) increased in 0 kg da^{-1} olive mill pomace treatment, the grain(7.17, 7.67 and 7.95 % respectively) protein rate of the maize was observed to increase except 2 tons/da OMP (Figure 7).

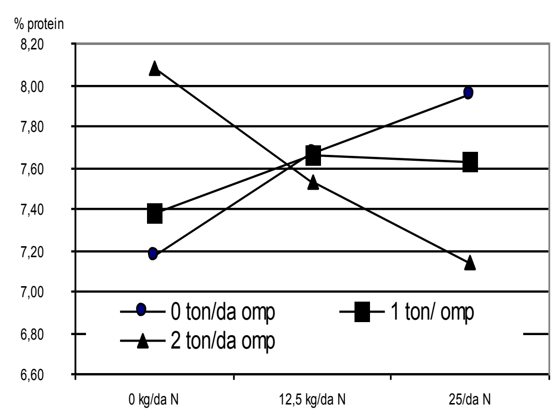

Figure 7 The effect of olive mill pomace (omp) x nitrogen rate interaction on protein ratio (%)

When 1 ton/da olive mill pomace was applied to the soil, it was detected that the protein rate in 12.5 kg da^{-1} N application (7.66 %) was higher than in 0 kg

da^{-1} N application (7.37 %) but lower than 25 kg da^{-1} N application (7.62 %). This implies that 1 ton/da olive mill pomace treatment had no significant effect on the PR. When 2 tons /da olive mill pomace was applied to the soil, the highest protein rate was obtained in 0 kg da^{-1} N application (8.0 %) but as the N rate increased (12.5 and 25 N kg da^{-1}) the PR was observed to decrease (7.53 and 7.14 % respectively). This result clearly indicated that using olive mill pomace alone (without N) provided much better results. This result is highly consistent with the finding of Yolcu (2011).

Such interactions which have positive effect on stem diameter and grain yield per ear were also observed in previous studies (Cesurer, 1995; Okalebo et al., 1999; Nziguheba et al., 2002; Starcevic et al., 2005; Idikut et al., 2009).The effects of other interactions were insignificant on the features examined (Gachengo et al., 1999; Idikut and Kara, 2011).

Conclusion

We aimed to investigate the effect of olive mill pomace on second crop corn plant in this study. We have partly reached to our aim as a result of the study. Grain yield was decreased by increasing of olive mill pomace, but increased by application of nitrogen. The plants did not benefit from olive oil pomace that had high amount of organic matter. It was showed that organic matter was needed to breakdown by microorganisms and later plants would be used. Because, the mojorty of the features examined showed great differences depending on the years. Finally, the findings of this study indicate the long-term value of an organic amendment for a slow release of nutrients for crop growth. In fact, soil application of these materials is important to sustain yields. Moreover, in the second year increase was significant. The study was carried out with fixed plots and wheat was the previous plant in both years. If the study is carried out for longer years, better results might be obtained.

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