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THE EFFECT OF SOWING DATE ON YIELD AND YIELD COMPONENTS AND SEED QUALITY OF CORN (*Zea mays* L.)

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Abstract

The seed yield of corn (Zea mays L.) consists of different proportional contributions of the effective factor in all growth stages from emergence to maturity. The aim of this study was to investigate the effects of two sowing dates on agronomic and seed quality traits such as oil, protein and starch content of three commercial corn cultivars (31G98, NK-Arma and Aveline). Experiments were carried out at two different sowing dates (30 of April and 26 of May) one month between sowing dates in the Aegean region of Turkey during 2012 and 2013 summer growth periods. The experiment was a randomized block design with three replications. The results of this study showed that sowing date had statistically effected on thousand seed weight, the seed number in corncob, corncob length, seed yield, ash, oil, protein, starch contents of corn seed. In particular, it was revealed that thousand seed weight, the seed number in corncob, corncob length, seed yield, protein, ash and oil contents of seed were decreased with the delaying sowing date due to decreasing the time of growth period and seed filling. On the other hand, starch content of seed was increased by delaying sowing date in both years. The highest seed yield was obtained from Aveline corn cultivar in late sowing date in both years because of having high thousand seed weight. The percentage of decreased in terms of protein was to highest in Aveline cultivar with the delaying sowing date. It was suggested that eventough the Aegean climate has a long growing period and is a suitable environment for second crop corn growth, the selection of cultivar is very important to grown in terms of seed yield in late sowing date because of the fact that plant can be exposed to inappropriate excessive temperature during the vegetative period in late sowing date in Aegean region.

Key words: *corn, sowing date, seed yield, protein, NIRS.*

INTRODUCTION

The seed yield of corn (*Zea mays* L.) consists of different proportional contributions of the effective factor in all growth stages from emergence to maturity. For a better understanding of climatic and cultural effects on corn yield and grain quality, intensive research that evaluates different geographic locations, sowing dates and genotype selection are needed. In order to minimized negative effect of some abiotic and biotic stress on plant, sowing date can play a major role in determining the seed yield, quality, seed germination and understanding whole phenological stages in many regions. Some researchers pointed out that especially, the effect on sowing date and plant density on corn expressed that delay in sowing reduces the number of kernels in corn (Cantarero et al., 2000). Shunway et al. (1992) explained that delay in sowing reduces quality performance and performance components of maize. Early and intermediate sowings tend to best utilize solar radiation for grain production (Otegui et al., 1995). The most widely used information about how corn hybrids respond to sowing date and plant population have been generated from research done about for a long time, in which the first sowing dates were late April or early May in Turkey.

This experiment was conducted to the effect of different two sowing dates on agronomic and seed quality traits such as oil, protein and starch content of three commercial corn cultivars.

MATERIALS AND METHODS

The experiment was conducted in the Research and Experimental Farm at the Adnan Menderes University in Aydın, located in the Western Turkey at 37º 44’ N 27º 44’ E at 65 m above sea level in the 2012 and 2013 years the city of Aydın on western Turkey. The results of some

analysis on soil samples from the experiment field are given in Table 1. The soil analysis results are observed that the experiment field has loamy sand content, its reaction had alkaline characteristics and it has low levels of organic matter. The average monthly temperature and precipitation values during the time of the experiment (2012 and 2013) are presented in Table 2. It can be seen that the monthly temperature values for the corn season (April – August) in the first year is higher than that of the second year (Table 2).

The field experiment was carried out by split plot design for 4 repeats in two years. 31G98, NK-Arma and Aveline, which are hybrid corn varieties, were used as a experiment material. The main block was sowing date, sub-block was varieties. The harvest area for each variety was 11.2 m^2. The experiment's sowing dates were 30/April/2012-2013 (normal sowing date) and 26/May/2012-2013 (late sowing date) and the emerging dates were observed in 27 of May 2011 and 07 of May 2012.

1000 Seed Weight (g) was obtained by the average weight of 4 x 100. The seed number in corncob (number $plant^{-1}$) was obtained by counting the number of seed of 20 randomly selected cob at each parcel. Data was collected on seed yield per unit area (t/ha) according to the follow equation: Seed yield (t ha^{-1}) = seed weight (kg/plot) × 10.000 m^2 /plot area (m^2) × 100. Per cob yield was calculated by taking their average of 20 cobs from parcel. Per corncob length was obtained by the average corncob lenght of 20 plants in each plot.

Protein, starch and oil content of corn grain were analyzed by using NIRS-FT (Bruker MPA). Ash determination steps: 5 g of ground samples were weighed by tarring the crucible. After the samples were dried for 15 min at 550°C, 5 h, the heater and furnace were kept waiting. Then all were kept in a desiccator to cool. The results were analyzed using the TARİST package software (Açıkgöz et al., 1994) to determine the effect of nitrogen and water dosages on the corn varieties.

Table 1. Soil texture and chemical analysis of soil

Soil texture (%)			pH	Organic matter	P	K	Ca	Na	Fe	Mn
Sand	Silt	Clay		(%)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)
72.0	16.7	11.3	8.4	1.2	2978	101	19	5.6	594	21

Table 2. Monthly mean temperature and total rainfall and long-term mean (1975–2011) during the growing seasons of 2011 and 2012 at the study site in Aydin Province, Turkey

Months	Temperature (°C)			Precipitation (mm)		
	2011	2012	Long term	2011	2012	Long term
January	8.1	5.6	8.2	147.2	160.0	121.0
February	9.6	6.8	8.9	68.6	154.0	95.5
March	11.4	10.6	11.7	26.1	38.6	71.1
April	14.6	16.3	15.7	51.5	83.8	45.5
May	19.6	20.1	20.9	44.7	43.6	33.5
June	25.1	27.0	25.9	14.6	2.4	14.0
July	31.0	29.6	28.4	0.0	3.2	3.5
August	28.8	27.9	27.2	0.2	0.0	2.2
September	26.2	22.7	23.2	32.2	0.0	14.4
October	16.3	19.9	18.4	69.8	60.4	43.8
November	11.3	14.5	13.0	-	45.6	87.5
December	9.6	9.7	9.4	87.8	202.0	110.2

RESULTS AND DISCUSSIONS

The results of the analysis of variance showed (Table 3) that sowing date significantly affected on thousand seed weight, the seed number in corncob, corncob length, seed yield, ash, oil, protein, starch contents of corn seed. There were also statistically significant differences in terms of corncob length, thousand seed weight and protein content among the years (Table 3).

It was revealed that corn cultivars different response to sowing date in terms of corncob length, seed yield, starch and thousand seed weight. In respect to yield attributes such as cob length, weight of cobs per plant were found significantly higher in 26 May sowing date in both years (Table 4).

It could be due to the better growth and development of crop as Kolawole et al. (2009) reported that due to the fact that good photosynthates accumulated in leaves and its transfer to economic part like grains, cobs etc.

This research showed that early sowing produced greater yields compared to late sowing in both years, and also the lowest pod yield was obtained for the latest sowing date in both years (Table 4), since seed filling and harvest time were affected by cold weather, rain, and frost after the late sowing date (Naab et al., 2004). In addition, the late sowing date has a higher probability of experiencing water stress during the critical seed-filling phase, resulting in lower yields (Nigam et al., 1998).

It might be suggested in this study that the late planted crop had a shorter period for the production of seed and a slightly lower rate of seed production due to reduced growth, and exposure of plants to warmer and longer photoperiod (long day) after the late sowing date. These differences were also largely related to the number of developing seed on cob. Percent of protein content in grain significantly affected by dates of sowing in both the years, the highest protein value was recorded in 2012 year.

Table 3. The result of variance analyses for all components measured of three corn genotypes in different sowing in 2012 and 2013 years

Variance Source	d.f	Calculated of Mean Square							
		CL	GN	1000SW	Yield	Protein	Oil	Ash	Starch
Y	1	30.932**	ns	9842.293**	ns	ns	ns	ns	ns
G	2	25.977**	ns	ns	4.938*	ns	ns	ns	3.484*
S.D	1	81.571**	473389.868**	7609.364**	111.769**	ns	3.731**	0.016**	9.151**
YxG	2	49.414**	18902.626**	ns	ns	ns	ns	ns	ns
YxS.D	1	ns	ns	6605.087**	ns	1.460**	ns	ns	ns
GxS.D	2	24.707**	ns	4422.008**	ns	1.342**	ns	0.009*	ns
YxS.DxG	2	37.656**	ns	3003.563*	ns	1.465**	ns	ns	ns
$LSD_{0.05\ Y}$		1.182	ns	19.078	ns	ns	ns	ns	ns
$LSD_{0.05\ G}$		1.447	55.031	ns	114.328	ns	ns	ns	0.809
$LSD_{0.05\ S.D}$		1.182	ns	19.078	93.349	ns	0.121	0.029	0.661
$LSD_{0.05\ YxG}$		2.047	77.826	ns	ns	ns	ns	ns	ns
$LSD_{0.05\ YxS.D}$		ns	ns	26.980	ns	0.478	ns	ns	ns
$LSD_{0.05\ GxS.D}$		2.047	ns	33.043	ns	0.585	ns	0.049	ns
$LSD_{0.05\ YxS.DxG}$		2.894	ns	46.730	ns	0.827	ns	ns	ns

*** P<0.001; ** P<0.05, ns: non-significant, Y: Years, G: Genotype, S.D: Sowing Date, CL: Cob Length, GN: Grain Number per cob, 1000SW: Thousand Seed Weight, d.f: degree of freedom.

Table 4. Growth characters of three hybrid corn as influenced by dates of sowing and years

Treatments	Cob lenght (cm)		Number grain per cob (number)		1000 seed weight (g)		Seed yield (kg ha)	
	2012	2013	2012	2013	2012	2013	2012	2013
Sowing date								
30. April	21.75	24.11	703.51	752.48	317.22	357.97	1493.03	1576.53
26. May	19.24	20.60	485.16	512.15	353.98	379.37	1040.29	1078.20
Cultivars								
31G98	20.78	25.40	571.73	700.42	316.78	386.00	1111.50	1301.42
NK-Arma	19.26	21.31	608.30	612.38	316.55	366.50	1272.06	1339.20
Aveline	21.46	20.36	602,96	584.16	374.47	353.51	1416.39	1341.48

Table 5. Grain quality parameters of three hybrid corn as influenced by dates of sowing and years

Treatments	Oil content (%)		Protein (%)		Ash (%)		Starch content (%)	
	2012	2013	2012	2013	2012	2013	2012	2013
Sowing date								
30. April	3.76	3.79	8.40	7.89	1.40	1.34	72.48	72.25
26. May	3.14	3.12	7.76	7.97	1.34	1.38	73.44	73.31
Cultivars								
31G98	3.44	3.44	8.07	8.11	1.41	1.40	72.85	71.66
NK-Arma	3.36	3.41	8.20	7.61	1.38	1.36	72.76	73.27
Aveline	3.55	3.51	8.10	8.06	1.39	1.38	73.05	73.41

The changing of protein content affected by sowing was very different in terms of years and cultivars. Protein content was decreased by late sowing date in 2012, while it was insignificantly increased by sowing date in 2013 (Table 5).

Differences in oil content among sowing date are usually associated with differences in the proportion of the kernel constituted by the embryo in different stage. In both years oil content of cultivars were decreased by sowing date.

The highest oil content from grain was obtained from Aveline corn hybrid in both years (Table 5). There are conflict opinion in literature that Gyenes-Hegyi et al. (2001) also reported no significant effect of growing season on the oil content of the 12 single-cross maize hybrids studied in their two-year research, whereas other authors (Zhang et al., 1993) reported significant variations in protein and/or oil contents in different years.

And also according to Fabijanac et al. (2006) point outed that the negative association between oil concentration and kernel weight can be partially explained by differences in the structural components of the kernel (i.e., the weight of the endosperm and the embryo).

Hybrids with small kernels would have a higher proportion of their kernels as embryo and endosperm aleurone layer, which contain almost all of the total grain oil (Kereliuk and Sosulski, 1995). Therefore, the oil content obtained from early sowing, which has small grain was higher than that of late sowing. Hence, our results finding was agree with those results.

The highest yielding hybrid, which was Aveline cultivars, had the highest grain starch content (Table 4 and 5).

CONCLUSIONS

In this study, corn hybrids commercially available at delayed sowing date cannot be successfully grown (4 weeks later than optimum) in Turkey because of having season shorter than full season maturity characteristics. All recently released hybrids, studied in our investigation, there were significantly differences among the cultivars in both sowing date.

But in both years Aveline corn hybrid cultivar produced higher grain yields than the others corn hybrid.

And also to achieve high oil, starch in corn grain, the cultivars, which have highest seed yield, can be selected in the future breeding program.

Generally, late sowing date can easily disrupt the quality of grain in all corn cultivars. Therefore, it was suggested that eventough the Aegean climate has a long growing period and is a suitable environment for second crop corn growth, the selection of cultivar is very important to grown in terms of seed yield in late sowing date because of the fact that plant can be exposed to inappropriate excessive temperature during the vegetative period in late sowing date in Aegean region.

REFERENCES

Açıkgöz N., Akba M.E., Moghaddam A., Özcan K., 1994. Turkish data based statistics programmer for PC. Turkey Field Crops Congress, Ege University Press, p. 264-267.

Cantarero M.G., Lugue S.F., Rubiolo O.J., 2000. Effects of sowing date and plant density on grain number and yield of a maize hybrid in the central region of Córdoba, Argentina. J. Agric. Sci. 17:3 -10.

Fabijanac D., Varga B., Svecnjak Z., Grbesa D., 2006. Grain yield and quality of semiflint maize hybrids at two sowing dates. Agriculturae Conspectus Scientificus. 71:45-50.

Gyenes-Hegyi Z., Kizmus L., Zaborszky S., Marton L.C., 2001. Trends in the protein and oil contents and thousand kernel mass of maize under various ecological conditions. Novenytermeles. 50:385-394.

Kereliuk G.R., Sosulski F.W., 1995. Properties of corn samples varying in percentage of dent and flint kernels. L.W.T. 28:589-597.

Kolawole E., Samson U., 2009. Growth and yield of maize as influenced by sowing date and poultry manure application. Not. Bot. Hort. Agrobot. Cluj., 37:199-203.

Naab B.J., Tsigbey K.F., Prasad P.V.V., Boote J.K., Bailey E.J., Brandenburg L.R., 2004. Effects of sowing date and fungicide application on yield of early and late maturing peanut cultivars grown under rainfed conditions in Ghana. Crop Prot. 24:325-332.

Nigam S.R., Rao R.C.N., Wynne J.C., 1998. Effects of temperature and photoperiod on vegetative and reproductive growth of groundnut (*Arachis hypogaea* L.). J. Argon. Crop. Sci. 181:117-124.

Otegui M.E., Nicolini M.G., Ruiz R.A., Dodds P.A., 1995. Sowing date effects on grain yield components for different maize genotypes. Agron. J. 87:29-33.

Shumway C.R., Cothren J.T., Serna-Saldivar S.O., Rooney L.W., 1992. Planting date and moisture level effects on grain yield, physical grain quality, and alkaline-processing characteristics of food-grade maize. Crop Sci. 32:1265-1269.

Zhang F., Mackenzie A.F., Smith D.L., 1993. Corn yield and shits among corn quality constituents following application of different nitrogen fertilizer sources at several times during corn development. J. Plant Nut. 16:1317-1337.