

CULTIVATION POSSIBILITIES OF SOME COMMON BEANS VARIETIES UNDER SECOND CROP CONDITIONS

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ABSTRACT. This research was carried to determine the yield and yield components on some common bean (*Phaseolus vulgaris*) varieties in 2017 and 2018 years, in Diyarbakir, southeast Anatolia of Turkey. In the experiment, Onceler-98, Karacasehir-90, Yunus-90, Akman-98, Goynuk-98, Aras-98, Terzibaba, Adabeyazi, Cihan and Noyanbey cultivars were used. Experiment was set up in randomized complete block design with three replications. Plots were 6 m length with five rows, the inter-row and intra-row spacing were 0.7 m and 0.10 m. Seeds were sown after wheat harvest as second crops. The differences among cultivars were significant for number of days of flowering and maturity, plant height, number of pods and seeds per plant, grain yield and 100 seed weight. Number of days to flowering ranged from 48.0 to 62.8; number of days to maturity ranged from 99.8 to 113.8. The number of pods and seeds per plant varied from 12.8 to 30.8, and 24.3 to 105.6, respectively. Grain yield ranged from 792.3 kg ha⁻¹ (Cihan and Noyanbey) to 2709 kg ha⁻¹

(Goynuk-98 and Onceler-98). In the experiment area, high heat temperature and high evaporation throughout July and August, negatively affected the blooming, pollination and fertilization on cultivars of dwarf and determinate plant habit types. Brushy type and late-maturing varieties should be preferred under second crop conditions.

Keywords: dry bean; *Phaseolus vulgaris*; yield.

INTRODUCTION

The domestication of *Phaseolus vulgaris* (common bean) occurred independently in South America and Central America, leading to two different domesticated gene center, the Andean and Mesoamerican, respectively (Debouck *et al.*, 1993). The common bean is currently estimated to be one of the most important legumes worldwide. It is an important source of nutrients,

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representing 65% of total protein consumed, 32% of energy, and a major source of micronutrients (iron, zinc, thiamin and folic acid) (Broughton *et al.*, 2003; Fageria *et al.*, 2010). The annual global dry bean production is approximately 31 million metric tons, and the highest producer is India continent. Turkey total dry bean production exceeds 220000 metric tons, of which 65% are produced in Center of Turkey. Bean production is almost half that of chickpea.

A large part of bean production in Turkey takes place on both small and big farms, ranging from 1 to 10 ha in size, ranged on sloping land and low fertility to high fertility land (FAO, 2019). Southeastern of Turkey is a very hot and dry summer seasons. Dry bean is not cultivated in the region for many years due to the high temperature and high evaporation. Dry beans are only grown about 1 or 1.5 ha, which has a cool and wet climate, as called micro-climate. In the last 30 years, with irrigation projects in the region, corn and cotton cultivation has become widespread, and this has increased the relative humidity rate of the region. Bean production became possible thanks to increased irrigation possibilities and high humidity. Also, local farmers were very interested in bean cultivation practices and cultivars. In this study, the possibilities of beans, especially after wheat harvest, were investigated in the second crop cultivation.

MATERIAL AND METHODS

This research was conducted out at Dicle University Agriculture Faculty, Diyarbakir, southeast Anatolia of Turkey during 2017 and 2018 growing seasons. The Diyarbakir is located on grid 37.91°N, 40.2°E, at an altitude of 640 m above sea level. The area receives rainfall with an annual mean below about 500 mm, with a wide variation between the years. Precipitation is mainly received from November to May, and between June and October is not. Mean temperature is about 30-35°C in June to September. The relative humidity varies between 20% and 35% in June to September, and evaporation is very high (*Table 1*). Prior to planting, soil samples were taken from the field for soil fertility analyses. The soil analysis indicate that soils are neutral (pH: 7.5), insufficient in organic matter (0.63%) and phosphorus content (20.0 kg ha⁻¹) with clay texture.

Ten dry bean varieties, namely, Onceler-98, Aras-98, Terzibaba, Karacasehir-90, Adabeyazi, Yunus-90, Akman-98, Noyanbey, Cihan and Goynuk-98, were sourced from different Agricultural Research Institute of Turkey. Yunus-90, Goynuk-98, Onceler-98, Terzibaba, Aras-98, Noyanbey, Cihan are a dwarf shrubs habit, and Noyanbey and Cihan are dwarf and determinate type I. Karacasehir-90, Adabeyazi and Akman-98 are semi-climbing growth habit.

Experiment was laid out in a randomized complete block design, with three replications, over two years. Plots were 6 m length with five rows, the inter-row and intra-row spacing were 0.7 m and 0.10 m. Sowing dates were June 16, 2017 and June 20, 2018.

Table 1 - Meteorological data in Diyarbakir, Southeastern Turkey

Months	Mean temperature (°C)			Total precipitation (mm)			Moisture (%)		
	2017	2018	Long-term	2017	2018	Long-term	2017	2018	Long-term
June	26.7	26.5	26.2	2.6	14.4	8.0	30.6	37.9	35.0
July	32.3	31.2	31.1	0.0	0.0	0.7	19.8	24.2	26.0
August	31.1	31.5	30.4	0.0	0.8	0.4	23.0	24.1	26.0
September	26.9	31.2	24.9	0.0	4.15	3.9	22.0	20.0	30.0
October	17.3	18.8	17.3	1.0	35	32.2	35.8	52.4	48.0
November	10.1	10.2	9.5	21.2	59	54.2	67.4	80.2	66

The plots were irrigated with drip irrigation, total 600 mm of water was applied, and applications were twice a week. N and P fertilizers were applied to the plots, as recommended doses: 200 kg N ha⁻¹ (as starter in the form of urea) and 100 kg ha⁻¹ P₂O₅ (as triple superphosphate). Trifluralin was applied pre-emergence at 800 g a.i./ ha to control weeds. Subsequent weed control was by hoeing.

Plants were harvested at end of October and at the beginning of November, in both years. At maturity stage, yield components, viz. plant height, days to flowering, days to maturity, number of pod per plant, number of seeds per plant and 100-seed weight were determined on a randomly selected subsample of 10 plants. Matured pods were harvested, hand threshed, and weighed. Seed yield was adjusted to 16 - 18% seed moisture content.

To minimize the border effect, all samplings in each plot were done only on four central rows of 4 m (leaving two border rows and 0.5 m, at the beginning and at the end of each row).

Data were subjected to analysis of variance (ANOVA) using MSTAT-C (Freed *et al.*, 1991). Means were compared at the 5% level of significance, using Fisher's protected least significant difference (LSD).

RESULTS AND DISCUSSION

Analysis of variance for seed yield and its components on common bean varieties was given *Table 2*. Variety, year and year × variety interaction were significant ($p < 0.01$) for days to flowering and days to maturity (*Table 2*).

Number of days to flowering ranged from 48.0 to 62.8, variety Yunus-90 and Goynuk-98 (61.0 days) late flowered. Variety Adabeyazi was early flowered. Number of days to flowering among years ranged from 58.3 in 2017 to 53.8 in 2018.

Number of days to maturity ranged from 99.8 in Adabeyazi to 113.8 in Goynuk-98. Number of days to maturity among years ranged from 108.1 to 105.7 (*Table 3*), and flowering and maturity traits were affected by environmental factors.

Variety and year were significant ($p < 0.01$) for plant height (*Table 2*). Plant height ranged from 55.8 cm to 162.7 cm.

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Table 2 - Analysis of variance for seed yield and its components on common bean varieties

	Df.	Mean square						
		Days to flowering	Days to maturity	Plant height	Number of pods plant ⁻¹	Number of seeds plant ⁻¹	Seed yield	100-seed weight
Year	1	312.817**	88.81**	660.01**	221.95	1330.76**	248107**	52.26*
Error	4	2.583	3.06	29.16	36.50	3.96	2443	10.46
Variety	9	122.594**	84.97**	10684.8**	189.72**	4138.27**	292302**	354.45**
Year* Variety	9	5.409**	22.26**	120.2	34.19*	92.57	13130**	7.63*
Error	36	2.546	4.62	60.13	16.46	75.45	3749	3.18
CV %		2.85	2.01	7.83	16.7	17.19	173.8	4.69

*,** F-test significant at the $p = 0.05$ and $p = 0.01$ levels, respectively.

Semi-climbing varieties, Adabeyazi (162.7 cm) and Karacasehir-90 (153.0 cm), had the maximum plant height. Although Terzibaba (146.7 cm) was a dwarf variety, it was among the tallest ones. Yunus-90 (55.8 cm) and Onceler-98 (59.5 cm), among dwarf varieties, had the shortest plant height (Table 3).

Other studies report that plant height ranged from about 35 cm to 60 cm in same varieties, but in different ecologies (Ozbekmez, 2015; Yeken *et al.*, 2018; Bildirici and Demir, 2019). In our study, irrigation water was applied total 600 mm, to prevent the flower abortion, due to high evaporation. The amount of water was increased the plant height and stem diameter more than it should be. Especially, in dwarf types, the plant height was reached an abnormal size. El-Noemani *et al.* (2009) reported that increasing the irrigation level up to 100% increases vegetative growth (plant height, number of branches, leaf area, root and stem dry matter), due to the positive effect of water on cell division. In order to prevent overgrowth of the plant stem,

irrigation water should be stopped towards the end of the pod setting period.

Variety and variety \times year interaction for number of pods per plant were significant ($p < 0.01$ and $p < 0.05$, respectively) (Table 2), and number of pods per plant ranged from 12.7 in Noyanbey to 30.8 in Karacasehir-90. Variety \times year interaction revealed that in first experiment year, the number of pods of all varieties, except for Yunus-90, Cihan and Akman-98 varieties, is higher than second year ones (Table 3).

The number of pods is higher in semi-climbing types, than dwarf and determinate type I ones. In the experiment area, the weather was hot, 40°C/30°C day/night, and continued throughout July and August. In dwarf and determinate types of varieties, such as Cihan and Noyanbey, since flowers are formed at the upper point of the plant, high temperature negatively affected flowering, pollination and fertilization. Although some flowers was pollinated and fertilized, the pods have resulted in a zygotic-embryo. High air temperature

with high evaporation and the problem of pollination caused by temperature in dwarf and determinate growth types is an important productivity problem, such as our experiment area. The reason why our irrigation water amount is high is to increase productivity in dwarf types at least, but no success has been recorded on it.

Young *et al.* (2004) reported in *Brassica napus* that high temperature stress during flowering, decreases seed production in many plants. Also, under heat stress, flowers either developed into seedless, parthenocarpic fruit or aborted on the stem. During

the heat stress, pollen viability and germinability were slightly reduced. Gupta *et al.* (2015), on pearl millet, revealed that the day-time maximum temperature beyond 42°C and the associated increase in VPD during flowering time linearly reduced seed set. Varieties with semi-climbing plant type covered the soil and prevented evaporation. The pods formed under branches and leaves were able to escape the negative effects of the hot. But still, some semi climbing varieties had low number of pods per plant, due to their genetic potential of genotypes, as reported by El-Noemani *et al.* (2010).

Table 3 - Days to flowering, days to maturity, plant height and number of pods per plant in common bean varieties

Varieties	Days to flowering (days)			Days to maturity (days)			Plant height (cm)			Number of pods plant ⁻¹		
	2017	2018	Mean	2017	2018	Mean	2017	2018	Mean	2017	2018	Mean
Terzibaba	55.3	49.7	52.5	99.33	109.0	104.2	154.0	139.3	146.7	30.0	23.2	26.6
Yunus-90	64.3	61.3	62.8	108.7	110.7	109.7	56.3	55.3	55.8	19.4	21.0	20.2
Cihan	55.3	53.3	54.3	106.7	109.7	108.2	73.3	76.0	74.6	18.0	18.5	18.3
Noyanbey	59.0	56.7	57.8	107.7	103.3	105.5	66.3	72.6	69.5	15.6	9.68	12.7
Aras-98	56.3	50.3	53.3	104.0	106.0	105.0	74.0	74.0	74.0	27.3	25.3	26.3
Karacasehir-90	56.6	50.3	53.5	107.7	105.0	106.3	162.7	143.3	153.0	37.3	24.2	30.8
Goynuk-98	64.3	57.7	61.0	112.3	115.3	113.8	81.3	62.3	71.8	30.4	24.0	27.2
Onceler-98	61.0	58.6	59.8	108.0	111.0	109.5	61.7	57.3	59.5	30.5	28.0	29.3
Akman-98	60.3	54.3	57.3	104.7	109.7	107.2	126.3	118.0	122.2	25.3	27.8	26.5
Adabeyazi	50.6	45.3	48.0	98.0	101.7	99.8	167.0	158.3	162.7	24.6	18.3	21.5
Mean	58.3	53.8		108.1	105.7		102.3	95.7		25.8	21.9	
LSD (0.05)	2.61		2.55	3.12		2.77	12.84		8.65	6.71		9.68

Means followed by the same letter within a column are not significant different according to LSD (0.05).

Kumar *et al.* (2016) reported that pulses are particularly sensitive to heat at flowering and pod development stages. If the crop encounters a few days of exposure to high temperatures (30-35°C) at these

stages, heavy yield losses are reported, due to flower drop and pod abortion. However, this sensitivity varies from genotype to genotype.

Variety and year for number of seeds per plant were significant

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($p < 0.01$) (Table 2), and number of seeds per plant ranged from 12.0 in Noyanbey to 105.6 in Karacasehir-90. Karacasehir-90 variety is a small-seeded variety, and had a lot of seeds per pod (Table 4). Although determinate type varieties (Cihan and Noyanbey) and some semi-climbing varieties had pods per plant, were not produced more than 1 or 2 seeds in the pod. In our study, high irrigation (600 mm) and heat increased plant height and number of pods per plant, but not number of seeds per plant, due to low seeds per pod. Sehirali (1988)

and Sita *et al.* (2017) reported that the dry bean grows optimally at temperatures of 18 to 24°C. The maximum temperature during flowering should not exceed 30°C. High temperatures during the flowering stage lead to abscission of flowers and a low pod set, resulting in yield loss. Day temperatures upper 35°C cause empty mature pods. Cultivated under rainfed conditions, the crop requires a minimum of 400 to 500 mm of rain during the growing season, but an annual total of 600 to 650 mm is considered ideal.

Table 4 - Number of seeds per plant, 100-seed weight and seed yield in common bean varieties

Varieties	Number of seeds plant ⁻¹			100-seed weight (g)			Seed yield (kg ha ⁻¹)		
	2017	2018	Mean	2017	2018	Mean	2017	2018	Mean
Terzibaba	58.5	42.9	50.7	42.0	41.3	41.7	2111	1400	1755
Yunus-90	35.3	34.9	35.1	44.3	41.7	43.0	1081	973.3	1027
Cihan	26.9	21.7	24.3	38.0	33.6	35.8	827.3	757.3	792.3
Noyanbey	11.4	12.6	12.0	40.7	42.3	41.5	813.3	773.0	793.2
Aras-98	70.8	63.7	67.3	39.6	40.7	40.2	2439	2218	2329
K.sehir-90	118.3	92.9	105.6	19.0	18.0	18.5	1983	1503	1743
Goynuk-98	60.5	47.5	54.0	49.0	44.7	46.8	3130	2289	2709
Onceler-98	74.0	60.7	67.4	41.3	40.0	40.7	3000	2257	2629
Akman-98	54.7	49.2	52.0	39.0	34.0	36.5	1852	1515	1684
Adabeyazi	42.0	32.0	37.0	37.0	35.0	36.0	1887	1371	1629
Mean	55.2	45.8		39.0	37.1		1912	1505	
LSD (0.05)			3.19	2.95		5.09	32.02		25.05

Means followed by the same letter within a column are not significant different according to LSD (0.05).

Variety, year and variety × year interaction for 100-seed weight were significant ($p < 0.01$ and $p < 0.05$, respectively) (Table 2), and 100-seed weight ranged from 18.5 g in Karacasehir-90 to 46.8 g in Goynuk-98 (Table 4). Variety × year interaction revealed that Noyanbey and Aras-98 varieties in first experiment year, but

other varieties in the second year had high 100-seed weight. Although 100-seed weight had high heritability, could be affected by soil and climate conditions (Elkoca and Cinar, 2015). Siddique *et al.* (1999) reported that a few days of exposure to high temperatures (30-35°C), during seed filling, accelerates senescence,

diminish seed set and seed weight, and reduce yield in pulses.

Variety, year and year \times variety interaction were significant ($p < 0.01$) for seed yield (Table 2), and seed yield ranged from 792.3 kg ha⁻¹ to 2709 kg ha⁻¹. The highest seed yield was in Goynuk-98 (2709 kg ha⁻¹) and Onceler-98 (2629 kg ha⁻¹) varieties.

The lowest seed yield was in Cihan (792.3 kg ha⁻¹), Noyanbey (793.2 kg ha⁻¹) and Yunus-90 (1027 kg ha⁻¹) varieties. Seed yield among years ranged from 1912 kg ha⁻¹ in 2017 to 1505 kg ha⁻¹ in 2018 (Table 4). Since seed yield is highly affected by environmental conditions, such as climate and soil factors, differences among years for seed yield are generally significant. We observed significantly higher unfilled pods for some genotypes, indicating the impacts of high temperature on pod formation. Kumar *et al.* (2016) reported that in legumes high temperature during anthesis reduces seed set due to impaired pollen tube growth and fertilization. Especially, in dwarf types, number of pods and seeds per plant were low.

CONCLUSIONS

It is aimed to determine the suitable semi-climbing and dwarf common bean varieties that can be grown under second crop conditions in this study. Yunus-90 and Goynuk-98 varieties were late flowered and matured. High heat and full irrigation were increased plant height, and plant height was between 55.8 cm and

162.7 cm. Cihan and Noyanbey varieties had low number of pods and seeds per plant, due to dwarf and determinate growth habit. Number of seeds per plant and seed yield were negatively affected by heat. Seed yield ranged from 792.3 kg ha⁻¹ to 2629 kg ha⁻¹, and the highest seed yield was in Goynuk-98 and Onceler-98 varieties. Also, Aras-98, Akman-98 and Adabeyazi varieties had good performance for this region and such as high heat environments.

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