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Effects of Different Row Spacing and Seeding Rate on Seed Yield and Some Yield Components of Birdsfoot Trefoil (*Lotus corniculatus* L.) in Tokat Region

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A B S T R A C T

Birdsfoot trefoil (*Lotus corniculatus* L.); is a considerable component of natural meadow-rangelands and grassland, besides producing sufficient forage in environmentally restricted fields. In order to for increase birdsfoot trefoil cultivation, it is necessary to the sufficient quantity produce quality seeds. The information regarding the row spacing and seeding rate is important for achieving yield targets and better economic returns of birdsfoot trefoil. This study was carried out in order to determine the optimum row spacing and seeding rate for seed production of Sarıyıldız 60 variety that new registered in the semi-arid climate conditions of the Central Black Sea transition zone, where this plant was not grown before. The field experiment was conducted at the using a randomized complete block split-plot design with three replicates in 2017 to 2019 growing seasons. The study was tested four different (20,40, 60 and 80 cm) row spacings and (5, 10, 15 and 20 kg ha^{-1}) seeding rates. Results of connectedly analysis showed that row spacing and seeding rate application on that the effect of on seed yield and number of pods per plant, 1000 seed weight was significant statistically but didn't have any significant effect on number of seed per pod and harvest index. The interaction between row spacing and seeding rate did not show any significant statistical be different on seed yield and yield components. In general accepted, the number of pods per plant, the number of seeds per pod, the weight of thousand seeds and the harvest index decreases with the increase in the seed rate in all row spacings. Results showed that seed yield increases with narrower row spacing. The mean data from the three years experimental showed that the highest seed yield was obtained with plants grown in 20-40 cm row spacing's at a seeding rate of 10-15 kg ha^{-1} (248.0 and 257.0 kg ha^{-1}).

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1. Introduction

For many crop growers, production guides are very important to help them be successful both agriculturally or economically. One of the most considerable the difficulty encountered in forage plants cultivation and meadow and pasture improvement is the inability to obtain sufficient quantity and quality seeds (Acıkgoz et al.,2002).

While not commonly grown in our country, birdsfoot trefoil produces high quality forage, that supports, animal performance from ruminant livestock, that are often superior to alfalfa or other forages. Birdsfoot trefoil (*Lotus corniculatus* L.) is a special perennial legume plant with a medium lifespan that grows in different geographical region of the world. It is a forage plant that is commonly used in different parts of the world and is mostly for fodder, silage and cover crop, or a managed pasture is grown in pure or mixed form (Hannaway et al., 2004; Anonymous, 2014). Birdsfoot trefoil is a quality forage with its high crude protein content (16.66-20.50 %) beside that as well low neutral detergent fiber (33.38-40.85 %) and acid detergent fiber content (28.4-38.4 %) in dry matter (Churkova et al., 2016). Concentrated tannins in the birdsfoot trefoil recude urinary N excretion and prevent bloat in ruminants, together with anthelmintic activity (Waghorn, 2008; Anonymous, 2014). Lotus corniculatus can tolerant some soil salinity,it thrives in area where alfalfa and other forage legumes cannot grow because of acid soil and humid soil (Hannaway et al., 2004; Anonymous, 2006; Anonymous, 2014). Birdsfoot trefoil is an N-fixing legume, contribute for wildlife, it is o good pollen plant for bees and bumble bees (Bush 2002; Hannaway et al.,2004). The difficulty of optaining consistently high yields of seeds has restriction the use of the birdsfoot trefoil importantly. The pods shattering are easily and the seeds often spill over (Fairey, 1994). Potential seed yield of the birdsfoot trefoil is estimated at 1200 kg ha-1 while the mean yields the global be below 200 kg ha-1(Turkington and Franco, 1980; Gullien, 2007). McGraw et al. (1986a) to test the plant's seed yield have conducted a research in three apart geographic region and have determined that genotype with environment had important interactions between each other. The researchers, have concluded that the seeds yields test have to be conducted in the geographic region where the plant is trading zone cultivated. Brecke (1995) reported, low density or high-density of plant spacing may reason adverse influence, like diseases, weed and increased pressure from other plants.

Row spacing and seeding rates are two crucial factors that affect at plant production yield and yield components. In our country, little is known about the effects of interactions between these two factors on the amount of yield main elements and quality traits of birdsfoot trefoil.

This research, for recognize on the influence of plant density on the seed yield and some yields components of *Lotus corniculatus* and aims to determine the requsite optimum row spacing and seeding rate in order to obtain maximized high-quality seed yield. The results obtained from this study can be used as guidelines the implementation to generalize *Lotus corniculatus* cultivation and to improve high-quality forage production.

2. Materials and Methods

The experiment was effected at during three growing seasons (2017 to 2019) at the region of Kazova (geographic latitude 40° 18', longitude, 36° 34', altitude 585 m above sea level), to the city of Tokat.

The according to results from soil lab analysis the trial area soil:
texture of medium heavy textured (clay-loam) structure and the total salt content of (0.028%) the soils is low. Soil pH (7.6) of the they are slightly alkaline (Anonymous, 1993). The textures of the soil samples are the medium-heavy (clayey-loamy) structure, and the total salt content of (0.028%) the soils is low. The plant-consumable phosphorus concentrations of soil samples (kg P_2O_5 13 ha^{-1}) and organic matter content (% kg N 9 ha^{-1}) was low. Apart from this, lime content of the soil samples (kg $CaCO_3$:77 ha^{-1}) is optimum and the potassium content of (kg K_2O: 813 ha_{-1}) are high (Ulgen and Yurtsever, 1995).

Climate of Tokat-Kazova region; It has a transition climate between the Black Sea climate with the Central Anatolia region steppe climate. The spring last frost, summer and early spring droughts and increasing temperatures in the years of the experiment affect plant production negatively. The monthly average temperatures and maximum temperature averages of years in which the experiment was conducted, were higher than the temperature averages for previous years and were much lower in terms of minimum temperatures. The field experiment had important less receive annual precipitation throughout the growing season as compared to the past. The experimental year and long-term average (1929-2019) temperature, relative humidity and average rainfall values are shown in (Table 1).

Table 1. Monthly lowest, highest and mean temperature, relative humidity and rainfallin values of the experimental years and long-term average (1978- 2018) *

	Monthly mean temperature (˚C)				**Highest monthly temperature mean (°C)**				**Lowest monthly temperature mean (°C)**			
Years / Months	2017	2018	2019	Long term	2017	2018	2019	Long term	2017	2018	2019	Long term
January	0.4	4.7	2.2	1.9	-13.5	-3.3	-14.5	-1.7	14.0	14.3	14.3	6.1
February	2.7	7.4	5.9	3.5	-12.2	-5.2	-2.3	-0.7	21.4	21.6	16.6	8.2
March	9.2	11.0	7.2	7.4	-4.2	-1.8	-3.5	2.4	23.8	28.1	20.4	13.0
April	11.8	13.4	11.5	12.5	-2.7	-3.1	-0.3	6.6	29.5	30.0	27.6	19.0
May	15.6	17.9	19.1	16.5	0.3	2.4	6.7	10.1	32.2	31.5	34.8	23.5
June	19.8	21.3	23.1	19.9	5.4	6.4	14.9	13.1	34.3	36.7	33.5	26.8
July	17.7	23.8	21.9	22.3	7.5	9.4	9.7	15.4	41.8	37.3	38.7	29.0
August	24.5	22.7	22.4	22.4	12.8	9.8	12.2	15.6	39.4	36.7	38.0	29.7
September	20.6	19.4	19.0	18.8	4.8	6.3	4.1	12.1	36.9	38.6	30.9	26.5
October	11.9	15.7	15.9	13.7	0.2	2.8	5.9	8.1	29.3	28.3	31.3	20.7
Novembe	6.2	9.2	7.0	7.9	-6.1	-1.7	-0.7	3.4	20.4	20.0	16.3	13.7
December	4.8	5.1	5.3	3.8	-5.8	-8.9	1.3	0.2	17.9	15.0	10.1	7.8
Total/ Mean	12.1	14.3	14.3	12.6	-1.12	1.09	2.9	7.05	28.4	28.1	27.5	18.6

Table 1 (continued). Monthly lowest, highest and mean temperature, relative humidity and rainfallin values of the experimental years and long-term average (1978- 2018) *

	Monthly precipitation total (mm)				**Monthly relative humidity mean (%)**		
Years/ Months	2017	2018	2019	Long term	2017	2018	2019
January	53.5	26.9	71.6	40.9	76.3	81.0	76.5
February	3.3	9.9	14.7	33.8	66.2	75.6	67.0
March	27.5	74.7	36.8	40.8	60.1	74.5	61.8
April	32.6	4.3	63.5	54.2	58.2	63.4	65.2
May	66.6	68.1	49.1	58.9	68.1	77.2	59.7
June	102.4	46.6	26.2	38.2	71.3	71.3	63.4
July	0.0	8.2	16.9	11.2	59.2	67.6	59.6
August	0.7	4.5	52.2	5.6	62.7	63.1	63.0
September	4.0	40.5	1.6	17.7	56.7	65.4	61.7
October	31.3	39.6	3.7	39.3	73.3	69.3	70.6
November	32.6	8.2	9.9	44.0	83.3	73.8	75.7
December	44.6	49.4		47.1	86.3	80.4	82.4
Total/ Mean	399.1	380.9	346.2	431.7	68.5	71.8	65.0

* Official climatology statistics, Directorate General of Meteorology. https://mgm.gov.tr› provinces-and-counties-statistic

Birdsfoot trefoil cultivar "Sarıyıldız 60" which was newly registered by our institute, was used as plant material in the field experiment. Cultivar is of erect or semi-erect growth characteristic. Cultivar has forage yield of 32.0/51.0 tons ha^{-1} under different conditions, while it has a seed yield that vary between 287 and 347 kg ha^{-1} (Karadag et al., 2016; Çınar et al.,2016).

The field experiment was conducted at using a randomized complete block split-plot trial design with three replications. In research were tested four different row spacing (20,40,60 with 80 cm) in the main plots and seeding rates (5, 10, 15 and 20 kg ha^{-1}) in the subplots.

The field soil was applied 200 kg ha-1 diammonium phosphate (It contains 18% nitrogen (N) and 46% phosphorus (P) as P_2O_5.) bottom fertilizer before sowing.

The birds foot trefoil "Sarıyıldız 60" cultivar was sowing with a in single file machine at a depth of 1.5-2.0 cm at 19 April 2016. Weed control was made hand hoe and mechanical rotary hoe during in the experiment. Field trials were conducted under precipitation dependent natural terms and conditions. Some components of yield were determined infield: number of pods per plant (counting on ten randomly selected plant from in the subplots), number of seeds per pod (was determined from a sample of 10 mature pods selected at randomized) each from in the subplots. The later mature pods were hand threshed and the seeds were cleaned, sieved and numbered in laboratory were determined. The seed yield was determined during the stage where 70 to 80% of the pods were return brown (Winch and Macdonald 1960). Every sub-parcel was mowed in 5 to 7 cm height using a parcel weedeater. In the current study, twice yearly mowed were made for seed production in 2017 and 2019, a once cutting was made due to late spring frosts in if 2018. All the cut up plants materials were gathered by hand and dried exposure to natural weathering for during 4 weeks. The air-dried haystack in sub-parcels was then threshing using a parcel thresher.

The seed yield every seed sample after was siffed using 11.2 and 2.5 mm siffers and cleaned using a portable fan set and weighed in laboratory were determine. The obtained seed weights were recorded in kg ha converted value.

The 1000 grain weight (g) was calculated by counting 4 repetitions of 100 seeds for each sub-subject in the laboratory and multiplying by 10.
The harvest index (%) was calculated as the percentage ratio of the total seed weight obtained from each subplot to the total dry biomass above ground (Garcia-Diaz and Steiner, 2014).

The obtained data statistical analysis was subjected to analysis of variance by the combined variance (Anova 2-Factor) analysis using. Resultant all significant of treatment means was grouped data using the Least significant difference test at 5% level of significance (Yurtsever, 2011).

3. Results and Discussion

Seed Yield

When the row spacing and seeding rate were changed in the study, the differences between the seed yields were found to be significant ($p<0.01$) the experiment years. The highest seed yield (258.5kg ha^{-1}) was found in 2017 and the lowest yield (142.6 kg ha^{-1}) was determined in 2018 (Table 2). The late spring frosts in 2018 had a negative impact on seed yield and the yield components examined (Table 1). The results showed that both row spacing and seeding rate had a significant ($p<0.01$) influence on seed yield, and seed yield increases significantly with narrow row spacing but as row spacing increased, decreased yield. The highest seed yield was obtained with application of 20 and 40 cm row spacing (248.0 and 257.0 kg ha^{-1}) and 10 and 15 kg hectare seeding rate (230.3 and 231.0 kg ha^{-1}) which are in the same group as statistically. Seed yield decreased significantly in 60 and 80 cm row spacings and in the applications of 5 kg ha^{-1} seed rate (183.0 and 175.0 kg ha^{-1}) (Table 2). The result there were no statistically influences of the row spacing x seeding rate interaction on seed yield.

In previous studies evaluating the response of the birdsfoot trefoil plant to various seed ratios and row spacing:

Seed yields of birdsfoot trefoil in USA range between 50 and 170 kg ha^{-1} (Fairey and Smith, (1999) in Uruguay between 120 and 150 kg ha^{-1} (Garcia et al. 1991) and Argentina between 25 and 150 kg ha-1 (Mazzanti et al., 1988). Pankiw et al. (1977) found that the 'Leo' cultivar from Alberta, Canada produced the highest seed yield in narrow rows (15 cm) and at a seeding rate of 8.8 kg ha^{-1}. Hare (1984) obtained maximum (86 to 88 g m²) seed yield in the first year of the experiment in populations of 22 to 33 plants/m² at row spacings of 0.30 or 0.45 m. It was determined that the seed yield decreased significantly at 66 and 133 m² densities and in rows with 0.15 m spacing. Vinc et al. (1985) noted that although seed yield could potentially go up to 750 kg ha^{-1} the average yield in

Ontario was about 110 kg ha^{-1} meaning 85% was lost due to seed coat fragmentation. According to McGraw et al. (1987) reported, the average seed yield of birdsfoot trefoil vary 50-175 kg ha^{-1} or about 100 kg ha-1. Bologna et al. (1996) reported that the seed yield various from 45.8- 65.1 (g/m^2) and 1000 seed weight 1.385-1.528 (mg). Vojin et al. (2001) obtained 272 kg ha^{-1} birdsfoot trefoil seed yield in Banja Luka region. Churkova (2006) reported that the seed yield varied between 185-313 kg ha^{-1} and the highest seed yield (313 kg ha^{-1}) was obtained from the K-30 variety. In the study by Stevovic et al. (2013) sowed birdsfoot trefoil varieties using 10 kg ha-1 seeds at 20 cm row spacing, Rocco variety (408.6 kg ha^{-1}), K-37(85 kg ha^{-1}) and It has been reported that it has a significantly higher seed yield than the Zora variety (54 kg ha^{-1}). Karadag et al. (2016) reported that the seed yield ranged between 280-347 kg ha^{-1} and Cınar et al. (2016) reported ranged between 243-287 kg ha^{-1} in their study conducted in different locations. Stevovic et al. (2017) reported the pre-sowing seed inoculation of with bacteria *M. loti*, had significant influence on the seed yield and yield components and the seed yield ranged between 1186 with 1422 kg ha^{-1} Ozpınar et al (2019) determined that the seed yields ranged between 97-234 kg ha^{-1}. Seaney and Henson (1970) reported that seed shattering pod is a be important problem in lotus, and the gap between theoretical and actual seed yield is very large and seed yield of *Lotus corniculatus* vary between 50-560 kg ha^{-1}. Steiner et al. (1995) reported that the seed yield of perennial leguminous plants is determined firstly by the plant's genetic basis, which was followed by ecological factors, first harvest time, presence of insects and pollinators and the interaction between genotype and environment. Basic (2014), Delic (2014) have reported that the ecological factors, plant cultivation techniques, biotic factors (host plant, vegetation, plant diseases and insect pest) are important.

Table 2. Effect of years row spacing and seeding rate birdsfoot trefoil seed yield

Years Row spacing (A)	**2017** Seed yield (kg ha^{-1})	**2018** Seed yield (kg ha^{-1})	**2019** Seed yield (kg ha^{-1})	**Avarage of 3 Years** Mean for the period (kg ha^{-1})
20 cm	279.4	164.0	301.0	248.0a
40 cm	311.5	167.0	294.0	257.0a
60 cm	203.5	134.0	213.0	183.0b
80 cm	239.2	106.0	179.0	175.0b
F-test	**	*	**	**
Lsd value	2,19	4,46	1,22	3.16
Seeding rate (B)				
5 kg ha^{-1}	229.7	1310	181.0	181.0b
10 kg ha^{-1}	281.3	152.0	267.0	230.3a
15 kg ha^{-1}	276.0	148.0	270.0	231.0a
20 kg ha^{-1}	246.7	139.0	271.0	219.0a
F test	**	ns	**	**
LSD value	1,86	2,33	1,50	1.87
Coefficient of variation. CV(%)	11.9	19,4	21.0	18.4
AXB	ns	ns	ns	3.74 ns
Years yield	258.5a	142.6b	247.7a	216.2

Years*Row spacing: 0.05 ns, lsd: 5.47, Years*Seeding rate: 0.05** lsd:3.24, Years*Row spacing* Seeding rate: ns

Components of seed yield

The combined results obtained from the analysis of variance showed that the influence of year on the examined yield main component was statistically significant (P<0.01). The influence of row spacing, seeding rate, row spacing x seeding rate, year x row spacing, year x seeding rate and year x row spacing x seeding rate interactions on studied characteristics are presented in Table 3.

Table 3. Effects of years row spacing and seeding rate on birdsfoot trefoil seed yield components

	Number of pods per plant				**Number of seeds per pod**			
Years	2017	2018	2019	Mean	2017	2018	2019	Mean
Row spacing A								
20 cm	85.70b	42.71	101.2ab	76.6b	20.7	16.2	24.1	20.3
40 cm	122.02a	56.91	125.2a	101.3a	20.5	17.2	24.7	20.8
60 cm	93.5b	41.79	97.9ab	77.7b	20.5	18.1	23.4	20.7
80 cm	82.3b	44.65	82.6b	69.8b	20.1	16.1	23.4	19.9
F-test	*	ns	ns	**	ns	ns	ns	ns
LSD value	22.3	17.20	34.9	12.9	1.28	2.93	2.77	1.17
Seeding rate B								
5 kg ha^{-1}	110.2a	53.6a	105.3a	89.7a	20.6	17.1	24.6	20.7a
10 kg ha^{-1}	101.7a	47.9ab	113.7a	87.8a	20.5	17.9	24.2	20.9a
15 kg ha^{-1}	93.3ab	44.8ab	98.8ab	79.0b	21.2	16.4	24.4	20.6a
20 kg ha^{-1}	78.1b	39.5b	89.1b	68.9c	19.4	16.2	22.5	19.4b
F-test	*	*	*	**	ns	ns	*	ns
Lsd value	19.43	9.34	15.7	8.6	1.89	2.77	1.71	1.21
Coefficient of variation CV (%)	24.0	23.8	18.0	22.4	10.9	10.5	8.0	12.6
AXB	ns	ns	ns	ns	ns	ns	ns	ns
Years	95.87a	46.52b	101.78a	81.39	20.47	16.93c	23.94a	20.44b

Table 3 (continued). Effects of years row spacing and seeding rate on birdsfoot trefoil seed yield components

	Thousand-seed weight (g)				**Harvest index (%)**			
Years	2017	2018	2019	Mean	2017	2018	2019	Mean
Row spacing A								
20 cm	0.96	1.04	1.25ab	1.09ab	1.80ab	4.93	2.28	3.00
40 cm	1.08	1.13	1.29a	1.17a	1.83a	4.72	2.14	2.90
60 cm	1.00	1.03	1.20bc	1.08ab	1.24c	4.98	1.70	2.64
80 cm	0.96	1.01	1.15c	1.04b	1.44bc	3.92	1.47	2.27
F test	ns	ns	*	**	*	ns	ns	ns
LSD value	0.10	0.19	0.07	0.06	0.37	1.13	2.30	0.73
Seeding rate B								
5 kg ha^{-1}	1.06a	1.08	1.23	1.11	1.44b	4.87	1.54b	2.75
10 kg ha^{-1}	1.00ab	1.04	1.22	1.09	1.67a	4.61	1.95a	2.83
15 kg ha^{-1}	0.94c	1.06	1.22	1.08	1.74a	4.68	2.06a	2.62
20 kg ha^{-1}	1.00bc	1.03	1.21	1.08	1.45b	4.39	2.03a	2.75
F test	**	ns	ns	ns	**	ns	*	ns
LSD value	0.05	0.06	0.05	0.03	0.17	0.70	0.37	2.26
Coefficient of variation CV (%)	6.6	7.5	4.0	6.3	12.8	18.0	23.6	20.7
AxB	ns	ns	ns	ns	ns	ns	ns	
Years	1.01b	1.06b	1.23a	1.10	1.54b	4.64a	1.90b	

*- F test significant at p<0.05;**-F test significant at p<0.01;ns-F test not significant

Evaluation made; showed that the influence of row spacing and seeding rate on the number of pods per plant and 1000 seed weight was quite significant (P <0.01). The number of seeds per pod and the harvest index were not statistically affected by the variability in row spacing and seeding rate.

The number of pods per plant

The number of pods per plant studied is a trait directly related to seed production. In the research conducted, the highest number of pods per plant (101.8 pod/plant) was determined in 2019 and the lowest (46.5 pod/plant) in 2018 (Table 3)

The maximum number of pods per plant was obtained by applying 40 cm row spacing and 5-10 kg ha^{-1} seeding rates, lowest pods per plant by applying 80 cm row spacing and 20 kg ha^{-1} seeding rates (Table 3).

The number of seeds per pod

The number of seeds per pod created statistically significant (p<0.01) differences between the experimental years. The highest (23.9 seeds/pod) number of seeds per pod were determined in 2019, and the least (16.9 seeds/pod) in 2018.

In terms of the number of seeds in the pod, the application of row spacing and sowing rate did not have a statistically significant influence while the highest number of seeds per pod in 10 kg ha^{-1} seeding rate at 40 cm row spacing and at least of were determined in the application of 20 kg ha^{-1} seeding rate at 80 cm row spacing. (Table 3).

Thousand seed weight

Thousand seed weight is a considerable matter of seed quality, grain seed size and seed viability. The combined results obtained from the analysis of variance shoved that the effect of year and row spacing on thousand seed weight was quite significant (P<0.01), while the application of seeding rate insignificant influence. The thousand seed weight highest with 1.23 g was determined in the last year of the experiment, while the lowest (1.01 g) was obtained in the first year. The highest thousand seed weight is obtained 40 cm row spacing and 5 kg ha^{-1} seeding rate application, while the lowest is obtained 80 cm and 15-20 kg ha^{-1} seeding rate application determined (Table 3).

Harvest index

Harvest index (HI) is determined by interactions between genotypes, ecological factors and cultıvation techniques. The effect of row spacing and seeding rate applications on the harvest index was statistically insignificant. However, the differences establish between years were statistically significant. The highest harvest index (4.6%) value was determined in the second year of the experiment, while the lowest (1.5-1.9%) value was determined in the first and last years of the experiment. Although the application of row spacing and seeding rate did not have a statistically significant effect, the harvest index tended to be low except for applications with 20-40 cm row spacing and 10 kg ha^{-1} sowing ratio (Table 3).

Hare (1984) emphasized that the weight of pods per inflorescence, seeds per pod and 1000 seeds was not affected by row spacing and population density. Vınc et al. (1985) reported that the weight of one thousand seeds in the birdsfoot trefoil varied between 0.78-1.26 g. In a study by McGraw et al. (1986b) the harvest index decreased as the plant population density increased, while plant population densities required for optimum seed production (19.0 plants/m²) were required for optimum hay production (26.5 plants/m²). Therefore, it was emphasized that lower seed sowing rates could be used in the establishment of seed production fields. Chourkova (2006) reports have number of pods per plant range between 49.4-172.2 number seeds per pod 15.9-25.4 varies between. The same study reports a high positive correlation were be found between the number racemes per plant with number of pods per plant and number seeds per pod in seed productivity.

Vuckovic et al. (2006) determined that average number of seeds per pod vary between 8.4-12.9 and 18.3-25.6 in the collected populations. Ayres et al. (2008) determined that the average number of thousand seed weight vary between 0.72-1.17. Churkova and Lıngorskı (2011) reported that number of seeds per pod was least 10.8, highest 26.4 and the weight of 1000 seeds was lowest 1.09 and highest 1.38 g. Gataric et al. (2013) determine that number of pods per plant vary between 257.8-566.6 the number of seeds per pod 12.4-20.3 the thousand-seed weight vary between 1.01-1.26 g. Stevovic et al. (2017) report that number of seed per pod was 22.7-24.6 piece and thousand seed weight was 1.16-1.27 and that seed yield was in positive correlation with these values. Garcia-Diaz and Steiner (2014) reported that the harvested seed yield vary between 130 and 790 kg ha^{-1} and the harvest index varies between 1.5 and 13.6% by applications and years. Radic et al. (2014) concluded that number of pods per plant varies between 361 with 960, one thousand seed weights in the plant collection samples various from 0.87 g to 1.32 g. Ozpınar et al. (2019) it was determined that 1000 seed weight vary between 1.04-1.21 g.

4. Conclusions

Generating reliable information on some agronomic practices such as appropriate row spacing and seeding rate is quite considerable to come up with profitable and sustainably birdsfoot trefoil production. The results of the present study demonstrated that birdsfoot trefoil can be successfully grown in the under rain-dependent agriculture in the Tokat-Kazova region and similar agro-ecological conditions, reaching yields. This experiment result showed:

1-The effects of row spacing and seeding rate on seed yield and number of pods per plant, thousand-seed weight were also found to be significant of birdsfoot trefoil. The effects of different row spacing and seeding rates on number of seeds per pod and harvest index ratios were found to be insignificant.

2-The effect of row spacing x seeding rate interaction on seed yield and character traits was not influence significant.

3- Based on these data, it is recommended that birdsfoot trefoil Sarıyıldız 60 cultivar production in the Tokat-Kazova region and similar agro-ecological conditions use 20 or 40 cm row spacing and seed 10 kg ha-1.

4- Besides that the results of this test indicate that narrow row spacing (20-40 cm) has positive effects on weed control.

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