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Full Length Research Paper

Seed yield and agronomic parameters of cowpea (*Vigna unguiculata* L.) genotypes grown in the Black Sea region of Turkey

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Nine cowpea (*Vigna unguiculata* L.) genotypes (two released cultivars and seven lines) were evaluated for grain yield and agronomic parameters at two locations within the Middle Black Sea region of Turkey for two years (2005 to 2006). Genotypes were evaluated for plant height, first pod height from ground, branches number per plant, main branch diameter, pod length, seed number per pod, thousand seed weight and seed yield. Results indicate that the effect of genotype, year and location were significant ($P<0.05$) for many of the traits studied. Line G1 had the highest plant height (122.4 cm). Seed number per pod was higher in line G1 (9.9) than in other genotypes. Thousand seed weight ranged between 138.7 and 233.2 g. Seed yield ranged from 1,010 to 1,420 kg ha^{-1}. The highest seed yield (1,420 kg ha^{-1}) was obtained in cultivar Karagoz. Among locations, average values for most variables studied were higher in Samsun than in Kavak.

Key words: *Vigna unguiculata*, seed yield, thousand seed weight, Black Sea.

INTRODUCTION

The cowpea (*Vigna unguiculata* L.) is an important legume widely cultivated in tropics and subtropics for forage, green pods and grains (Ali et al., 2004). Cowpea is usually better adapted to drought, high temperatures and other biotic stresses compared with other crops (Kuykendall et al., 2000; Martins et al., 2003). However, growth and development of many cowpea cultivars are affected by drought and high temperatures, especially during floral development (Dadson et al., 2005). Protein content of cowpea seed is among the the highest in cultivated legumes (Aremu et al., 2007) and can serve as an excellent source of dietary protein in animal feeds (Igbasan and Guenter, 1997). The mature grain contains 20 to 25% of protein (Kay, 1979 cited by Addo-Quate et al., 2011), 1.3 to 1.5% lipid and 5.1 to 5.8% crude fibre (Tshovhote et al., 2003). Forage yields of cowpea is the highest in sandy loam soils supplemented with suitable irrigation. Cowpea seed yield can be relatively high when grown in soils with low fertility. Moreover, high rates of nitrogen and excessive moisture are detrimental and can result in excessive vegetative growth, delayed maturity and pod shattering (Ali et al., 2004).

In Turkey, cowpea covers 2,200 ha with annual grain production of 2,290 kg and 1,040 kg ha^{-1} of grain yield (TUIK, 2010). It is widely cultivated in Aegean and Mediterranean regions. However, its cultivation in the north of Turkey (Black Sea region) is lesser and only for family consumption in Samsun, Sinop and Kastamonu provinces (Gulumser et al., 1989). In recent years, several studies have evaluated the performance of cowpea genotypes in the Black Sea region of Turkey (Glumser et al., 1989; Peksen et al., 2002; Peksen and Artık, 2004). However, these studies were conducted near coastal areas. Therefore, our knowledge on the agronomic performance of cowpea in the inner part of the Black Sea region is insufficient. There are only two released cowpea cultivars in Turkey, hence testing of

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Table 1. Average performance of cowpea genotypes evaluated in two years and at two locations, and the general means of locations and years.

Genotype	PH (cm)	FPH (cm)	NBP	MBD (mm)	PL (cm)	SNP	TSW (g)	SY (kg ha^{-1})
Karagoz	119.8^{a}	49.7^{b}	4.3^{a}	9.8^{a}	14.2^{a}	8.6^{b}	233.2^{a}	1,420^{a}
Akız	117.9^{abc}	36.6^{e}	4.1^{abc}	8.6^{d}	12.7^{b}	9.7^{a}	141.6^{g}	1,010^{d}
G1	122.4^{a}	63.2^{a}	3.6^{d}	8.7^{cd}	11.8^{d}	9.9^{a}	138.7^{g}	1,120^{c}
G2	109.9^{cd}	44.6^{bcd}	4.4^{a}	8.9^{cd}	12.4^{bc}	7.4^{c}	174.1^{f}	1,100^{c}
G3	101.0^{e}	42.5^{cd}	3.7^{cd}	9.1^{bc}	11.8^{d}	8.7^{b}	205.1^{b}	1,130^{c}
G4	121.7^{ab}	47.0^{bc}	4.2^{ab}	9.5^{ab}	14.4^{a}	9.5^{a}	190.9^{d}	1,160^{bc}
G5	107.3^{de}	43.4^{cd}	4.1^{abc}	8.7^{cd}	12.5^{b}	8.3^{b}	200.4^{c}	1,130^{c}
G6	113.6^{bcd}	49.8^{b}	4.2^{ab}	8.9^{cd}	12.6^{b}	8.2^{b}	184.1^{e}	1,200^{b}
G7	109.5^{cde}	40.2^{de}	3.9^{bcd}	8.9^{cd}	11.9^{cd}	8.2^{b}	193.1^{d}	1,220^{b}
Mean	113.7	46.2	4.0	9.0	12.7	8.7	184.6	1,170
2005	113.4	49.9^{a}	3.8^{b}	8.9	12.4^{b}	8.4^{b}	185.7^{a}	1,130^{b}
2006	114.0	42.6^{b}	4.2^{a}	9.1	12.9^{a}	9.1^{a}	183.5^{b}	1,200^{a}
Samsun	116.0	35.7^{b}	4.1	8.9^{a}	14.3^{a}	9.7^{a}	194.4^{a}	1,260^{a}
Kavak	110.9	56.9^{a}	4.0	9.2^{b}	11.1^{b}	7.7^{b}	174.7^{b}	1,070^{b}

PH, Plant height; FPH, first pod height from ground; NBP, number of branches per plant; MBD, main branch diameter; PL, pod length; SNP, seed number per pod; TSW, thousand seed weight; SY, seed yield. There are no significant differences ($p<0.05$) among mean indicated by the same letters.

new cowpea genotypes in various ecological conditions are needed to identify high-yielding genotypes adapted to Black Sea region of Turkey. This study was conducted to test seed yield and related parameters of different cowpea genotypes in Samsun and Kavak located in the Middle Black Sea Region of Turkey.

MATERIALS AND METHODS

Two released varieties (Akkız and Karagoz) and seven cowpea lines (G1,...,G7) were evaluated in 2005 and 2006 at two locations - Samsun and Kavak (both in the Middle Black Sea region) in Turkey. Samsun (41°21'51"N, 36°11'27"E) lies on the Black Sea coast at an altitude 196 m; while Kavak (41°03'14"N, 35°57'32"E) is located in the interior part of the region and almost 50 km from coastal area, at an elevation of 628 m. Both locations have similar rainfall and temperature regimes except for lower humidity and night temperature in Kavak (certain data not available). Total rainfall in Samsun during 2005 and 2006 was 788.1 and 714 mm, mean temperature was 15 and 14.5°C, while relative humidity was 75.4 and 74.3%, respectively (TSMS, 2007). The soil texture of Samsun and Kavak locations were clay and silt, respectively and pH was neutral in each site.

Cultivars Karagoz and Akkız were obtained from the Agriculture Faculty of Aegean University. Seven lines were selected from a total of 27 Turkish landraces according to seed coat and hilium color. Each of the genotypes was grown into a four-row plot of 2 × 5 m and spaced at 50 and 15 cm between and within rows using a randomized complete block design with three replications. Two inner rows were harvested to determine the yield. Other parameters related to seed yield were measured on 10 randomly selected plants from each plot.

Statistical analysis

The data were subjected to analysis of variance (ANOVA) and computation was performed by means of SPSS V 10.0 (SPSS Inc., 1999). Means were separated using Duncan multiple range test.

RESULTS AND DISCUSSION

The average performance of the nine cowpea genotypes is presented in Table 1. The effect of genotype was significant ($P<0.05$) in all parameters. A significant ($P<0.05$) year and location effect was observed for many of the variables studied (Table 1). The genotype × year, genotype × location and genotype × year × location interactions were however not significant ($P>0.05$) for many of the variables. Therefore, these data were averaged and analysed over years and locations.

Furthermore, plant height (PH) varied from 101.0 cm in line G3 to 122.4 cm in line G1 with significant differences, and was higher at Samsun location than Kavak (Table 1). The PH values determined in the present study were within the ranges reported in earlier studies (Peksen and Artık, 2004; Khan et al., 2010), but higher than that reported by Aboyomi et al. (2008) who found that PH was between 20.21 to 59.12 cm in cowpea genotypes.

First pod height from ground (FPH) was significantly different among the genotypes and varied from 36.6 to 63.2 cm with G1 having the highest value. FPH is an important component for conducting mechanical harvest

as prostrate growth (lower FPH values) limit mechanical harvest. In this regard, our results are promising with higher mean value (46.2 cm) than that reported by Peksen and Artık (2004) conducted in similar ecology and reported by Vural and Karasu (2007) conducted in Turkey. However, Peksen and Artık (2004) also reported a negative and significant corelation betweeen FPH and seed yield. Average FPH was significantly higher in 2005 probably because of higher rainfall than in 2006. FPH was also significantly higher at Kavak probably as a result of lower temperatures which delayed flowering.

More also, number of branches per plant (NBP) among to genotypes ranged from 3.6 in G1 to 4.3 in G2 with a mean value of 4.0. Average NBP was significantly higher in 2006 over locations. Main branch diamater (MBD) (measured at 5 cm above ground level) was significantly different among genotypes with the highest values obtained in cultivar Karagoz and line G4 averaging 9.6 mm. In addition, pod length (PL) and number of seed per pod (SNP) varied significantly among cowpea genotypes. Average PL and SNP are significantly higher in 2006 than in 2005 and also significantly higher at Samsun than at Kavak. Line G4 and cultivar Karagoz had the higher PL values averaging 14.4 and 14.2 cm respectively. The highest SNP value was obtained in genotypes G1 (9.9), Akkız (9.7) and G4 (9.5). Cowpea has a high variation regarding both PL and SNP. Khan et al. (2010) reported that the range was 10 to 38 cm for PL and 7 to 21 for SNP in 24 genotypes. The PL varied between 9.2 to 43.7 cm in more than 400 cowpea genotypes (Pasqueth, 1998). In this respect, the range for PL (11.8 to 14.4 cm) and for SNP (7.4 to 9.9) among the genotypes found in the present study were very low.

The range for thousand seed weight (TSW) among the genotypes was 138.7 to 233.2 g with a mean of 184.6 g. The highest TSW was achieved in cultivar Karagoz. Regarding average TSW, the present study is in accordance with previous studies (Peksen and Artık, 2004; Vural and Karasu, 2007; Akande and Balgun, 2009). Also, the average seed yield (SY) was 1,170 kg ha^{-1} and the maximum yield was obtained from Karagoz (1,420 kg ha^{-1}). Peksen and Artık (2004) reported that the range for SY was 680 to 1,120 kg ha^{-1} in six cowpea genotypes grown in Black Sea coastal ecology. SY was highly significant and ranged from 317 to 3,550 kg ha^{-1} in 24 genotypes in Pakistan ecology (Khan et al., 2010). Moreover, in a study conducted with 10 genotypes in diffrent condution (in Nigeria) for two years with three locations, SY varied from 915 to 1,173 kg ha^{-1} (Akande and Balgun, 2009).

The effect of years and locations on SY were significant. Even though annual rainfall was higher in 2005, average SY was higher in 2006. It was reported that heavy rainfall favoured excessive vegetative growth and caused lower seed yield (Karungi et al., 2000). Average SY at Samsun (1,260 kg ha^{-1}) was higher than at Kavak (1,070 kg ha^{-1}). The differences between locations for average yield may be attributed to temperature patterns. Cowpea grows best at day temperatures of 25 to 35°C; night temperature should not be less than 15°C, and its growth is retarded at altitudes above 700 m (Brink and Belay, 2006). Samsun is located near the coastal area at an altitude of 196 m. Conversely Kavak is located 50 km away from coastal area and at higher alltitude (628 m), so it is a cooler location as compared to Samsun.

Conclusion

This study indicate that there is significant variation among the cowpea genotypes regarding yield and yield parameters. Also, year and location effects were significant for many of the variables studied. The released variety Karagoz was the best yielding genotype. However, average seed yield in all the cowpea lines was higher than for the other released cultivar, Akkız, suggesting that some of these genotypes (e.g. line G1, G4,G7) could serve as breeding lines to improve yield.

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