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Effects of Deficit Irrigation Treatments on Fatty Acid Contents and Mediterranean Corn Borer Infection Rates of Some Maize (*Zea mays indentata* Sturt.) Genotypes

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Abstract— *This study was conducted over the experimental fields of Siirt University Agricultural Faculty in 2015 and 2016 growing seasons with the first crop 31D24, ADASA16 and P1429 maize genotypes to determine kernel yields and Mediterranean corn borer (Sesamia nonagrioides* Lefebvre*) infection rates under deficit irrigation treatments (I_{100}, I_{70}, I_{35}). Experiments were conducted in randomized blocks – split plots experimental design with three replications. The Chemical analyses revealed the lowest fatty acid content in full irrigation (I_{100}) and the greatest fatty acid content in deficit irrigation (I_{35}) treatment. As the average of two years, the greatest yield (10400 kg ha^{-1}) was obtained from I_{100}x31D24 interaction and the lowest yield (2853.3 kg ha^{-1}) was obtained from I_{35}xP1429 interaction. The greatest infection rate was observed in full irrigation (I_{100}) (11.87%) and the least infection rate was observed in deficit irrigation treatment (I_{35}) (7.01%). The greatest fatty acid content was observed in deficit irrigation (I_{35}) and the greatest fatty acid content was observed in full irrigation (I_{100}) treatment.*

Keywords— *Deficit irrigation, Mediterranean corn borer, Fatty acid, Infection rate*.

I. INTRODUCTION

Maize supplies about 22% of daily calorie consumed in human nutrition worldwide. Just because of availability for machinery culture and high yield levels, maize plays a great role both in human and animal nutrition. As it was in the world, there are several pests with negative impacts on maize culture in Turkey. Of these pests, European corn borer (*Ostrinia nubilalis* Hübner) and Mediterranean corn borer (*Sesamia nonagrioides* Lefebvre) are the most important ones. Turkay et al. (2010a) reported that only 60% protection was provided with 3 pesticide treatments against European corn borer and Mediterranean corn borer in second crop maize culture. European corn borer is widespread in several countries like Europe, America and Turkey (Zeren et al., 1988). On the other hand, Mediterranean corn borer is widespread in Mediterranean countries including Spain, France, Italy, Greece and Turkey (Kayapınar and Kornoşor, 1998). Therefore, it is called "Mediterranean Com Borer" in literature (Castanera, 1986). Cerit et al. (2006) indicated contamination ratio in Çukurova region as 70% for Mediterranean corn borer and 30% for European corn borer based on infected number of plants; as 87% for Mediterranean corn borer and 13% for European corn borer based on alive larva + pupa ratio per plant. Both pests create damages on all organs of maize plants except for root region. About 60% protection was achieved with 3 pesticide treatments (Turkay et al. 2011a). When the pesticide treatments were not practiced on time, corn borer larva get into the plant and then chemical treatments become ineffective (Dicke and Guthrie, 1988). Uçak et al. (2011) investigated the effects of different irrigation treatments (I_{100}, I_{80}, I_{60}, I_{40}, I_{20}, I_0) on Mediterranean corn borer (*S.nonagrioides* Lefebvre) and European corn borer (*O. nubilalis* hübner) populations and reported greater population (27.167 per plant) in full irrigation treatments (I_{100}) than in non-irrigated treatments (I_0) (13.50 per plant). Turkay et al. (2011b) indicated quite narrow variation in maize lines resistant to European and Mediterranean corn borer under Çukurova conditinos and pointed out a need for hybridization of the lines able to transfer the resistance to F_1 hybrids with the sensitive lines. Turkay et al. (2011c) reported heritability in resistance to Mediterranean corn borer as 53% for number of holes / 100 internodes and 57% for tunnel length / plant height. All these previous studies indicated the significance of development of high-yield cultivars also resistant to European and Mediterranean corn borer and transfer of these developed lines and cultivars into practice. Interactions of radicals with unsaturated fatty acids alter saturated and unsaturated fatty acid ratios of cell membranes (Monteiro de Paula et al., 1993). Salama et al. (2007) exerted abiotic stressors on some maize cultivars and reported increased total saturated fatty acid ratios under stress conditions. Eicosapolyenoic acids (EP), which do not occur in higher plants, elicit a cascade of responses in plants, including an oxidative burst and the transcriptional activation of genes involved in phytoalexin synthesis, lignification, programmed cell death, and other responses typically associated with the hypersensitive response (HR) to pathogens (Savchenko et al., 2010). The present study was conducted to investigate the effects of deficit irrigation treatments (I_{100}, I_{70}, I_{35}) on yield, Mediterranean corn borer (*S. nonagrioides* Lefebvre) infection rates and fatty acids of first crop 31D24, ADASA16, P1429 hybrid maize cultivars.

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II. MATERIALS AND METHODS

Experimental site has an altitude of 894 m and located between 37˚ 58' N latitudes and 41˚ 50' E longitudes. Silage maize genotypes of P32K61, P31Y43 and P30B74 with different maturity groups were used as the plant material of the experiments.

Average summer temperature of the experimental site throughout the maize growing season is 26 ºC and average winter temperature does not drop below 2.7 ºC. The greatest long-term average relative humidity is observed in January as 70.2% and the lowest value is observed in August as 26.9%. Annual average relative humidity is 50.41%. Long-term annual average precipitation is 669.2 mm and monthly precipitations vary between 1.3 – 103.6 mm. Experimental soils were classified as brown forest soil with low electrical conductivity and salinity, low phosphorus content, high potassium content and medium organic matter content. Lime levels were not posing any problems for plant growth. Field capacity (FC) (for 0-90 cm soil profile) was 443 mm in depth and permanent wilting point (PWP) was 322 mm, soil bulk density was 1.40 gr/cm^3 and available water holding capacity was 121 mm. Irrigation water used in experiments was classified as C_2S_1. Irrigation water was of high quality with an electrical conductivity of 0.34 dS/m, and a pH of 7.21. Irrigation water does not pose any problems for maize culture. Experiments were conducted in randomized blocks – split plots experimental design with 3 replications.

P32K61, P31Y4 and P30B74 silage maize cultivars were placed in main plots and $I_{100,}$ I_{70} and I_{35} irrigation treatments were placed in sub-plots. Irrigation program was scheduled as to have irrigations once a week. Treatments were selected as full irrigation (I100) in which 100% of depleted moisture was supplied, deficit irrigation treatment (I70) in which 70% of depleted moisture was supplied and deficit irrigation treatment (I35) in which 35% of depleted water was supplied. Therefore, one full irrigation and two deficit irrigation treatments were created.

The holes through which pests get in/out from the plant shoots and cobs were counted one by one and infection rates were determined (Turkay et al., 2011 d).

Infection rate / Plant + cob: 25 plants and cobs over which number of holes was counted were split into half from the mid-sections and infection ratios were determined both in shoots and cobs through separately counting infections (Turkay et al., 2011c).

Fatty Acid Contents:

GS-MS device was used to determine the fatty acid composition of maize cultivars (31D24, ADASA16, P1429) at different irrigation levels (I100, I70, I35). Plant samples were grounded in a hand mill. Then, 5-7 grams of ground samples were extracted with petroleum ether at 110 °C for 45 minutes. Following the soxalate cartridge, extracts were kept in an oven at 120 °C for 2 hours to fully volatilize the solvent. Then the samples were reweighted and placed again into the oven. This process was repeated until a constant weight. Sample with constant weight was weighted last time. Oil content was determined by using the following equation:

$$\%Oil = \frac{Obtained\ oil\ quantity}{Sample\ quantity} \times 100$$

Esterification of Oil Sample and GC-MS Process:

About 3 mL oil samples were placed in tubes and then supplemented with 5 mL 1 M KOH solution (dissolved in methanol). Tubes were vortexed and thoroughly shaken. Esterified fatty acids formed an upper phase and this phase was filtered through 0.22 micron filter. Then, 0.5 mL of filtered sample was completed to 2 mL with methanol.

All the data acquired through these methods have been subjected to an Analysis of Variance (ANOVA) in accordance with randomized blocks – split plots experimental design. Based on the results obtained from the analysis of variance, significant treatments were compared with LSD (Least Significant difference) and Tukey multiple comparison tests, accordingly.

III. RESULTS AND DISCUSSION

Results on irrigation water quantities applied to maize genotypes and plant water consumption values under semi-arid climate conditions and statistical analyses results (LSD groups) are provided in table I. Kernel yields of the first year varied between 10443.3 - 2916.6 kg/ha with the greatest yield from I_{100}x31D24 interaction and the least yield from I_{35}xP1429 interaction. In the second year, yields varied between 10353.3 - 2800.0 kg/ha with the greatest value in I_{100}x31D24 interaction and the lowest value in I_{35}xP1429 interaction. While I_{100}x31D24 interaction was placed in Group A, I_{35}xP1429 interaction was placed in Group I. The 31D24 genotype had the greatest yield both under full and deficit irrigation conditions (Table I).

In the first year, the greatest infection rate with Mediterranean corn borer was observed in full irrigation treatment (I_{100}) (11.87%) and the lowest infection rate was observed in deficit irrigation treatment (I_{35}) (7.01%). In the second year, the greatest infection rate was observed in again full irrigation treatment (I_{100}) (14.25%) and the lowest infection rate was observed in deficit irrigation treatment (I_{35}) (8.20%). The pests (Mediterranean corn borer) preferred the genotypes with high fatty acid contents and did not prefer the genotypes poor in fatty acids. The genotype (P1429) sensitive to Mediterranean corn borer had greater number and quantity of fatty acids than the resistant genotype (31D24). In this case, it was concluded that sensitive genotypes had greater fatty acid synthesis than the resistant genotypes under water deficit and biotic stress conditions.

IV. CONCLUSIONS

Mediterranean corn borers preferred full irrigation treatment (I_{100}) the most and excessive-water deficit treatment (I_{35}) the least. However, even in full irrigation treatment, pests did not prefer all genotypes at the same level. The greatest infection rate was observed in full irrigation and the least infection rate was observed in deficit irrigation treatment.

Mediterranean corn borer mostly preferred the genotypes rich in fatty acids and did not prefer the genotypes poor in fatty acids. The sensitive genotype (P1429) had greater number and quantity of fatty acids than the resistant genotype (31D24). It was concluded that sensitive genotypes had greater fatty acid synthesis levels than the resistant genotypes under deficit irrigation and biotic stress conditions. Therefore, high fatty acid contents were thought to be the defense mechanism developed against biotic and abiotic stressors.

TABLE I. Yield and infection rates of maize genotypes under different irrigation treatments.

Treatments	Yield (kg ha $^{-1}$) **	Infection Rate (%)**	Treatments	Yield (kg ha $^{-1}$) **	Infection Rate (%)**
2015 (First year)			2016 (Second year)		
Irrigation treatments			Irrigation treatments		
I_{100} (FI)	1027.44 a	11,8777 a	I_{100} (FI)	1018.00 a	14,2555a
I_{70} (DI)	718.22b	8,8233 b	I_{70} (DI)	709.22 b	10,5333b
I_{35} (DI)	353.44 c	7,0111 c	I_{35}	341.66 c	8,2000c
LSD (0.05)	5.38	0,20	LSD (0.05)	4.53	0.34
Genotypes			Genotypes		
31D24	727.66 a	10,2677a	31D24	717.55 a	11,9555a
ADASA16	703.55 b	8,9977b	ADASA16	692.88 b	11,0111b
P1429	667.88 c	8,4466c	P1429	658.44 c	10,0222c
LSD (0.05)	4.40	0.18	LSD (0.05)	4.60	0.46
Irrigation x genotype interactions			Irrigation x genotype interactions		
I_{100}x31D24	1044.33 a	13,6666a	I_{100}x31D24	1035.33 a	15,6666a
I_{100}xADASA16	1024.66 b	11,5000b	I_{100}xADASA16	1015.66 b	14,1000b
I_{100}xP1429	1013.33 c	10,4666c	I_{100}xP1429	1003.00 c	13,0000c
I_{70}x 31D24	734.66 d	9,5366d	I_{70}x 31D24	724.00 d	11,5333d
I_{70}x ADASA16	721.33 e	8,6333e	I_{70}x ADASA16	711.33 e	10,63333e
I_{70}xP1429	698.66 f	8,3000e	I_{70}xP1429	692.33 f	9,4333f
I_{35}x 31D24	404.00 g	7,6000f	I_{35}x 31D24	393.33 g	8,6666g
I_{35}xADASA16	364.66 h	6,8600g	I_{35}xADASA16	351.66 h	8,3000g
I_{35}xP1429	291.66 ı	6,5733g	I_{35}xP1429	280.00 ı	7,6333h
LSD (0.05)	9.33	0.34	LSD (0.05)	7.98	0,59

* and **, significant at P≤0.05 and P≤ 0.01 level, respectively; ns, not significant; means in the same column with the same letter are not significantly different from each other

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REFERENCES

[1] Anglade, P., 1972. Les Sesamia. İn A.S. Balachowsky (ed.) Entomologie appliquee a l'agriculture. II. Lepidopteres, II. Mason et Cie, pp.1389 - 1400. Paris.

[2] Cerit, İ., Sarihan, H., Turkay, M.A., Uçak, A.B., Güllü, M., Kanat, A.D., 2006. Mısırkurdu (*Ostrinia nubilalis* Hübner) (Lepidoptera: Crambidae)ve Mısır Koçankurdu (*Sesamia nonagrioides* Lefebvre) (Lepidoptera: Noctuidae) 'na dayanikli transgenik misir çeşidi Pioneer 33P67 (MON 810) Bt' nin alan denemesi. projesi sonuç raporu, Adana (in Turkish).

[3] Dicke, F.F., Guthrie, W. D., 1988. The most important corn insects. pp. 767-867. In G. F. Sprague and J.W. Dudley (ed) Corn and Corn Imrovement. Argon. Monogr. 18 ASA, CSSA, Madison, WI.

[4] Kayapınar, A., Kornoşor, S., 1998. Çukurova Bölgesi'nde Mısır Koçankurdu'nun mevsimsel çıkışı ve populasyon gelişmesi. Proceedings of A Symposium On Corn Borers And Control Measures, 1-3 November Adana, pp. 87-91 (in Turkish)

[5] Monteiro de Paula, F., Pham Thi, A.T., Zuily Fodil, Y., Ferrari-Iliou, R., Vieira da Silva, J., Mazliak, P., 1993. Effect of water stress on the biosynthesis and degradation of polyunsaturated lipid molecular species in leaves of *Vigna unguiculata* Plant Physiology and Biochemistry 31: pp. 707–715.

[6] Salama, K.H.A., Mansour, M.M.F., Ali, F.Z.M., Abou-hadid, A., 2007. NaCl-induced changes in plasma membrane lipids and proteins of *Zea mays* L. cultivars differing in their response to salinity. Acta Physiol Plant, 29, pp. 351-359.

[7] Savchenko, T., Walley, J.W., Chehab, E.W., Xiao, Y., Kaspi, R., Pye, M.F., Mohamed, M.E., Lazarus, C.M., Bostock, R.M., Dehesh, K., 2010. Arachidonic acid: an evolutionarily conserved signaling molecule modulates plant stress signaling networks. Plant Cell 22, pp. 3193–3205.

[8] Turkay, M.A., Sarihan, H., Uçak, A.B., 2011a. Mısır Koçankurdu (*Sesamia nonagrioides* Lef.) ve mısırkurdu (*ostrinia nubilalis* hübn.)'na dayanıklı türkay mısır çeşidinin ilaçlı ilaçsız şartlardaki verim kaybı ve dayanıklılık değerlerinin belirlenmesi. Türkiye IX. Tarla Bitkileri Kongresi, 12-15 Eylül 2011 Bursa / Türkiye (in Turkish).

[9] Turkay, M.A., Korkut K.Z., Özkan H., Ülger A.C., Sertkaya E., Güllü M., Sarihan H., Uçak, A.B., Bolat A., 2011b. Mısır Koçankurdu (*Sesamia nonagrioides* Lefebvre) (Lepidoptera: Noctuidae)'na dayanıklı çeşit islahı. Tübitak 107O804 nolu proje sonuç raporu, Mayıs 2011 Tübitak/Ankara (in Turkish).

[10] Turkay, M.A., Soysal M., Korkut, K Z., Tosun, M., 2011c. Mısır Koçankurdu *(Sesamia nonagrioides* Lef.) ve Mısırkurdu (*Ostrinia nubilalis* Hübn.)'na dayanıklı çeşit geliştirme islahında kullanılan islah ve bazı dayanıklılığı belirleme yöntemleri. Melez Mısırla 100 Yıl Çalıştayı. 18-20 Mart 2011 Antalya / Türkiye (in Turkish).

[11] Turkay, M.A., Sarihan H., Uçak, A.B., 2011d. Mısır Koçankurdu (*Sesamia nonagrioides* Lef.) ve Mısırkurdu (*Ostrinia nubilalis* Hübn.)'na dayanıklı türkay mısır çeşidinin geliştirilmesi. Türkiye IX. Tarla Bitkileri Kongresi, 12-15 Eylül 2011 Bursa / Türkey (in Turkish).

[12] Uçak, A.B., Değirmenci, H., Akyol, A., Aykanat, S., 2011. İkinci ürün mısırda farklı sulama konularının Mısır koçankurdu ve Sap kurdu populasyonu üzerine Etkisi. GAP 6.Tarım Kongresi 09-12 Mayıs Şanlıurfa-Turkey Presentation, pp. 40-44 (in Turkish).

[13] Zeren, O., Güllü, M., Şimşek, N., 1988. Some Biological Investigations Relating To The Control of Stalk Borer (*Sesamia* spp.) and European Corn Borer (*Ostrinia nubilalis* Hbn.) on Corn in Mediterranean Region. Proceedings of a Symposium On Corn Borers and Control Measures, 1-3 November Adana, pp. 1-19 (in Turkish).