

Comparing the Yield of Promising White Bean Lines in Shahrekord

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Received: 25 May 2018

Accepted: 10 JUNE 2018

ABSTRACT

In this study, 10 promising lines of white bean (*Phaseolus vulgaris* L.) along with Dorsa and Paak control cultivars were evaluated in a randomized complete blocks design with three replications over two years. During the growing season, the status of the lines was determined in terms of growth type, number of days from planting to flowering and maturity, number of pods per plant, number of seeds per pod, 100-seeds weight, single plant yield and total yield. Results of combined analysis of variance over two years followed by LSD test showed that grain yields of lines 7, 3 and 6 were 49%, 42% and 41% higher than the control, respectively. Of these three lines, line 3 was superior because of its higher 100-seeds weight. Therefore, this line is suitable for Shahrekord and similar areas. Correlation coefficients of grain yield and its main components were positive and significant. Further experiments to introduce Line 3 as a new cultivar will take place in the coming years.

Keywords: White, Seed, Yield, Line, Bean

INTRODUCTION

Increased crop yield can be attributed to improved genetic variability due to advanced cultivars, better use of inputs, improved farming and more favorable environmental conditions. Advanced cultivars are the main factor of higher yields (Debouck, 1994). In the most populous countries of the world such as India, the per capita consumption of beans is 11.7 kg. In our country, beans with an average consumption of 4.8 kg (Parsa and Bagheri, 2008) play an important role in feeding low-income people, though it is lower than the world average (6.1 kg). Fortunately, the per capita consumption of legumes in Iran has now increased to 10 kg, compared to previous years. The consumption of beans in the country is about 4 kg which is very low compared to cereals (170 kg), and in the future, per capita consumption of beans should reach to 50 kg. Per capita consumption of beans in Brazil is 18.2 to 20.8 kg /year and in Africa 40 kg /year (Broughton *et al.*, 2003).

Bean cultivation is very important for Chaharmahal and Bakhtiari province. This crop plays important roles both in the diet of individuals and in the economy of farmers. Dorsa, Paak and Shekoofa are from advanced cultivars which have increased production. Dorsa cultivar was introduced by Dorri in 2010. The average grain yield of this cultivar was 3319

kg/ha whereas the control cultivar had yield of 2870 kg/ha. Dorsa has type III growth and is resistant to two-spotted spider mite. This cultivar is semi-susceptible to common bacterial leaf blight disease. The shape of the Dorsa seed is kidney shaped. This is also tolerant to common bean mosaic virus and cucumber mosaic virus diseases. Dorsa seeds have about 20% of protein and take about 150 minutes to be cooked. Shekoofa has growth type III (indeterminate growth with runner stems and weak twisted branches). This cultivar has a good ability to grow longitudinally and spatially, and to form branches and has higher yield components (number of pods per plant, number of seeds per pod, number of seeds per plant and 100-seed weight) than control. Due to the lack of pods on the ground, it will be protected from decay. Because the pods do not fall to the ground, they will be protected from rotting. The marketability of this cultivar is good. Seeds are kidney-shaped. Plants are resistant to BCMV disease, and have high protein content (20.42). Grains take 130 minutes to be cooked and have more uniformity in cooking (Seed and Plant Improvement Research Institute, 2011).

Lighting is a Type II white bean cultivar (standing with short tendrils) that is suitable for areas with over 2600 degree days. The yield potential of this cultivar is high and seeds are of good quality and suitable for canning. White flowers appear 45 days after planting. Plant height at ripening stage is about 46 cm. The pods are light beige at the stage of processing, although in some environments the pods may have streaks of slightly purple color. Seeds are white opaque with 22.7 g of 100-seed weight. The average grain yield of this cultivar is 3482 kg/ha (Smith *et al.*, 2009). Nautica white bean was introduced in Canada. The yield of this cultivar is 3415 kg/ha. It ripens 96 days after sowing and has a 100-seed weight of 19.1 g. It is of excellent quality for baking and canning (Park AND Rupert, 2007).

Verano is adapted to hot and humid regions. This cultivar was introduced in the US in 2007. Useful traits of this cultivar (tolerance to high temperatures, resistance to common bean mosaic virus and blight-producing bacteria) can be used in bean breeding programs (Beaver *et al.*, 2008).

MATERIALS AND METHODS

This study was carried out in Lordegan (Chaharmahal and Bakhtiari Province) as a randomized complete block design with three replications during 2013 and 2014. Ten promising white bean lines (derived from F2-F5 segregating generations, purification plans and preliminary yield comparisons at research stations of the country), along with Dorsa and Paak control cultivars were evaluated (Table 1).

Seeds were disinfected with Rural-TS fungicide prior to planting and weeding was performed during the growth season. The irrigation was done every 5 to 7 days. Each experimental plot consisted of four rows of five meter length. During the growing season, growth type, flowering time, physiological maturity, number of pods per plant, number of seeds per pod, 100-seeds weight, single plant yield and total yield were recorded.

Common plant types in the lines include Type I (determinate and standing growth), Type II (indeterminate growth and standing pod formation) and Type III (indeterminate growth plus runner type at the time of pod formation).

Flowering date is when the first flower is found in 50% of the plants. The date of physiological maturity is when the first pod of 50% of the plants is dried. At the time of maturity and before harvest, five plants were harvested from each plot and number of pods and seeds were counted. The average of 5 plants represented the number of pods per plant

and the number of seeds per pod. After harvesting, four random samples of 100-seeds were weighed from each treatment. The mean of samples was 100-seeds weight for the respective treatment. Average grain yield was determined for 5 harvested plants. Also, after harvesting plants of each plot, the grain yield per hectare was determined.

Obtained data were analyzed using combined analysis of variance and means were compared using LSD test (least significant difference) to determine the best lines over two years.

Table 1. The studied line number and genotype

Line Number	Genotype
1	DANESHKADE/G11867
2	JULES/DANESHKADE
3	JULES/DANESHKADE
4	JULES/74EMERSON
5	11805/DANESHKADEH
6	74EMERSON /JULES
7	SEFEN/74EMERSON
8	KARA/G11867
9	KARACASIHIRO
10	GOYONOK98
11	Dorsa
12	Paak

RESULTS AND DISCUSSION

Combined analysis of variance showed significant differences for number of seeds per pod but it was not significant for other traits. However, the means of traits (except days to flowering and days to maturity) were higher in the second year which was related to more favorable environmental factors (such as soil condition, water, temperature, and humidity) in the second year. Non-significant interactions of the year and line for the studied traits showed that the trend of changes was the same over two years of experiment (Table 2).

Table 2. Mean squares of studied traits

Source of variation	Degrees Of Freedom	Plant Yield	Total yield	Number Of Pods Per Plant	Number Of Seeds In The Pod	100-Seed Weight	Day To Flowering	Day To Maturity
Year	1	150.7 _{n.s}	648433 _{n.s}	358.7 _{n.s}	23 [*]	7.5 _{n.s}	125.3 _{n.s}	120 _{n.s}
Error (Block Per Year)	4	28.3	155309	139.3	1.7	38.4	45.1	54.3
line	11	232.3 ^{**}	1818001 ^{**}	229.7 ^{**}	2.1 ^{**}	193.2 ^{**}	77.1 ^{**}	156 ^{**}
Year*line	11	1.99 _{n.s}	10412 _{n.s}	5.9 _{n.s}	0.14 _{n.s}	2 _{n.s}	0.68 _{n.s}	1.1 _{n.s}
Error	44	1.21	5449.1	3.97	0.13	1.17	1.8	2.7

_{n.s}: no significant, ^{*} and ^{**}: significant at 5% and 1% probability levels, respectively

Mean comparisons results showed that most of the lines were better than Dorsa and Paak controls in terms of yield and its main components. However, only line 7 with grain yield of 2684 kg /ha was placed in group a. After this line, lines 3, 6, 10 and 4 were placed in b group, respectively. The highest number of pods per plant and number of seeds per pod were observed in lines 6 and 9, respectively. The number of days from planting to flowering ranged from 49 to 59 days whereas from planting to physiological maturity was lasted about 110 to 125 days (Table 3).

Table 3. Mean Comparison results of genotypes by Tukey test

Line Number	Plant Yield (g)	Total yield (kg ha ⁻¹)	Number Of Pods Per Plant	Number Of Seeds In The Pod	100-Seed Weight (g)	Day To Flowering	Day To Maturity
1	29.5 b	2483.8 b	32.8 d	3.9 d	30.7 c	49.2 cd	109.7 e
2	15 e	1553.9 f	24.8 fg	2 f	22.9 f	59 a	121.2 b
3	30.2 ab	2551.5 b	38.5 b	3.3 bcd	36.8 a	49 cd	112.5 d
4	29.3 b	2491.2 b	36.6 bc	3.2 cde	33.4 b	50.7 c	116 c
5	16.9 e	1403.8 e	23.4 g	2.7 e	24.2 ef	49.8 c	114 cd
6	29.3 b	2537.8 b	44.9 a	3.5 bc	28.4 d	50 c	115.2 c
7	32.2 a	2683.8 a	35.5 cd	3.9 ab	30.9 c	47.5 d	116.2 c
8	18.1 de	1529.7 d	28.4 e	3.2 cde	24.3 ef	49.8 c	115.5 c
9	19.6 d	1623.5 d	29.6 e	4.2 a	18.5 g	55.7 b	123.5 ab
10	29.7 ab	2497.6 b	33.9 cd	3.5 bc	37.1 a	55.2 b	122.7 ab
11	19.8 d	1627.3 d	27.3 ef	2.8 de	29.5 cd	55.3 b	124.5 a
12	23.5 c	1965.4 c	29.2 e	3.3 cd	25.7 e	54.3 b	124.7 a
least significant difference	1.7	1414.7	3.1	0.6	1.7	2.1	2.6

There is no significant difference between the means of each column ($p < 0.01$) with at least one common letter

In addition, lines were somewhat earlier mature than the Dorsa and Paak cultivars. Line 10 had growth type I whereas Lines 1, 2, 8, 9 had growth Type II_b (unlimited growth, the plants were initially standing and gradually the ends of the tendrils lie on the ground) and other lines and cultivars had Type III growth.

Grain yields of 7, 3, and 6, lines which had type III growth, were 49%, 42%, and 41% higher than control, respectively. Of these three lines, line 3 had a higher 100-seed weight and the seeds were larger; Therefore, in terms of grain yield and marketability, it is recommended as the top line for cultivation in Shahrekord and other cold regions of the province. In order to introduce this line as a cultivar, future agricultural and research-extension projects must be implemented.

Correlation coefficients indicated significant positive relationships between grain yield and the number of pods per plant, the number of seeds per pod and 100-seeds weight. The number of days from planting to flowering and the number of days from planting to maturity had negative non-significant correlation. The trends of total yield and plant yield were positive and significant. Increase of these two traits showed a significant correlation with increasing of grain yield components. Correlation between total yield and the number of days from planting to maturity was negative and non-significant. The pods of lines with relatively longer growth periods were not well filled due to the decreasing trend of temperature at the end of the growing season and these lines had lower yields (Table 4).

Table 4. Correlation coefficients between studied traits

Trait	(1) Plant Yield	(2) Total yield	(3) Number Of Pods Per Plant	(4) Number Of Seeds In The Pod	(5) 100-Seed Weight	(6) Day To Flowering	(7) Day To Maturity
(7)	-0.4 ^{ns}	-0.39 ^{ns}	-0.36 ^{ns}	-0.16 ^{ns}	-0.29 ^{ns}	0.82 ^{**}	1
(6)	-0.58 [*]	-0.58 [*]	-0.48 ^{ns}	-0.4 ^{ns}	-0.36 ^{ns}	1	
(5)	0.77 ^{**}	0.78 ^{**}	0.57 [*]	0.1 ^{ns}	1		
(4)	0.57 [*]	0.59 [*]	0.5 ^{ns}	1			
(3)	0.84 ^{**}	0.86 ^{**}	1				
(2)	0.99 ^{**}	1					
(1)	1						

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