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Studying the Effect of Tillage Row Spacing and Bush Spacing on the Performance and Components of Phaseou vulgaris var. (Line cos16) in Brujerd

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ABSTRACT

This study was aimed to the examination of the effect of tillage row spacing and bush spacing on the performance and components of Phaseou vulgaris var. (line: cos16). The investigation was conducted as cut terraces and in terms of complete random blocks in three replicates at Brujerd Agricultural Research and Natural Resources in the agricultural year 2009-2010. Here, the main terraces with three row spacing treatments (25, 50, & 75cm) and three density treatments of secondary terraces (30, 40, & 50 bushes/m^2) were respectively shown with symbols A1, A2, A3 and B1, B2, B3. Each experimental terrace included 7 lines with 6m length and one between 2 terraces was considered as non-tillage line. After soil test, the land under study was sowed and, after disk, loader and Farozni operation, the tillage was done on 10th of May. The amount of fertilizer was applied based on soil test. To control weed, Terflan herbicide was used (2l/hec). In growth period, controlling peps was done again. At the time of harvest, the following qualities were considered: bush height, the number of secondary branches in a bush, husk length, number of husks in a bush, number of seeds in husk, biological performance, seed performance, and yield index. Test results showed that the difference between seed performance in hectare in row spacing and different bushes spacing was at %5 level of significance. And, maximum production in square area was gained at maximum spacing and the highest density (B3).

Key words: Phaseou vulgaris var., row spacing, bush spacing, performance and performance components

INTRODUCTION

Cereals are dry edible grains belonged to Fabaceae 1 and Papilionoideae 2 (Kuchaki and Banayan, 1993). Grown seeds and dry cereals have high food value and good maintenance capability and they are among the main food sources rich with protein (%18 to %32). Based on studies done, a suitable combination of cereals and grains protein can resolve malnutrition and lack of amino acids. On the other hand, regarding the nitrogen fixation ability in these plants, placing them in arable alternation will contribute to the stability of arable systems (Torabi Jafrudi *et al*, 2007). Bean is an annual plant of Fabaceae. This is a selfed, and

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thermophilous plant and some of its cultivars are sensitive to the short length of day. Moreover, it has straight root system. Pinto bean is scientifically known as Phaseou vulgaris var. (pinto bean or spotted bean in English). Compared to other countries, it has a higher portion of the populated countries like India with consumption per capita 11.7km. This portion is 4.8km in our country despite being less than global average (6.1) (Baghdar, 2008).
Sunshine is essential for plant growth and shade will end into dwarfism and reduction of performance. In its natural habitat, Phaseou vulgaris var. is biennial sometimes but cultivated annually. Its major physiological growth chronologically includes: growing 10 days after tillage, developing the first three-leaflet leaves 15 days after growth, full vegetation after 46 days (Mohammadi, 2001). Cereal seeds are the second main food resource for human being and cattle after grains (Majnun Hosseini, 1993). Also, cereals young seeds, its fresh husks and leaves can be consumed as vegetable and their vegetative members are used for cattle after separating seeds (Kuckaki and Banayan Avval, 1993). Desirable bush density is the density as a result of which all environmental factors including water, light, nutrients, and soil are completely used and at the same time intra-bush and inter-bush competitions become minimal so as to gain maximum performance (Khajehpur, 2000). Also, the arrangement of bushes within a certain density is important so that the establishment of a desirable density of intact bushes in the most suitable bush arrangement pattern is the basis for a successful arable production system. Bushes arrangement or geometric condition can be changed by altering row width and bush spacing on the row (Ghanbari and Taheri Mazandarani, 2003). Accordingly, knowledge of proper arable management and knowing the issues related to the increase of arable performance are necessary. Present conditions of the world and lack of protein nutrients required and in particular in poor and developing countries and the disadvantages of too much meat consumption have led many countries and even the rich ones to tend to apply herbal protein nutrients (including cereals). In the meantime, Phaseou vulgaris var. plays a key role. Regarding the local conditions of Lorestan Province and the consumption market of this plant in Iran, conducting this study seems necessary (Abdi, 2009). This study is mainly aimed to examine the effect of density and tillage arrangement on Phaseou vulgaris var. (line COS16) performance and components at Brujerd Agricultural Research and Natural Resources so as to gain the optimized tillage arrangement and density in the zone. Studying the effect of tillage date and density on the qualities of chickpea, Falah (2007) concluded that the least number of husks in a bush were gained at the highest density. That is, as the density increased from 18 to 36bush/m^2, the number of seeds in each husk reached 1.16 from 1.124. He also concluded that the effect of bush density on seed weight is at %1 level of significance which the least seed weight belonged to the highest bush density. At Khomein Bean National Research Station, Ghanbari and Mazandarani (2003) concluded that there is a significant difference between different densities in terms of the number of husks in a bush, number of seed in a bush, seed weight, and seed performance in Phaseou vulgaris var. and maximum husk number and seed in bush and seed weight were gained from a density of 20 bushes in a square meter. Talei (2000) concluded that the number of husks in bush reduced with the increase in the bush density and the decrease was significant. As bush density increased, seed performance decreased and the main reason underlying the increase of performance was the number of bushes and consequently the increase in husks in a hectare. Based on reports, the number of husks in a bush is one of the components of bean performance which shows maximum sensitivity to environmental conditions such as humidity, temperature, and density. When the effective environmental stresses on final performance happen in bean growth period, a part of performance forming early in germinating stages is the number of husks in the plant which mainly demonstrates maximum effect toward environmental stress (shade stress). Following this, the number of seeds in husks and seed weight is affected. Maximum bush density effect as a result of shade appears at the time of maximum leaf area which is in accordance with the early stages of bean

germination (Adakanian, 2008). In Ilam and by examining Phaseou vulgaris var. density, it was concluded that maximum amount of husk was created in the least density (12.5cm) (Yasmi, 2009). Ayaz *et al* (2001) and Hayat *et al* (2003) reported that the number of seeds in husks in altered with a change in tillage density and the increase in density led to the decrease of seeds number in each husk. Hayat *et al* (2003) reported that seed weight in soy bean and tare was affected by tillage density. Based on the idea of Canadian Irrigation Center (2001), as row spacing increase, the amount of production each square area decreases and consequently maximum performance is gained in less row spacing (higher density). Yet, too much dense bushes lead to the increase of humidity around bushes and set the appropriate conditions to increase the probability of white mold infection.

MATERIALS AND METHODS

This study was conducted at Brujerd Agricultural Research and Natural Resources farms located 18km from Eastern Brujerd (N34' and E48.5' with 1476m from open sea level) on 10th of May 2009. Average annual precipitation 500ml and maximum 24h precipitation was 83ml and 91ml respectively for 10-year and 5-year periods. Wind direction is mostly south-north and an average shining hour is 8h daily in a year (Fig. 1).

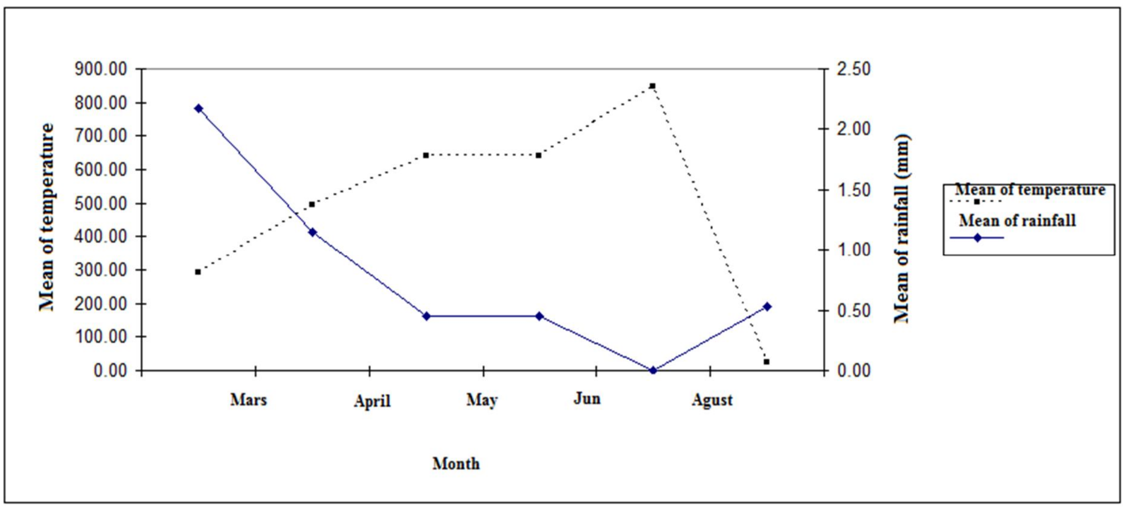

Figure 1: meteorological ombrothermic diagram for Brujerd in the agricultural year 2009

Samples of soil were prepared from 0-30cm depth of the farm and submitted to Brujerd Province Soil Lab for analysis. Results indicated that the soil with lumi –silty texture and organic carbon 1.01 and absorbable phosphor 6.3 and absorbable potassium 230, lime %27, absorbable Zn 0.6 and absorbable Fe 2.6 in ppm unit. This study was conducted on two factors row spacing and bush density in terms of split plots and in form of complete random blocks in three replicates for 6 months at Brujerd Agricultural Research and Natural Resources Station in agricultural year 2009. Here, the main terraces with three row spacing treatments (25, 50, & 75cm) and three density treatments of secondary terraces (30, 40, & 50 bushes/m^2) were respectively shown with symbols A1, A2, A3 and B1, B2, B3. Each experimental terrace included 7 lines with 6m length and one between 2 terraces was considered as non-tillage line. Fertilizer was recommended as 50km in hectare urea, 100km/hectare superphosphate, and 100km/hectare potassium sulfate dispersed in the farmland before disk and loader operation. Irrigation date till the time was about once in 4 days when germ was established and then once in 8 days. Removing pests was done mechanically and using human force as well as chemically, as required. To control weed, Terflan herbicide was used (2l/hectare) before disking. Also, during the growth, diazinon (1.5l/1000l water) was employed in two turns and danitole for once. For the sake of sampling, two marginal lines were deleted and five middle lines with 0.5m from line edges (top and bottom) and afterward sampling was conducted on rows and between them using 1*1m plots. Usually, sampling is done from the mid lines due to the effect of margin. In sampling, 5 or 10 bushes were examined. The following qualities were considered: bush height, the number of secondary branches in a bush, husk length, number of husks in a bush, number of seeds in husk, biological performance, seed performance, and yield index. SAS9.1 Software was applied for statistical analysis and EXCEL Software2007 for drawing curves and diagrams. The averages were compared using Danken Technique at level of 0.05.

RESULTS AND DISCUSSION

Table 1: results of statistical analysis

yield index	seed performance (hectare)	biological performance (hectare)	Seed weight	husk length	number of husks in a bush	number of seeds in husk	bush height	the number of secondary branches	df	Change sources
319/582	48/1974644/48	1347194/02	7/362	1/241	0/2983	0/254	33/36	0/029	2	Block
465/20*	3325161/99*	370478/26	13/91n.s	0/59 *	27/82 **	0/25n.s	n.s23/15	n.s0/31	2	Row spacing a
319/58	3346574/26	91785/77	24/04	0/12	5/81	0/97	18/7	2/42	4	mistake a
52/43n.s	8963275*	16885308/43	28/80*	0/51n.s	20/48**	0/12n.s	n.s20/55	1/46 n.s	2	Density b
187**	**3452397	373120/03	3/18*	0/43**	2/30**	0/65n.s	*42/36	0/40n.s	4	ab
11/43	13/94	10/99	8/88	4/35	17/49	29/81	10/46	20/21		c.v

Table 2: yield parameter of Phaseou vulgaris

Yield index	Biological performance (hectare)	Seed performance	Seed weight	The number of seed in husk	The number of husk in bush	Husk length	Number of secondary branches	Bush height	treatments
56/50 b	9033/8 a	13/71 a	38/13 a	3/66 a	9/14 b	10/42 ab	4/11 a	51/41 a	A1
68 a	8739/4 a	14/66 a	35/75 a	3/53 a	12/75 a	10/16 b	4/00 a	50/52 a	A2
73/55 a	8726/1 a	13/43 a	36/23 a	3/33 a	12/12 a	10/67 a	4/36 a	54/20 a	A3
64/37 a	7753/7 b	13/23 a	36/99 ab	3/44 a	13/12 a	10/60 a	4/33 a	53/37 a	B1
71/71 a	8504/1 b	13/62 a	38/38 a	3/44 a	11/14 ab	10/14 a	3/69 a	50/40 a	B2
65/71 a	10336/6 a	14/96 a	34/83 b	3/64 a	10 b	10/50 a	4/44 a	52/36 a	B3
66 ab	8989 bc	17/28 a	39/71 a	3/33 a	11/33bac	10/34 ab	4/33 a	51/24 ab	A1B1
67 ab	9200 bc	11/77 a	39/05 a	3/33 a	9/5 c	10/04 ab	4 a	51/62 ab	A1B2
36/50 c	8913 bc	10/63 a	35/64 a	4/33 a	5/5 d	10/88 a	4 a	51/36 ab	A1B3
56/33 b	7752 bc	12/73 a	35/03 a	3/33 a	13/66ab	10/67 a	4/33 a	55/06 a	A2B1
78/50 a	6950 c	13/07 a	37/86 a	3/66 a	12/5abc	9/67 b	3/33 a	44 b	A2B2
75 a	12010 a	15/06 a	34/36 a	3/61 a	12 abc	10/12 ab	4/33 a	52/51 ab	A2B3
71/33 ab	6932 c	14/82 a	36/25 a	3/66 a	15 a	10/79 a	4/33 a	53/80 ab	A3B1
70/33 ab	9076 bc	15/14 a	38/24 a	3/33 a	11/33 abc	10/72 a	3/76 a	55/58 a	A3B2
79 a	10170 ab	14/91 a	34/49 a	3 a	11 ac	10/49 a	5 a	53/22 ab	A3B3

Based on Table 2 (variance analysis) and Table 3 (comparison between averages), it was seen that the effect of row spacing did not have significant effect on bush height. Also, density had no significant effect on bush height. Results showed that the mutual effect of row spacing and density on the bush height was at %5 level of significance. Namely, maximum bush height was related to row spacing (A_3) and density (B_2) with height 55.58cm and minimum height to row spacing (A_2) and density (B_2) with height 44.00cm. In high density (more bushes in a square meter) led to bush height increase due to the plants competition for absorbing light and other environmental factors. Also, in high density, bush height increased that led to increase of shading and prevented from oxin hormone decomposition which in turn increased bush height. The results correspond with the results of Ghanbari and Mazandaranis (2003) study.

Number of Secondary Branches in a Bush

Based on Table 2 (variance analysis) and Table 3 (comparison between averages), it was seen that the effect of row spacing did not have significant effect on secondary branches. Also, density had no significant effect on secondary branches. Results showed that the mutual effect of row spacing and density on the bush height was not significant. The reduction of row spacing and bush spacing led to a reduction in the production of secondary branches inducing husks and the reduction of the number of husks in the plant. On the other hand, the resulted density led to the shading of lower parts of the plant and the reduction of the number of fertile husks.

Length of Husk

Based on Table 2 (variance analysis) and Table 3 (comparison between averages), it was seen that the effect of row spacing on husk length is significant (p=%5). Namely, maximum husk length was related to row spacing 10.67cm (A_3) and minimum height to row spacing 10.16cm (A_2). Also, density had no significant effect on husk length. Results showed that the mutual effect of row spacing and density on the bush height was at %1 level of significance. Namely, maximum husk length was related to row spacing (A_1) and density (B_3) with height 10.88cm and minimum husk length to row spacing (A_2) and density (B_2) with length 9.67cm.

The Number of Husks in Bush

Based on Table 2 (variance analysis) and Table 3 (comparison between averages), it was seen that the effect of row spacing on husk number in bush is significant (p=%1). Namely, maximum husk number was related to row spacing 12.75cm (A_2) and minimum husk number to row spacing 9.14cm (A_1). Also, the effect of density on husk number was at %1 level of significance. Namely, maximum husk number was related to density (B1) with 13.12 husks and minimum husk number is related to density (B3) with 10 husks in a bush. Results showed that the mutual effect of row spacing and density on the bush height was at %1 level of significance. Namely, maximum husk number was related to row spacing (A3) and density (B1) with 15 husks and minimum husk number is related to row spacing (A_1) and density (B_3) with 5.5 husks in a bush. Maximum husk number can be attributed to the higher secondary branches number in row spacing. In fact, the increase in the number of secondary branches leads to the increase in the number of flowers and finally husks. This situation is true with bush spacing, as well. These results can be interpreted so that when density increases, the number of husks in a bush decreases; because at higher density, the shade over lower parts of the plant leads to the reduction of husk number in these parts of the plant. Also, the fall of flowers and husks in the loser parts is higher at higher densities.

The Number of Seeds in Husk

Based on Table 2 (variance analysis) and Table 3 (comparison between averages), it was seen that the effect of row spacing and density on seeds number in bush is insignificant. Also, the mutual effect of row spacing and density on seeds number is insignificant. If seeds number changes in cereals such as beans, it will quickly increase/decrease the amount of seed production. Yet, mostly, in this product, seeds number in husk is affected less by environmental factors. This is because there is no competition in early growth stages at lower densities, so a great number of rapeseed cells emerge and concomitant the growth trend increase, gradually competition increases. Hence, in the stage of seed filling, photosynthesis materials are not provided for them adequately. And this results in the abortion of many flowers. Consequently, at low density, seed number and weight reduces yet at desirable densities since the number of seeds is formed based on previous competition, the plant is not able to provide photosynthesis materials. The results correlate with the results from Ghanbari and Mazandarani (2009) and Hashemi et al (2003). They stated that seed number in husk is not affected by tillage arrangement and this trait is mostly controlled by genetic.

Weight of Seeds

Based on Table 2 (variance analysis) and Table 3 (comparison between averages), it was seen that the effect of row spacing and density on seed weight is insignificant. Also, density had significant effect on seed weight (%5). Namely, maximum weight 38.38gr was related to density (B2) and minimum related to density on seed weight is not significant. To absorb environmental resources existing in soil and air, plant compete with each other. At the same time of lead area development, neighbor bushes start overlapping and competition for light begins. At the time of mutual shading, this leads to an inefficient leaf system and lower leaves of the umbrella act at a low level of photosynthesis. So, in selecting bush density and bush arrangement for arable plant, light competition matters. The further the densities are, the lower the seed weight will be. At higher densities, the amount of nutrients in a single bush is reduced which will affect the seed weight. Kahrazian (2002) concluded that at lower densities competition between plants is reduced and more photosynthetic materials are allocated to each seed of the plant so the seed weight increases which is not in accordance with the present study results. This is because at undesirable densities intensive competition occurs between bushes and consequently plant encounters lack of resources and is not able to provide photosynthetic materials for the stores formed. It will result in hollowness and the production of seeds with low weight.

Biological Performance in Hectare

Based on Table 2 (variance analysis) and Table 3 (comparison between averages), it was seen that the effect of row spacing on biological performance is insignificant yet density had significant effect on biological performance (%5). Namely, maximum biological performance related to density (B3) with 10336.6kg and minimum biological performance related to density (B1) with 7753.6. As bush density increases, biological performance is affected by farm management, genotype, and environment. And, biological performance increases to a certain amount, and if any limitations appear (e.g. lack nutrients, lack of space for growth, and bushes umbrella), the biological performance will gradually decrease. Also the mutual effect of row and density on biological performance (in hectare) was significant (p=%1) so that maximum biological performance was related to row spacing (A2) and density (B3) with 12010kg and minimum biological performance to row spacing (A3) and density (B1) with 6932kg. Total performance of the dry matter produced is resulted from the efficiency of herbal society in terms of solar radiation during vegetative season. In this regard, the society also needs adequate leaf area distributed uniformly and cover the ground totally. This will be realized by altering the bushes densities and suitably distributing them on the ground. So, we can conclude that, as specified in the diagrams, biological performance increases with an increase in density. Afterward, the competition for nutrients and light increases in growing parts of the plant. And, then, the size of germinal and growing members increases, the so-called fuel of biological performance increases. In studying the trait weight for each single bush, it is observed that, with an increase in density, the weight of a single bush decreases. This is because of competition and lack of access to nutrients, but due to the increase in the number of bushes in a square area, it is observed that finally bushes' weight increases. This correlates with the results of some researchers including Abdi (2009); Zhu (1998), Rosalinid (2000), and Danjal (2001).

Seed Performance in Hectare

Based on Table 2 (variance analysis) and Table 3 (comparison between averages), it was seen that the effect of row spacing on seed performance is significant (%5). Namely, maximum seed weight related to row spacing with 6535.1kg density (B3) and minimum seed weight (A1) with 5551.3kg. The effect of density on seed performance is significant so that maximum seed performance was related to row spacing (A3) and density (B3) with 8180kg and minimum seed performance to row spacing (A1) and density (B1) with 3271.5kg. Sunshine, soil humidity, and fertility are of environmental factors affecting bush desirable density for performance. If the density is too low, total potential production will not be exploited; if it is too much, the too much competition as a result of stress will decrease total product efficiency. Performance components have compensatory relationship with each other. That is, we can never suppose a situation where all components are at maximum level rather we increase one or more components based on agricultural management yet omit the others. Seed performance shows that in small row spacing (compared to large spacing), bushes search soil volume completely and more quickly and absorb most of the water available in growing status yet remain a little for germinal stage. This limitation in germinal stage and small row spacing becomes critical when density is at maximum level. As density increases, seed performance increases, because with density increase in a square area, photosynthesis level increases and the percentage of photosynthetic materials absorbed by bushes increases and as a result total performance enhances. As stated in trait examination, with larger row spacing, the numbers of husks in bush increases (one of performance components) which can be one of the reasons for seed performance increase. Hashemi Jazi and Danesh (2003) concluded that with an increase in row spacing, seed performance increases which is in accordance with the results of the present study.

Yield Index

Yield index is defined as the percentage of organic materials transmitted from reservoir to repository. It can be concluded that cultivars with higher yield index are able to transfer more carbohydrates from the plant green members and lead to higher seed performance. Based on Table 1-4 (variance analysis) and Table 2-4 (comparison between averages), it was seen that the effect of row spacing on yield index is significant (%5). Namely, maximum yield index related to row spacing with %73.55 (A3) and minimum yield index (A1) with %56.50. it can be mentioned that at low density – due to the production of seeds at rational level and consequently lack of negative competition between growing and germinal growth can respond the demand for photosynthetic materials for its own seeds and seed performance will be higher and seed weight (1000seed) is equal to other densities. This indicates that the plant has allocated more its photosynthetic materials to economic performance (seed). The effect of density on yield index was insignificant. Also, the mutual effect of row spacing and density on yield index is significant (%1). Namely, maximum yield index was related to row spacing (A3) and density (B3) with %79 and minimum seed performance to row spacing (A1) and density (B۳) with ۳۶.۵۰%. As a result, with an increase in row spacing, yield index increases. Examining the mutual effect, as density increases, yield index increases as well. Since yield index is resulted from dividing economic performance by biological performance multiplied to 100 and as seen in the diagrams related to total economic performance and total biological performance, as density increases in two row spacing (A2) and (A3), economic performance and biological performance increase, as well. Therefore, about yield index again, by dividing economic performance by biological performance, it is expected that the same result (i.e. yield index increase) is gained with density. This correlates with the results of studies by Rezazadeh (2008) and Estirus et al (1971). Adkanian and (2008) and Kaviani (2009) concluded that the effect of density on yield index was insignificant which is in accordance with the results of the present study.

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