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A Study on Cultivating of Soybean in the Middle Kızılırmak Basin

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Abstract

This study was conducted in as known the Middle Kızılırmak Basin, Kızılırmak/Çankırı-Turkey, in 2012 and 2013. Rice plant was cultivated as monoculture system in this area for many years in this area. Aim of the research was determine of cultivating alternative field crops in this area. Ten soybean genotypes were conducted in randomized block design with 3 replicates. Grain yield, plant height and some other agronomic characters were investigated in the study. The differences among the values obtained in all examined characters except grain yield were statistically significant. Flowering time and plant height of genotypes was changed respectively between 71.7-73.0 day and 99-118 cm. Genotypes maturated in average 127 day and grain moisture was changed between 15.0-19.6% in harvest. As the results, soybean cultivating is possible with suitable cultivars in the Middle Kızılırmak Basin.

Key Words: Soybean, yield, yield components, the Middle Kızılırmak Basin

Orta Kızılırmak Havzasında Soya Fasulyesi Yetiştiriciliği Üzerine Bir Araştırma

Özet

Bu çalışma Orta Kızılırmak Havzası olarak bilinen Çankırı İli, Kızılırmak İlçesinde 2012 ve 2013 yıllarında yürütülmüştür. Bu alanlarda uzun yıllardan beri çeltik bitkisi monokültür olarak yetiştirilmektedir. Araştırmanın amacı bu alanda alternatif tarla bitkilerinin yetiştiriciliğinin belirlenmesidir. Bu amaç için 10 soya fasulyesi genotipi 3 tekrarlamalı olarak denemeye alınmıştır. Çalışmada tane verimi, bitki boyu ve diğer bazı agronomik karakterler incelenmiştir. İncelenen özellikler bakımından tane verimi hariç genotiplerden elde edilen veriler arasındaki farklılık istatistiksel olarak önemli bulunmuştur. Genotiplerin çiçeklenme süresi be bitki boyu değerleri sırasıyla 71.7-73.0 gün ve 99-118 cm arasında değişmiştir. Genotipler ortalama 127 günde olgunlaşmışlar, hasatta tane nemi değerleri %15.0-19.6 arasında değişmiştir. Sonuç olarak Orta Kızılırmak Havzasında soya fasulyesi yetiştiriciliğinin uygun çeşitlerle yapılabileceği kanaatine varılmıştır.

Anahtar Kalimeler: Soya Fasulyesi, verim, verim unsurları, Orta Kızılırmak Havzası

INTRODUCTION

The soybean (*Glycine max* L. Merril) is one of the most cultivated grains, providing oil and protein, in the entire world. Soybean plays an important role in supplying protein and oil needed by humans; in addition biodiesel has been produced from Soybean oil. It has composition of 40% protein and 20% oil. Soybean protein is rich in valuable amino acid lycine (5%). Soybean oil is widely used as eatable oil whereas its meal is mainly used in animal feed industry. Soybean is gaining importance on account of its excellent characteristics and adaptability to varied agro-climatic conditions. Stressful conditions, such as high temperature or moisture deficiency reduce soybean yield in one or more of its components. Soybean needs irrigation, flowering period is one of the most sensitive growth periods to environmental stress, especially to water stress [1].

United States is the single largest producer of soybean in world while Brazil and Argentina are the second and third biggest producers of soybean respectively. It is grown in about 430.000 ha field area in Turkey. Soybean is grown as main crop in Black Sea, Thrace, Marmara, Aegean, Mediterranean and South East Anatolia Regions in Turkey. It is grown as second crop in irrigated area of Aegean, Mediterranean and South East Anatolia Regions [2, 3]. Grain yield were changed from 200 kg da-1 to 500 kg da-1 in different studies [4, 5, 6, 7, 8 and 9].

Rice is grown in this area for a long time. This has caused some soil problems in field area. So, the rotation must be applied for to protect this field area. Soybean is one of the crop plants for this aim. This study was carried out to determine of growing soybean genotypes in the Middle Kızılırmak Basin.

MATERIALS AND METHOD

The experiment was carried out at the research field of Çankırı Karatekin University, in Kızılırmak, Çankırı-Turkey (Lat. 40°20'E, long. 33°58'N, 550 m above sea level), in 2012 and 2013 growing seasons. The Middle Kızılırmak Basin is situated in northern part of Central Anatolia Region These genotypes are A3127, Bravo, Nova, Arısoy, Üstün1, Ataem7, S01-01-02, S01-08-03, S01-08-15 and S01-09-34. These materials obtained from Black Sea Agricultural Research Institute, Samsun-Turkey. Ten soybean genotypes were conducted in randomized block design with 3 replicates the study. The experimental plots included 4 rows, each 5 meters long with spacing 0.6 m between rows and 5 cm within rows. Fertilizer of 3 kg N, and 6 kg P_2O_5 da^{-1} was applied [10]. Bacteria (*Rhizobium japonicum*) were inoculated to soil. The soil in the location was clay and rich for K. Therefore K fertilizer wasn't applied to plots. Grain yield, plant height, flowering time, the first pod height, pod number, harvest grain moisture and maturating time were investigated in the study. Data were taken on grain yield (kg da-1), flowering time (days from planting to 50 % of plants flowering) in all plot. Plant height (cm), first pod height (cm), grain moisture at harvest (%), pod number was estimated from a sample of 10 plants from each plot.

Continental climate condition is predominant in the Middle Kızılırmak Basin. Annual average temperatures are 19.7°C, 17.6°C and 17.3 in research years and average of long-term, respectively. Average rainfall of research years is less than average of long-term. Soil of research area has medium heavy thin, light salt, limy and light sandy character.

All the data were analyzed according to completely randomized design with analysis of variance (ANOVA) procedures. The comparison of the treatment means was made using the Least Significant Difference (LSD) test using the JMP statistics program.

FINDINGS AND DISCUSSION

The statistical analyses of investigated characters of soybean genotypes are given in Table 1. Year was significant for flowering time, plant height, maturating time, grain moisture and first pod height. Genotype was significant for all studied characters except grain yield. Block was not significant for all characters except plant height. Genotype x year interaction was significant ($p<0.01$) for flowering time and plant height.

Flowering time

Results of flowering time of genotypes are given in Table 2. The differences of flowering time of the soybean genotypes were statistically significant in 2012 and mean data (Table 2). The effect of years on flowering time and genotype x year interaction for grain yield was significant. Based on the means, the flowering time of genotypes ranged from 67.0 to 69.5 day, and averaged 68.5 day. The highest flowering time was obtained from promising hybrids S01-09-34. Cultivar Nova was the earliest flowered. Mean flowering time of genotypes in 2013 were higher than the flowering time in 2012.

Pollination and fertilization is factor to effect number of seed [11]. Generally early flowered plants were maturated at earlier time. Differences of region and climate are effect flowering time all plants. Different researchers were found different result with regard to flowering of soybean genotypes [5, 6, 8, 12]. Our results are higher from results of these researchers because of climate conditions of our studied area.

Plant height

Plant height of the genotypes varied from 75 to 92 cm in 2012, from 110 to 143 cm in 2013 and from 99 to 118 cm as average (Table 2). There were statistically significant differences among genotypes in every year and as average. Year, block, genotype and genotype x year effect for plant height was significant. Based on the means, the cultivars

Table 1. Summary of ANOVA for variables examined in soybean genotypes

Source of variation	DF	Mean squares						
		Grain Yield	Flowering time	Plant height	First pod height	Grain moisture	Pod number	Maturating time
Year (E)	1	214.7ns	912.6**	27778.0**	29.4**	29.2*	1.73ns	1016.8**
Block (Env)	2	1173.4ns	0.10ns	488.1*	0.5ns	7.35ns	3.1ns	1.63ns
Genotype (G)	9	7160.1ns	33.3**	2391.8**	66.9**	94.9*	824.7**	96.3**
G X E	9	20909.7ns	39.7**	2087.1**	14.5ns	17.9ns	10.4ns	28.4**
Error	38	1281.2	0.19	49.0	0.77	4.93	1.41	0.45
CV (%)		17.2	0.64	6.6	5.18	11.9	2.77	0.51

**, *: indicates significance at 0.01 and at 0.05 respectively. CV: Coefficient of Variation ns: not significant

Table 2. Mean data and statistical groups of soybean genotypes

Genotypes	Flowering time (day)			Plant height (cm)			Grain yield (kg da^{-1})		
	2012	2013	Mean	2012	2013	Mean	2012	2013	Mean
A 3127	66.0 a	72.3	69.2 a	90 ab	124 ce	107 bc	225 ab	169	197
Arısoy	65.0 b	72.7	68.8 b	86 c	139 ab	113 ab	193 c	220	207
ATAEM7	63.0 d	71.7	67.3 d	90 ab	137 ac	113 ab	193 c	218	205
Bravo	65.0 b	72.7	68.8 b	87 c	125 be	106 bc	197 bc	187	192
Nova	61.0 e	73.0	67.0 d	75 e	126 bd	101 c	200 ac	218	209
S01-01-02	64.0 c	72.3	68.2 c	85 c	115 de	101 c	191 c	275	233
S01-08-03	65.0 b	72.3	68.7 bc	80 d	119 de	99 c	214 ac	228	221
S01-08-15	65.0 b	72.3	68.7 bc	88 bc	110 e	99 c	216 ac	200	208
S01-09-34	66.0 a	73.0	69.5 a	78 de	142 a	110 ab	227 a	189	208
Üstün1	66.0 a	71.7	68.8 b	92 a	143 a	118 a	213 ac	203	208
Mean	64.6	72.4	68.5	85	128	107	207	211	209
CV (%)	12,3**	8.8ns	6.4**	2,04**	6,58**	6.60**	7,94**	11,2ns	17.2ns

Means followed by the same letter in the same column are not significantly different. CV: Coefficient of Variation

Üstün1, Arısoy and Ataem7 have the highest plant height. As average, data of plant height in 2013 was found higher than data of in than 2012. Cause of this can be differences of rain, temperature and relative humidity between studied years.

There are positive and significant relation between grain yield and plant height (r=0.30**), between plant height and the first pod height (r=0.63**), and between plant height and pod number (r=0.38**) [7]. Karaaslan (2001) stated that grain yield of soybean lines were ranged from 108.7 to 138.8 cm as second crop in Diyarbakır-Turkey [9]. Our findings are similar to results of some researcher [6, 8 and 9].

Grain yield

The differences of grain yield of the soybean genotypes (6 cultivar and 4 promising genotypes) were statistically significant (p<0.01) in 2012, not significant in 2013 and as average (Table 2). The effect of years on grain yield and genotype x year interaction for grain yield was not significant. Based on the means, the grain yields of genotypes ranged from 192 (cultivar Bravo) to 233 kg da^{-1} (promising genotype S01-01-02), and averaged 209 kg da^{-1}.

Tayyar and Gül (2007), stated that there are positive correlation (r=0.30**) between grain yield and plant height [7]. Karaaslan (2001) stated that grain yield of soybean lines were ranged from 187.1 to 287.1 kg da-1 as second crop in Diyarbakır-Turkey [9]. Our results are lower from results of some researchers [5, 6, 7, 12 13, 14, 15] because of different climate conditions of studied area. Our results are similar to results of some researcher [4, 8, 16].

Number of pod per plant

Results of number pod per plant of genotypes are given in Table 3. The differences of pod number of the soybean genotypes were statistically significant (p<0.01) in each studied years and as average. Number pod per plant of genotypes ranged from 38.0 to 50.3 and from 38.8 to 49.1 respectively in 2012 and 2013. Based on the means, cultivars Ataem7 and Üstün1 had the highest number of pod per plant.

Soheil Kobraee at al (2011) stated that positive correlation between grain yield and the number of pod per plant (r=0.753**). Tayyar and Gül (2007), stated that there are positive correlation (r=0.38**) between number of pod per plant and plant height [7]. Reported that water deficit at flowering stage has more effect on the yield through affecting the pod number decrease [17]. Our results are different than the results of Karaarslan 2001 and Anonymous 2008, similar Tuğay and Atikyılmaz 2009, Karasu at al 2002, Arıoğlu at al 2003 and Acar at al 2008. Different materials may be caused by differences.

The first pod height

It was measured interval from level of soil surface to first pod node as first pod height. Data first pod height of genotypes is given in Table 3. The differences of pod number of the soybean genotypes were statistically significant (p<0.01) in 2012 and as mean data. Based on the means, the first pod height of genotypes ranged from 14.2 (cultivar Nova) to 18.0 cm (promising genotype S01-08-03), and averaged 16.8 cm.

It is desirable that high of the first pod height distance for mechanized agriculture. There is positive and significant relation between plant height and the first pod height (r=0.63**) [7]. (Tayyar and Gül, 2007). Researchers [4, 6, 7, 8, 9 and 13] found different results. Materials and ecological differences may be caused by differences.

Harvest grain moisture

Grain moisture of the genotypes was measured at harvest time. Data of grain moisture of the genotypes varied from 16.1 to 19.6 % in 2012, from 17.1 to 20.0 % in 2013 and from 15.0 to 19.5 % as average (Table 3). There were statistically significant differences among genotypes in 2013 and as average. Based on the means, all the genotypes except S01-08-15 had been in the same group. As average, data of grain moisture in 2013 was found higher than data of in than 2012. Cause of this can be differences of rain, temperature and relative humidity between studied years. Soybean is a warm season and short-day plant, needs high total temperature [14]. So soybean is cultivating in coastal areas in Turkey. Our results are higher than the results of Anonymous, 2008 [8].

Maturating time

Results of maturating time of genotypes were given Table 4. The differences of maturating time of the soybean genotypes were statistically significant (p<0.01) in each studied years and as average. Maturating time of the genotypes ranged from 125.0 to 128.0 and from 133.0 to 137.0 day respectively in 2012 and 2013. Based on the means, cultivar Nova had the earliest maturated. Cultivars A3127, ATAEM7, Bravo, Üstün1 and promising genotype S01-09-34 had the latest maturated. Soybean needs high total temperature. Climate and altitude is effect on maturating of soybean.

Table 3. Mean data and statistical groups of soybean genotypes

Genotypes	Number of pod per plant			The first pod height (cm)			Harvest grain moisture (%)		
	2012	2013	Mean	2012	2013	Mean	2012	2013	Mean
A 3127	44,7 bc	44.3 bc	44.5 c	17,3 a	17.4	17.4 ab	17,9	18.7 b	18.3 a
Arısoy	42,7 cd	43.5 c	43.1 d	17,3 a	17.7	17.5 ab	17,4	19.3 ab	18.4 a
ATAEM7	49,7 a	49.1 a	49.4 a	17,0 ab	18.2	17.6 ab	18,4	19.6 ab	19.0 a
Bravo	45,3 b	45.5 b	45.4 bc	16,0 bd	17.3	16.7 bc	18,2	19.6 ab	18.9 a
Nova	38,0 f	38.8 d	38.4 f	12,3 e	16.1	14.2 d	18,9	20.0 a	19.5 a
S01-01-02	40,0 ef	40.4 d	40.2 e	15,3 d	17.1	16.2 c	19,3	19.6 ab	19.4 a
S01-08-03	41,7 de	40.3 d	41.0 e	17,2 ab	18.8	18.0 a	18,2	19.4 ab	18.8 a
S01-08-15	40,3 e	39.4 d	39.9 e	16,7 ac	18.6	17.7 ab	16,1	17.1 c	15.0 b
S01-09-34	46,3 b	45.7 b	46.0 b	16,6 ac	17.4	17.0 ac	17,8	19.8 ab	18.8 a
Üstün1	50,3 a	48.6 a	49.5 a	15,7 cd	16.7	16.2 c	19,6	19.5 ab	19.6 a
Mean	43,9	43.6	43.7	16,1	17.5	16.8	17,8	19.3	18.6
CV (%)	2,91**	2.20**	2.77**	4,33**	5.34öd	5.18**	16,9öd	3.4**	11.9*

Means followed by the same letter in the same column are not significantly different. CV: Coefficient of Variation

Table 4. Mean data and statistical groups

Genotypes	Maturating time (day)		
	2012	2013	Mean
A 3127	128 a	137 a	132 a
Arısoy	126 bc	137 a	131 b
ATAEM7	128 a	137 a	132 a
Bravo	128 a	137 a	132 a
Nova	125 c	133 b	129 d
S01-01-02	127 ab	133 b	130 bc
S01-08-03	128 a	133 b	131 b
S01-08-15	125 c	133 b	129 d
S01-09-34	128 a	137 a	132 a
Üstün1	128 a	137 a	132 a
Mean	127	135	131
VK (%)	9,46**	4,5**	5.1**

Means followed by the same letter in the same column are not significantly different. CV: Coefficient of Variation

CONCLUSION

The differences of grain yield of the soybean genotypes (6 cultivar and 4 promising genotypes) were statistically significant ($p<0.01$) in 2012, not significant in 2013 and as average (Table 3). Based on the means, the grain yields of genotypes ranged from 192 to 233 kg da^{-1} and averaged 209 kg da^{-1}. The result of the study, soybean may cultivate in the Middle Kızılırmak Basin. Rice is grown in this area for a long time. This has caused some soil problems. So, the rotation must be applied for to protect this field area. Soybean is one of the crop plants for this aim.

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