

Effects of Plant Densities on Seed Yield and Some Agricultural Characteristics of Jofs Pea Variety

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Abstract—This research was conducted to determine effects of plant densities on seed yield and some agricultural characteristics of pea variety- Jofs in Konya ecological conditions during 2012 vegetation period. The trial was set up according to “Randomized Blocks Design” with three replications. The material “Jofs” pea variety was subjected to 3-row spaces (30, 40 and 50 cm) and 3-row distances (5, 10 and 15 cm). According to the results, difference was shown statistically for the effects of row spaces and row distances on seed yield. The highest seed yield was 2582.1 kg ha⁻¹ on 30 cm of row spaces while 2562.2 kg ha⁻¹ on 15 cm of distances. Consequently, the optimum planting density was determined as 30 x 15 cm for Jofs pea variety growing in Konya.

Keywords—Pea, row space, row distance, seed yield.

I. INTRODUCTION

PEA, which is one of edible legume plants is grown and is consumed as a protein source. It is also used abundantly as a raw material of the canning industry in Turkey in recent years. Hence, methods of the highest crops obtainment for the unit area are researched, and scientific and technique studies increase day by day for this purpose [1].

In Pea that include edible legume is consumed both as fresh and as dry, seeds of pea contain 20-30% protein and several vitamins, in addition, pea is a good vegetable protein source in terms of sufficient carbohydrates, plenty of calcium, iron, and phosphorus. In addition, the pea is used for human and animal nourishment, the pea is capable of fixing free nitrogen in the atmosphere to soil because of bacteria (*Rhizobium leguminosarum*) that live on roots of a pea. The pea plant is capable of fixing nitrogen approximately 50-150 kg ha⁻¹ to soil throughout a vegetation period [2].

According to statistics of the year of 2013, the pea is ranked second after bean because of planting area of pea is 7.170 bin ha and production quantity of pea is 12.932 bin ton in the world. In addition, Pea is ranked fifth because of planting area of pea is 1.305 ha and production quantity of pea is 3.628 ton in Turkey [3].

In order to increase yield which is obtained from the unit area, varieties which have superior efficiency, high quality, and resistance to disease and pests must be improved, and these must be delivered to the producer. In addition, cultural proceeds which will provide to reveal genetic potentials of

these varieties must be put into practice. Cultural proceeds which are demanded by varieties determine by means of agronomic studies to be done. So as to pea varieties which have high yield take place in rotation uniquely as hoeing plant and legume in Konya region, cultivation techniques and particularly sowing density which differ from ecology to genotype must adjust the optimal level.

In this research; different sowing density of Jofs pea variety which belongs to *Pisum sativum* L. type was planted. In this research, in order to dry seed yield of Jofs pea variety which was used in research in Konya ecological conditions, determination of optimum sowing density was aimed.

II. MATERIAL AND METHODS

A. Material

In this study, Jofs pea (*Pisum sativum* L.) variety was used as the material. Characteristics of Jofs pea variety was given in Table I.

TABLE I
SOME AGRICULTURAL FEATURES BELONGED PEA GENOTYPE WHICH IS USED IN TRIAL

Genotype	Some Morphological Features
Jofs	Leaves of Jofs are green, plant length is 70-85 cm, pod length is 8-9 cm and a bigger pod that has 7-9 seeds. Seed yield is about 1500-5000 kg ha ⁻¹ .

Table II shows the climate data of Konya for the year of 2012 and the average of 33 years (1975- 2011).

Throughout four-month (April, May, June, July) in vegetation period of trial area, meteorological observation averages for; temperature, areal precipitation and relative humidity is 18.6 °C, 112.5 mm, % 46.8 respectively, for many years. As for 2012 year, when was conducted to this research, these took place 20.0 °C, 66.8 mm and % 42.8 respectively.

TABLE II
2012 YEAR VEGETATION DURATION IN KONYA AND OBSERVATION BELONGED METEOROLOGICAL FIGURES IN 33 YEARS

Months	Rainfall (mm)		Temperature (°C)		Moisture (%)	
	2012	Long Years	2012	Long Years	2012	Long Years
April	4.6	38.7	14.4	11.5	43.7	56.0
May	51.0	56.2	16.3	16.5	55.2	51.2
June	11.0	17.6	23.0	21.4	39.3	42.7
July	0.2	0.0	26.2	24.9	33.1	37.4
Sum/ Mean	66.8	112.5	20.0	18.6	42.8	46.8

The soil of the trial area has clay loam texture, low organic matter (% 1.23). The soil which has got medium lime quantity

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(% 11.65) demonstrate subtle alkali reaction ($\text{pH}=7.72$). The soil which has not got salinity problem demonstrate low levels in terms of convenient phosphorus (17.2 kg ha^{-1}).

B. Methods

This study was conducted in Altınekin town-Konya during the year of 2012, so as to determine optimum sowing density of Jofs pea variety in Konya ecological conditions. The previous plant was wheat in the trial area after wheat was harvested, stubble was released to soil in autumn, and area was deserted in winter. Before planting, tillage was made by applying disc harrow to the field, in addition, weeds which emerged was recently eliminated.

In the study, considering trial which was set up according to "Randomized Blocks Design" with three replications, Jofs pea variety consisted of 3-row spaces (30, 40 and 50 cm), 3-row distances (5, 10 and 15 cm) and consisted of a total of 27 plots. Plots constituted from $4.0 \text{ m} \times 2 \text{ m} = 8 \text{ m}^2$ dimensions. In the trial, planting in plots which consisted of 7 alignments in 30 cm row spaces, 5 alignments in 40 cm row spaces and 4 alignments in 50 cm row spaces was fulfilled. An amount of 150 kg ha^{-1} DAP (18% N and 46% P) fertilizer was distributed uniformly in the whole trial area. Seeds were sown by hand to rows which opened by the marker to tillage in 5-6 cm depth on 29th of April 2012.

During plant growth period, hoeing was done for two times in order to remove weeds and provide capillarity deformation by crushing duff layer which formed after irrigation in the trial area; irrigation was done sixth times with regard to water requirement of pea plant depending on the climate conditions. Irrigation proceeds in the form of drip irrigation were fulfilled.

Harvest was done by hand on July 6, 2012. Harvest was made when 90% of the plants ripened. Plants which appeared in the remained area were harvested by means of one apiece sides of per parcels area and 50 cm portions of main parcels were discarded as a side effect. These were let to dry by tying plants which were harvested and later by means of hand mix after harvest- threshing; these were made ready to fulfill measurement and appreciations to be done.

On genotypes which were used in research, the number of pod per plant (number), the number of seed per pod (number), the number of seed (number) per plant, thousand seed weight (g) and seed yield (kg ha^{-1}) was determined [1].

Variance analysis and LSD test were fulfilled by using "MSTAT-C" packet program on the computer.

III. RESULT AND DISCUSSION

A. The Pod per Plant

Alteration with regarded to different row space of the pod per plant of pea variety which was used in the trial was founded important as statistical on % 1 possibility level (Table III). The numbers of pod per plant which were growth on 50 cm row spaces as the average of row distance were the highest (15.70 number). The numbers of pod per plant which were growth on 40 cm (14.71 number) and 30 cm (14.36 cm) row space followed with descending order (Table IV). With

findings of Kara and Ünver [4], Girgel [5], and İnanç [6] findings which were obtained from this study show parallel with substantially.

According to analyzing of Table III, effects on the number of pod per plant of row distance were founded important as statistical ($p < 0.001$). The number of pod per plant which were sown on parcels over 15 cm row as the average of row space was the highest number (15.98 number). The number of pods per plant which was growth followed with 10 cm (15.59 number) and 5 cm (13.19 number) row distance with descending order (Table IV). Similar conclusions were also determined by Girgel [4].

TABLE III
ANOVA OF THE INVESTIGATED CHARACTERISTICS IN THE JOFS PEA VARIETY

Variance Source	S.D.	Pod per Plant	Seed per Pod	Seed per Plant
Block	2	0.303	0.129	22.116
Row Space (RS)	2	20.586**	1.925**	404.351**
Error ₁	4	0.044	0.026	6.918
Row Distance (RD)	2	4.349**	0.327*	333.360**
RS * RD Int.	4	3.150**	0.302*	22.827
Error ₂	12	0.269	0.063	11.417
Variance Source	S.D.	Hundred Seed Weight	Seed Yield	
Block	2	6.694	48.881	
Row Space (RS)	2	412.704**	1021.761**	
Error ₁	4	3.752	45.162	
Row Distance (RD)	2	195.127**	463.443**	
RS * RD Int.	4	40.328**	641.613**	
Error ₂	12	5.239	21.637	

*: $p < 0.001$; **: $p < 0.001$

According to variance analysis which was done, the difference between row spaces x row distance was founded important %1 level in terms of the number of pod per plant (Table III). According to different row space, when pea variety which was used in the trial was evaluated, the number of bean on the plant was obtained the highest number from 50 cm row space and 15 cm row distance (Table IV).

B. The Seed per Pod

According to different row space, alteration of the number of seed per pod was founded important as statistical on % 1 possibility limit (Table III). As an average of row distance, the number seed per pod was growth with 50 cm row distance on parcels was the highest number (4.69 number). The number of seed per pod which were growth on row distance followed with descending order. İnanç [6]'s study reported that the more row distance increases, the more the number of seed on bean increases.

In the study which was fulfilled, effects on the number of seed per pod of row distance as statistical were founded important on %5 possibility limit (Table III). The number of seed per pod which was sown on 5 cm row distance on parcels as the average of row space was the highest number (4.84 number). The number of seed per pod which were growth on 15 cm (4.69 number) and 10 cm (3.97 number) followed with descending order (Table IV).

According to variance analysis, in terms of the number of seed per pod different between row spaces x row distance was founded important % 5 limits (Table III). According to different row space, when pea variety which was used in the trial was evaluated, the highest the number of seed per pod was obtained from 5.04 number and 30 cm row space and 5 cm row distance. (Table IV).

TABLE IV
MEANS OF THE INVESTIGATED CHARACTERISTICS IN THE JOFS PEA VARIETY

Row Space	Row Distance			Mean
	5 cm	10 cm	15 cm	
Pod per Plant (number)				
30 cm	11.50 ^d	13.50 ^c	14.57 ^{bc}	14.36 ^b
40 cm	16.15 ^a	14.52 ^{bc}	16.11 ^a	14.71 ^b
50 cm	15.42 ^{ab}	16.10 ^a	16.42 ^a	15.70 ^a
Mean	13.19 ^b	15.59 ^a	15.98 ^a	14.92
Seed per Pod (number)				
30 cm	5.04 ^a	4.75 ^{abc}	4.71 ^{abc}	4.84 ^a
40 cm	3.57 ^c	3.97 ^{de}	4.38 ^{bcd}	3.97 ^b
50 cm	4.32 ^{cd}	4.77 ^{ab}	4.99 ^a	4.69 ^a
Mean	4.31 ^b	4.50 ^{ab}	4.69 ^a	4.50
Seed per Plant (number)				
30 cm	52.20	58.15	62.36	57.57 ^b
40 cm	52.23	52.20	64.25	56.23 ^b
50 cm	60.60	69.96	74.79	68.45 ^a
Mean	55.01 ^c	60.11 ^b	67.13 ^a	60.75
Hundred Seed Weight (g)				
30 cm	23.42 ^c	24.66 ^b	24.49 ^b	24.19 ^b
40 cm	24.52 ^b	25.73 ^a	25.48 ^a	25.25 ^a
50 cm	25.33 ^a	25.29 ^a	25.74 ^a	25.45 ^a
Mean	24.43 ^b	25.23 ^a	25.24 ^a	24.96
Seed Yield (kg ha ⁻¹)				
30 cm	2358.9 ^d	2671.3 ^a	2716.1 ^a	2582.1 ^a
40 cm	2388.8 ^{cd}	2221.7 ^e	2499.2 ^{bc}	2369.9 ^b
50 cm	2526.2 ^b	2481.2 ^{bc}	2471.5 ^{bcd}	2492.9 ^{ab}
Mean	2424.7 ^b	2458.1 ^b	2562.2 ^a	2481.6

Values in the same column with the same letter are not significantly different.

C. The Seed per Plant

Alteration with regard to different row space of the number of seed per plant of Jofs pea variety was founded important as statistical on %1 level (Table III). The highest of seed per plant was obtained from 68.45 number and plants which were growth on 50 cm row space on parcels as the average of row distance. The number of seed per plant which were growth on 30 cm row space (57.57 number) and 40 cm row space (56.23 number) followed with descending order (Table IV).

Effects on the number seed per plant of row distance were founded important on %1 possibility level as statistical (Table III). The number of seed per plant were sown with 15 cm row distance on parcels as the average of row space were the highest number (67.13 number). The number of seed on bean of plants which were growth with 10 cm (60.11 number) and 5 cm (55.01 number) row distances followed with descending order (Table IV).

D. Hundred Seed Weight

Alteration with regard to different row space thousand seed weight was founded important on % 1 level (Table III). Thousand seed weight of plants which were growth with 50 cm row distance on parcels as the average of row distance was the highest number (254.54 g). Thousand seed weight of plants which were growth with 40 cm (252.46 g) and 30 cm (241.91 g) row spaces followed with descending order (Table IV). Studies which were done previously was obtained similar conclusions [4]-[6].

As the investigation of Table IX appeared, effects on thousand seed weight of row distance were founded important on % 1 level (Table III). Thousand seed weight of plants which were growth with 150 cm row distance on parcels as the average of row distance was the highest number (252.39 g). Thousand seed weight of plants which were growth with 10 cm (252.26 g) and 5 cm (244.26 g) row distances followed with descending order (Table IV). Cesuro [7] reported that the more row distance increases on pea, the more pea of thousand seed weight increases.

In the trial, according to variance analysis which was fulfilled in terms of numbers of thousand seed weight, the interaction of row space x row distance as statistical on % 1 possibility limit (Table III). The highest thousand seed weight was 50 cm row space (257.44 g) and 15 cm row distance (Table IV).

E. Seed Yield

Effects on seed yield of row space in the trial were founded important on % 1 possibility limit as statistical (Table III). Some researcher reported that row space on seed yield of pea was an effective factor [4]-[6]. The highest legume yield was obtained from the plant which was growth with 2582.1 kg ha⁻¹ and 30 cm row space as the average of row distance. Seed yield of the plant which was growth with 50 cm row space (2492.9 kg ha⁻¹) and 40 cm row distance (2369.9 kg ha⁻¹) followed with descending order. As row space increase, seed yield of genotypes which were used in research usually increases (Table IV). Eşiyok and Bozokalfa [8] reported that the more the number of the plant in unit area increases, yield increases per hectare. Gülümser [9] obtained that the highest seed yield between pea genotype was 40 cm, Kanwar *et al.* [10], 30 cm, Tosun and Sepetoğlu [11] 15 cm, Girgel [4] 30 cm and İnanç [6] 15 cm row space.

Effects on seed yield of row distance were founded important on % 1 level as statistical (Table III). The highest seed yield was obtained plants which were sown with 2562.2 kg ha⁻¹ and 15 cm row distance on parcels as the average of row space. Seed yield of plants which were growth with 10 cm (2458.1 kg ha⁻¹) and 5 cm (2424.7 kg ha⁻¹) row distance followed with descending order (Table IV). Gülümser [9] obtained that the highest legume yield was 5 cm on pea, Tosun and Sepetoğlu [11] 10 cm, Girgel [4] 5 cm and Cesuro [7] 15 cm row distances.

Row space x row distance interaction was founded important on %1 level as statistical (Table III). While seed yield with 30 cm row space and 15 cm row distance was

obtained the highest yield (2716.1 kg ha⁻¹), seed yield with 40 cm row space and 10 cm row distance was obtained the lowest yield (2221.7 kg ha⁻¹) within whole applications (Table IV). İnanç [6] obtained that the highest legume yield amount was 7030 kg ha⁻¹ with 30 x 5 cm norm, and the lowest seed yield was 3170 kg ha⁻¹ with 70 x 7.5 cm norm in terms of density combination on pea. Conclusions of the research show similarity to our research.

IV. CONCLUSION

According to the conclusion of the one-year study, for recommendations about specific sowing density isn't sufficient. Conclusions of this research in the second year and third year must be evaluated. According to one-year conclusions, the highest worth of row space for dry seed yield was 30 cm norm, the highest amount of row distance was 15 cm. When sowing combination was evaluated in Konya, 30 x 15 cm sowing norm was determined as the most suitable norm.

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