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Agronomic Potential of Grasspea (*Lathyrus sativus* L.) under Rainfed Condition in Semi-Arid Regions of Turkey

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Abstract: This study was conducted under Tokat-Kazova conditions during 2001/02 and 2002/03. Five grasspea lines (38, 439, 452, 455, 463) obtained from ICARDA, five grasspea varieties (*Lathyrus sativus* L. var. azureus, L. *sativus* var. biflorus, L. *sativus* L. var. coloratus, L. *sativus* L. var. leucotetragonus, L. *sativus* L. var. albus) obtained from Romanya and one grasspea local population (Elazig) were used as a material. There were significant differences among lines and varieties. In the first year, higher rainfall, especially in March, April and May, gave rise to higher green forage yield, dry matter yield, biological yield, seed yield and straw yield in the genotypes. According to average two years, green forage yield ranged between 7743 and 17222 kg ha^{-1}, dry matter yield ranged between 1596 and 3269 kg ha^{-1}, biological yield ranged between 4566 and 6858 kg ha^{-1}, seed yield ranged between 1029 and 1681 kg ha^{-1}, straw yield ranged between 3537 and 5262 kg ha^{-1}, 1000-seed weight ranged between 106.6 and 204.5 g and harvest index ranged between 22 and 27%. At the end of this study, it was found that the line 452 for green forage and dry matter yield and lines 455, 463 and 439 for seed yield had good performance.

Key words: Grasspea (*Lathyrus sativus* L.), line, yield, harvest index

INTRODUCTION

On many cereal producing farms in the arid and semi-arid regions, livestock production is an important, economic activity. In the arid and semi-arid regions (medium rainfall <400 mm), both grain and straw are used to feed livestock which also graze non-arable common lands[1, 2]. Approximately 4.5-5 million ha of the total agricultural area in Turkey receive less than 400 mm average annual precipitation and in terms of the distribution pattern typically 70% of the precipitation falls between December and May[1,3]. Annual forage legumes need to be introduced in these regions to improve soil fertility and livestock population[1,2,4]. Grain legumes have been taken considerable attention in the central and southeastern areas of Turkey. Vetches (*Vicia* ssp.), gresspea (*Lathyrus* spp.), lentil (*Lens culinaris*) and chickpea (*Cicer arietinum*) shows good potential for their resistance do dry wheather and adaptabitily to unfavourable environments[2,4,5].

Grasspea is adapted a wide range of environmental conditions including drought and it has a high crude protein content. It may be used as dual-purpose crop for both grain and hay or green manure[2,6]. In addition, *Lathyrus* species also have potential as pasture legumes and it has better grazing tolerant than other grain legumes[2]. Buyukburc and Karadag[7] reported that seed yield productions for Hungarian vetch and hairy vetch were ranged from 823 to 891 kg ha^{-1} and 590 to 682 kg ha^{-1} in winter sowign, respectively. Grasspea has high seed production compared to Hungarian vetch and hairy vetch and obtained 1969 to 2387 kg ha^{-1} of seed yield in the same dryland cropping areas[8]. In such environments, grasspea may be replaced as alternative annual forage crop for Hungarian vetch and hairy vetch because of its high seed production. However, Karadag and Buyukburc[8] observed that seed yields of grasspea varies considerably depending on the amount and distribution of winter rains.

The main objective of this study was to determine agronomic potential of grasspea genotypes under rainfed condition in the arid and semi-arid (medium rainfall <400 mm) regions of Turkey.

MATERIALS AND METHODS

This study was conducted in the Field Crops Department of the Agricultural Faculty, Gaziosmanpasa University, Tokat, Turkey (40°13′-40°22′ N, 36°1′-36°40′ E, altitude 623 m) in 2001/02 and 2002/03. Some climatic data

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Table 1: Climatic data of the experimental area

	Years	Nov.	Dec.	Jan.	Feb.	Mar.	Ap.	May.	Jun.	Jul.	Tot/Mean
Mean	2001-02	7.4	5.1	-4.5	4.1	9.3	11.1	15.6	18.8	23.2	10.0
temperature	2002-03	6.9	-2.0	5.5	2.2	3.0	11.0	17.0	18.2	21.7	9.3
(°C)	1962-88	7.1	3.1	1.3	2.9	7.1	12.5	16.3	19.5	22.0	10.2
Rainfall	2001-02	73.4	50.5	45.1	20.4	29.2	68.4	16.8	57.6	37.6	399.0
(mm)	2002-03	33.8	25.0	27.8	21.8	16.4	73.7	11.8	11.4	1.4	223.1
	1950-88	50.1	47.2	41.7	33.4	40.2	63.7	60.3	39.4	10.8	386.8

Data of Rural Services Research Institute, Tokat, 2003

for the research area are given in Table 1. The soils of the experimental area were slightly alkaline (pH 7.80), medium in calcium carbonate content (10.0%) and in P content (80.1 kg ha^{-1}), high in K (959 kg ha^{-1}) and poor in organic matter (1.68%) content. In the research, five grasspea lines (38, 439, 452, 455, 463) obtained from ICARDA, five grasspea varieties (*Lathyrus sativus* L. var. azureus, *L. sativus* var. biflorus, *L. sativus* L. var. coloratus, *L. sativus* L. var. leucotetragonus, *L. sativus* L. var. albus) obtained from Romanya and one grasspea local population (Elazig) were used as plant materials. Field experiments started on 9 and 15th of November 2001 and 2002. Experiment was designed in a factorial randomized compelete block with three replications. Plot size was 5x1.8 m and half of each plot was used to measure the forage yield and the other half to measure the grain yields. Sowing rate of grasspea was 80 kg ha^{-1}. N-P fertilizer, 30 kg ha^{-1} N and 80 kg ha^{-1} P_2O_5, was uniformly applied to the soil before sowing. Forage was harvested when legume plants reached the beginning of the pod formation stage subsamples were dried at 70°C for 48 h, to determine dry matter yield. The rest of the plots were harvested at maturity for grain yields. Harvest index was calculated by dividing the seed yield by the total biological yield.

Analysis of variance and Duncan analysis for mean comparisons were conducted as outlined by Gomez and Gomez[9]. Results from the two years were combined and analyzed as a factorial randomized complete block.

RESULTS AND DISCUSSION

Green forage yield: Green forage yields of genotypes were significantly different ($p<0.01$) in both years (Table 2). In the first year, the highest green forage yield (23889 kg ha^{-1}) was obtained from the genotype 452 and the lowest yield (9167 kg ha^{-1}) was obtained from the genotype azureus (Table 2). Green forage yield varied from 4584 to 10556 kg ha^{-1} in the second year. According to the two-year average, the lowest green forage yield (7743 kg ha^{-1}) was obtained from the genotype azureus and the highest green forage yield (17222 kg ha^{-1}) was obtained from the genotype 452 (Table 2). These results were higher than the findings reported by Abd El Moneim and Cocks[10]. These differences may have arisen from environmental conditions such as precipitation and temperature recorded during the vegetative cycle of growth and cultivars. Precipitation and temperature values in the vegetative growth period of present study were higher, resulting in higher yields than in the above experiment. Due to the higher precipitation in 2002 (especially in March, April and May), the mean green forage yields of genotypes were higher than those in 2003 (Table 1).

Dry matter yield: Dry matter yields of genotypes were significantly different in both years (Table 2). Dry matter yields varied from 1775 to 4852 kg ha^{-1} in 2002 and from 968 to 1685 kg ha^{-1} (Table 2). The average dry matter yield varied from 1596 kg ha^{-1} for genotype azureus to 3269 kg ha^{-1} for genotype 452 (Table 2). While these results are higher than the findings of Asghar *et al.*[11] and Abd El Moneim *et al.*[12], the values are lower than findings of some other researchers[13-16]. This could be due to the effects of the ecological factors such as precipitation and temperature and also the cultivars used in experiments. The mean dry matter yield in the first year (3309 kg ha^{-1}) was higher than that of the second year (1350 kg ha^{-1}) (Table 2). Since amount of rainfall during the vegetative period in the year of 2002 was higher than that in the year of 2003, so grasspea dry matter yield was high for the year of 2002. For annual forage legumes, the water is needed mostly during the sowing time (October, November) and the intensive growth period (March, April and May). Water deficiency especially in these mounts can constraints crop growth[1,17,18].

Biological yield: Biological yields were significant in the first year but not significant in the second year (Table 3). The highest biological yield (8819 kg ha^{-1}) was obtained from the genotype leucotetragonus while the lowest (5729 kg ha^{-1}) from the genotype Elazig in the first year (Table 3). Biological yield ranged from 3403 to 5625 kg ha^{-1} in the second year (Table 3). Two-year results indicated that the genotype biflorus produced the highest biological yield (6858 kg ha^{-1}), whereas the genotype Elazig had the lowest biological yield (4566 kg ha^{-1}) (Table 3). These results are higher than the findings of Abd El Moneim[19]. Abd El Moneim[19] reported that biological yield of grasspea was highly related to early

Table 2: Green forage yield and dry matter yield for grasspea genotypes at Tokat in 2001-2002 and 2002-2003

	Green forage yield (kg ha^{-1})			Dry matter yield (kg ha^{-1})		
Genotypes	2002	2003	Mean	2002	2003	Mean
Var. azureus†	9167c**	6319bc**	7743d**	1775c**	1416ab*	1596c**
Var. biflorus†	15000bc	4584c	9792cd	3077abc	1358ab	2218bc
Var. coloratus†	14722bc	6181bc	10452bcd	3139abc	968b	2053c
Var. leucotetragonus†	12222bc	6771bc	9497cd	2400bc	1299ab	1850c
Var. albus†	14167bc	8820ab	11493bcd	2814abc	1527ab	2170bc
452	23889a	10556a	17222a	4852a	1685a	3269a
439	19444ab	10486a	14965ab	3187abc	1382ab	2285abc
455	18334ab	7430abc	12882abc	3710abc	1324ab	2517abc
463	20834ab	8819ab	14827ab	3839ab	1363ab	2601abc
38	18889ab	7847abc	13368abc	4216ab	1291ab	2754ab
Elazig	18333ab	5625bc	11979bcd	3394abc	1234ab	2314abc
Mean	16818a+	7585b	12202	3309a+	1350b	2330
LSD	7845	3149	4017	1792	527	918

*Values with the same letters (with a column) do not differ significantly **Values with the same letters (with a column) do not differ significantly
+Values with the same letters (with a line) do not differ significantly, *Lathyrus sativus* L. var.azureus†.

Table 3: Biological yield and seed yield for grasspea genotypes at Tokat in 2001-2002 and 2002-2003.

	Biological yield (kg ha^{-1})			Seed yield (kg ha^{-1})		
Genotypes	2002	2003	Mean	2002	2003	Mean
Var. azureus†	7292abc*	5625	6458ab*	1834abc*	1228ab*	1531ab*
Var. biflorus†	8438a	5278	6858a	2134a	1058ab	1596ab
Var. coloratus†	8507a	4792	6649a	2059ab	1068ab	1563ab
Var. leucotetragonus†	8819a	4653	6736a	2014ab	999ab	1507ab
Var. albus†	6424bc	3403	4913bc	1585bc	666b	1125bc
452	7535abc	4792	6163abc	1818abc	1338ab	1578ab
439	7639abc	4861	6250abc	1983ab	1281ab	1632a
455	8333ab	5278	6806a	1875abc	1487ab	1681a
463	7744ab	5695	6719a	1668abc	1666a	1667a
38	7639abc	3403	5521abc	1936ab	994ab	1465abc
Elazig	57293c	3403	4566c	1390c	667b	1029c
Mean	7645a++	4653b	6149	1845a+	1132b	1489
LSD	1744	NS	1535	460	763	432

*Values with the same letters (with a column) do not differ significantly, +Values with the same letters (with a line) do not differ significantly
++Values with the same letters (with a line) do not differ significantly, *Lathyrus sativus* L. var.azureus†.

Table 4: Straw yield, 1000-seed weight and harvest index for grasspea genotypes at Tokat in 2001-2002 and 2002-2003

	Straw yield (kg ha^{-1})			1000-seed weight (g)			Harvest index (%)		
Genotypes	2002	2003	Mean	2002	2003	Mean	2002	2003	Mean
Var. azureus†	5458abc*	4397	4927ab*	198.5abc**	204.2a**	201.4ab**	25.2	21.7bc*	23.5ab*
Var. biflorus†	6304ab	4219	5262a	200.2ab	200.0abc	200.1ab	25.3	20.1bc	22.7b
Var. coloratus†	6448ab	3724	5086ab	213.5a	195.6abc	204.5a	24.2	22.3abc	23.3ab
Var. leucotetragonus†	6805a	3654	5230a	201.2ab	202.6ab	201.9ab	22.8	21.5bc	22.2b
Var. albus†	4839bc	2737	3788bc	206.2ab	194.0abc	200.1ab	24.9	19.6c	22.3b
452	5716abc	3453	4585abc	178.6bc	166.3c	172.5c	24.1	27.9ab	26.0ab
439	5657abc	3580	4618abc	180.2abc	173.9abc	177.1c	26.0	26.4abc	26.2ab
455	6458ab	3791	5124ab	192.2abc	167.3bc	179.8bc	21.5	28.2ab	24.9ab
463	6075abc	4029	5052ab	166.2c	174.2abc	170.2c	25.3	29.3a	27.3a
38	5703abc	2410	4056abc	187.6abc	175.6abc	181.6bc	25.3	29.2a	27.3a
Elazig	4339c	2735	3537c	112.2d	100.9d	106.6d	24.3	19.6c	22.0b
Mean	5800a+	3521b	4661	185.2	177.7	181.5	24.4	24.2	24.3
LSD	1553	NS	1212	29.7	31.6	20.6	NS	7.4	4.4

*Values with the same letters (with a column) do not differ significantly, **Values with the same letters (with a column) do not differ significantly
+Values with the same letters (with a line) do not differ significantly, *Lathyrus sativus* L. var.azureus†.

spring rains. The mean biological yields of genotypes were higher in 2002 than that in 2003 (Table 3) (due to the higher precipitation in 2002). Due to variability in amount of rainfall, there were important changes in biological yield of grasspea genotypes.

Seed yield: Seed yields of genotypes were significant ($p<0.05$) in both years (Table 3). The highest seed yield (2134 kg ha^{-1}) was obtained from the genotype biflorus while the lowest (1390 kg ha^{-1}) was obtained from the genotype Elazig in the first year (Table 3). Seed yield varied from 666 to 1666 kg ha^{-1} in the second year (Table 3). According to the two-year average, the genotype 455 had the highest seed yield averaging 1681 kg ha^{-1} while the genotype Elazig had the lowest averaging 1029 kg ha^{-1} (Table 3). Similar results reported by Abd El Moneim[19] and lower results reported by Asghar *et al*.[11]. Abd El-Moneim and Cocks[10] stated that seed yields of *Lathyrus* species was linearly related to total rainfall in similar ecological conditions. The mean seed yield in the first year (1845 kg ha^{-1}) was much higher than that of the second year (1132 kg ha^{-1}) (Table 3). In the second year, the low seed production was probably related to the delayed appearance of floral buds, corresponding with the onset of drought periods (low precipitation) in spring, particularly in May, causing high abortion rates in flowering and young pods after fertilization. Heath *et al*.[20] reported that critical period for forage legumes in terms of water need is from the beginning of flowering to seed formation. Yield could be low even if the water requirement is met after this critical period.

Straw yield: Differences of straw yields were significant in the first year but not significant in the second year. In the first year, the highest straw yield (6805 kg ha^{-1}) was obtained from the genotype leucotetragonus and the lowest yield (4339 kg ha^{-1}) was obtained from the genotype Elazig (Table 4). Straw yield varied from 2410 to 4397 kg ha^{-1} in the second year (Table 4). Two year results indicated that genotype biflorus, produced the highest straw yield (5262 kg ha^{-1}), whereas, the genotype Elazig had the lowest straw yield (3537 kg ha^{-1}).

1000-seed weight: There were differences between genotypes for 1000-seed weight in both years (Table 4). 1000-seed weight changed between 112.2 and 213.5 g in the first year and between 100.9 and 204.2 g in the second year (Table 4). Average 1000-seed weight varied from 106.6 g for the genotype Elazig to 204.5 g for the genotype coloratus. While these results are higher than the findings of Campbell *et al*.[21], the values are lower than findings of some other researchers[22, 23]. Ecological conditions, such as precipitation and temperature, as well as the different cultivars used in the field experiments could cause such differences.

Harvest index: Differences of harvest index were significant in the second year but not significant in the first year (Table 4). In 2002, the highest and the lowest harvest index (26.0 and 21.5%, respectively) were obtained from the 439 and 455 genotypes (Table 4). In 2003, the highest harvest index (29.3%) was obtained from the genotype 463 while the lowest harvest index (19.6%) was obtained from the genotypes albus and Elazig. The mean harvest index varied from 22.0% for the genotype Elazig to 27.3% for the genotypes 463 and 38. This experiment results have been higher than the findings of Abd El Moneim *et al*.[4]. Harvest index is an important yield component for grasspea. In semi-arid regions, grasspea with high grain yield and harvest index can be used as dual-purpose crop for grain and straw production. In general, the selections with high harvest index could have high potential biological yields[5, 20].

Annual rainfall and its distribution significantly affect yield and yield components of grasspea in semi-arid regions (<400 mm). Grasspea showed more adaptability to semi-arid regions than Hungarian vetch and hairy vetch, producing more herbage, grain and straw. Therefore, it could be seen as alternative legume in these areas. At the end of this study, it was found that the genotype 452 for green forage and dry matter yield and genotypes 455, 463 and 439 for seed yield had good performance.

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