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EFFECT OF ROW SPACING AND SEEDING RATE ON HUNGARIAN VETCH YIELD AND QUALITY

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ABSTRACT

The effects of 2 row spacing (17.5 and 35 cm) and 4 seeding rates (40, 60, 80 and 100 kg ha^{-1}) on dry matter yield, seed yield and yield components of hungarian vetch (*Vicia pannonica* Crantz.) were evaluated under rainfed conditions of Turkey during the 2007-2008 and 2008-2009 growing seasons. Based on the 2 year results, the row spacing and seeding rate had a significant effect on most of the measured traits and the yield components except quality parameters. The highest dry matter yield obtained for 17.5 cm row spacing and 80 kg ha^{-1} seeding rate, while the highest seed yield was determined in 35 cm row spacing and 80 kg ha^{-1} seeding rate combination.

Key words: Hungarian vetch, row spacing, seeding rate, forage yield, forage quality, seed yield.

INTRODUCTION

Hungarian vetch (*Vicia pannonica* Crantz.) is a winter hardy legume species, which is widely used in regions with cool winter growing conditions (Uzun *et al*. 2004; Acikgoz, 1982). There are many factors that effect productivity in agriculture. These factors are plant species and cultivars, agronomical techniques, soil and climate factors (Albayrak and Töngel, 2006). An advantage of narrow row spacing is more equidistant plant spacing that leads to increased canopy leaf area development and greater light interception earlier in the season (Shibles and Weber, 1966; Weber *et al*., 1966). These changes in canopy formation increase crop growth rate and dry matter accumulation (Andrade *et al*., 2002; Bullock *et al*., 1998; De Bruin and Pedersen, 2008). Plant population is another important factor for higher yield realization through light penetration in crop canopy. If plant density is above the optimum, the plant growth may be poor due to competition for nutrients, light and space. On the other hand, if it is below optimum then the nutrients, space and light will not be utilized to their fullest, thus resulting in poor yield (Lone at al. 2010). The objective of the present study was to investigate the effects of different seeding rates and row spacing on seed and forage yield and yield components of hungarian vetch.

MATERIALS AND METHODS

The research was performed at Isparta (37º 45' N, 30º 33' E, elevation 1035 m) located on the Mediterranean region of Turkey during 2007-2008 and 2008- 2009 growing season. Total precipitation and average temperature data are given in Table 1 for experimental area.

Table.1. Climatic data in the experimental area.

Months	Precipitation (mm)			Temperature (°C)		
	Long-period	2007-2008	2008-2009	Long-period	2007-2008	2008-2009
October	38.0	31.2	18.1	12.8	12.8	15.1
November	51.5	60.7	51.6	7.0	9.0	9.0
December	70.9	5.0	168.6	3.1	3.7	3.7
January	64.2	10.0	124.7	1.8	0.1	3.4
February	54.9	15.0	70.3	2.6	1.4	4.0
March	52.9	34.2	55.2	5.9	8.9	5.5
April	58.8	51.1	40.4	10.6	12.1	11.0
May	46.0	13.3	66.6	15.5	15.4	15.0
Jun	27.8	4.4	26.8	20.1	21.7	20.9
Total	465.0	224.9	622.3	-	-	-
Average	-	-	-	8.82	9.46	9.73

The major soil characteristics, based on the method described by Rowell (1996) were found to be as follows; the soil texture was clay; organic matter was 1.2% by Walkley-Black method; total salt was 0.35%; lime was 7.1% by Schiebler calcimeter, extractable P by 0.5N $NaHCO_3$ extraction was 3.4 mg kg^{-1}; exchangeable K by 1N NH_4OAc was 113 mg kg^{-1}; pH was 7.8 in soil saturation extract. Soil type was calcareous fulvisol (Akgül and Başayiğit, 2005).

The experiments were established in a randomized complete block design with three replications on October in 2008 and 2009. Two row spacing (17.5 and 35 cm) and four seeding rates (40, 60, 80 and 100 kg ha^{-1}) were used in this study. The Tarm beyazı cultivar of *Vicia pannonica* was used. Individual plot size was 1.8 × 10m=18 m^2. Half of the plots were harvested for forage yield in May, the rest of the plots were harvested for seed yield in June in both years.

When the plants had 50% flowers (in May), the plots were harvested for forage yield. Subsamples were dried at 70 °C for 48 h to determine dry matter yield. Crude protein (CP) content was calculated by multiplying Kjeldahl nitrogen concentration by 6.25 (Bozkurt and Kaya, 2010).

The ANKOM Fibre Analyser (Model No:ANKOM220, Ankom Technology, Fairport, NY) was used for NDF and ADF analysis. ANKOM F57 filter bags were used for ADF (acid detergent fiber) and NDF (neutral detergent fiber) analysis in this study. Total digestible nutrients (TDN), dry matter intake (DMI), digestible dry matter (DDM) and Relative feed value (RFV) were estimated according to the following equations adapted from (Aydın *et al*. 2010);

TDN = (-1.291 x ADF) + 101.35

DMI = 120% NDF % dry matter basis

DDM = 88.9-(0.779 x ADF % dry matter basis)

RFV = DDM% x DMI% x 0.775

The plots were harvested at maturity for seed yield in June. The following were measured for each experiment: Biomass yield (t ha^{-1}), seed yield (t ha^{-1}), harvest index (%), 1000-seed weight (g), number of pods (per plant), number of seed per pod (per plant).

The data from 2007-2009 were analyzed together using SAS 7.0 program. Means were separated by LSD at the 5 % level of significance. Regression analysis was conducted using the PROC REG statement in SAS.

RESULTS AND DISCUSSION

Row spacing had no influence on CP, ADF, NDF, TDN and RFV but narrow row spacing increased DM yield compared with the wider row spacing (Table 2). An advantage of narrow row spacing is more equidistant plant spacing that leads to increased canopy leaf area development and greater light interception earlier in the season (Shibles and Weber, 1966; Weber *et al*., 1966). These changes in canopy formation increase crop growth rate and dry matter accumulation (De Bruin and Pedersen, 2008; Andrade *et al*., 2002; Bullock *et al*., 1998).

Table 2. Forage yield and yield components of hungarian vetch at different by row spacing and seeding rate (average of 2 years).

	DMY (t ha^{-1})	CP (g kg^{-1})	ADF (g kg^{-1})	NDF (g kg^{-1})	TDN (g kg^{-1})	RFV (%)
Row spacing (cm)						
17.5	4.52 a	157.8	328.1	412.9	589.9	142.9
35	4.01 b	159.2	328.0	415.3	590.1	142.1
Seeding rates (kg ha^{-1})						
40	2.75 c	154.3 b	326.4	412.1	592.2	143.5
60	3.92 b	158.3 ab	328.4	411.5	589.6	143.3
80	4.95 a	161.9 a	330.4	414.9	587.0	141.8
100	5.44 a	159.5 ab	327.1	417.9	591.2	141.4
Results of analysis of variance and mean squares						
Year (Y)	0.005ns	46.02ns	205.84ns	3391.9**	343.1ns	531.7**
Rep(Year)	2.07**	75.64ns	3620.18**	1064.5**	6033.7**	428.2**
RS	3.10*	25.52ns	0.21ns	68.4ns	0.35ns	7.9ns
Y x RS	0.24ns	46.02ns	37.10ns	111.9ns	61.8ns	7.8ns
SR	17.01**	123.19*	36.64ns	101.6ns	61.7ns	14.5ns
Y x SR	0.09ns	30.74ns	142.81ns	51.2ns	238.4ns	14.2ns
RS x SR	0.05ns	45.24ns	82.73ns	20.5ns	137.8ns	6.1ns
YxRS x SR	0.16ns	33.19ns	54.39ns	14.3ns	90.6ns	1.3ns
CV (%)	15.31	4.05	3.17	1.69	2.28	2.08

Means followed by the same letters are not significantly different.
*, **: at p<0.05 and 0.01 levels; ns: not significance. RS: Row spacing, SR: seeding rates

Seeding rate treatments showed significant affects on DM yield and CP content of Hungarian vetch. Increased seeding rates gradually increased DM yield, averaging 2.75 t ha^{-1} at 40 kg ha^{-1} seeding rate and increasing to 5.44 t ha^{-1} at 100 kg ha^{-1} seeding rate (Table 2). There were no statistically significant difference between 80 and 100 kg ha^{-1} seeding rates for DM yield. Many researches reported that increasing seeding rate resulted in an increased forage DM yield of different forage crops (Yılmaz, 2008 ; Açıkgöz *et al.* 2007; Uzun *et al.* 2004 ; Albayrak *et al.* 2004 ; Turk *et al.* 2003 ; Anlarsal, 1996).

Concentrations of ADF and NDF are important quality characteristics of forages. In present study, both row spacing and seeding rates had no effect on ADF and NDF concentration of Hungarian vetch. It was reported that these varied from 350 to 380 g kg^{-1} for ADF concentration and 400 to 500 g kg^{-1} for NDF concentration in different vetch species (Albayrak *et al.* 2009; Türk *et al.* 2009, Türk *et al.* 2007).

The TDN refers to the nutrients that are available for livestock and are related to the ADF concentration of the forage. As ADF increases there is a decline in TDN which means that animals are not able to utilize the nutrients that are present in the forage (Aydın *et al*. 2010). In this research, both row spacing and seeding rates had no effect on TDN content of hungarian vetch.

The RFV is an index that is used to predict the intake and energy value of the forages and it is derived from the DDM and dry matter intake (DMI). Forages with an RFV value over 151, between 150-125, 124-103, 102-87, 86-75, and fewer than 75 are considered as prime, premium, good, fair, poor and reject, respectively. Relative feed value, though not a reflection of the nutrition of forage, is also important in estimating the value of forage, and all treatments had relative feed value ranging from 141.4 to 143.5, which is grade 2 or above (Rohweder *et al*., 1978; Van Soest, 1982).

As shown in Table 3, all seed yield and yield components significantly affected either row spacing or seeding rate in Hungarian vetch. The highest average seed yield and yield components (seed yield, number of pods, number of seed per pod, 1000-seed weight and harvest index) were obtained from 35 cm row spacing, and the highest biomass yield was obtained from 17.5 cm row spacing (Table 2). In agreement with previous studies conducted in various forage crops (Boquet 1990, Yunusa and Ikawelle 1990, Bowers *et al.* 2000, Gan *et al*. 2002, Acikgoz *et al*. 2009), row spacing had significant effect on yield and yield components (Tables 2 and 3). Producing significantly higher seed yield and yield components in wider spacing is in accordance with the results of most of the previous studies (Herbert and Litchfield 1984, Boquet 1990, Asanome and Ikeda 1998, Bowers *et al.* 2000, De Bruin and Pedersen 2008, Acikgoz *et al*. 2009). Our results are consistent with these researches.

Table 3. Seed yield and yield components of hungarian vetch at different by row spacing and seeding rate (average of 2 years).

	Biomass yield (t ha^{-1})	Seed yield (t ha^{-1})	Number of pods	Number of seed per pod	1000-seed weight (g)	HI (%)
Row spacing (cm)						
17.5	6.27 a	0.70 b	8.67 b	4.29 b	28.42 b	11.11 b
35	5.56 b	0.82 a	10.46 a	5.21 a	32.63 a	14.60 a
Seeding rates (kg ha^{-1})						
40	5.08 d	0.53 d	11.17 a	6.17 a	32.92 a	10.88 c
60	5.72 c	0.71 c	10.75 a	5.25 ab	32.17 ab	12.40 b
80	6.20 b	0.98 a	8.83 b	4.33 b	29.83 b	15.77 a
100	6.65 a	0.81 b	7. 50 c	3.25 c	27.17 c	12.38 b
Results of analysis of variance and mean squares						
Year (Y)	3.05**	0.01*	0.52ns	0.08ns	1.68ns	2.05ns
Rep(Year)	0.22ns	0.01**	2.67ns	8.67**	13.04ns	2.39ns
RS	6.03**	0.16**	38.52**	10.08**	212.52**	145.88**
Y x RS	0.85*	0.03**	0.52ns	0.001ns	13.02ns	20.35**
SR	5.42**	0.41**	35.07**	18.72**	80.68**	51.41**
Y x SR	0.12ns	0.03**	0.07ns	0.02ns	5.90ns	7.55**
RS x SR	0.26ns	0.001ns	2.18ns	0.25ns	13.74ns	3.06ns
YxRS x SR	0.13ns	0.01**	1.40ns	0.38ns	2.35ns	2.88ns
CV (%)	6.71	5.44	13.01	23.20	9.48	8.82

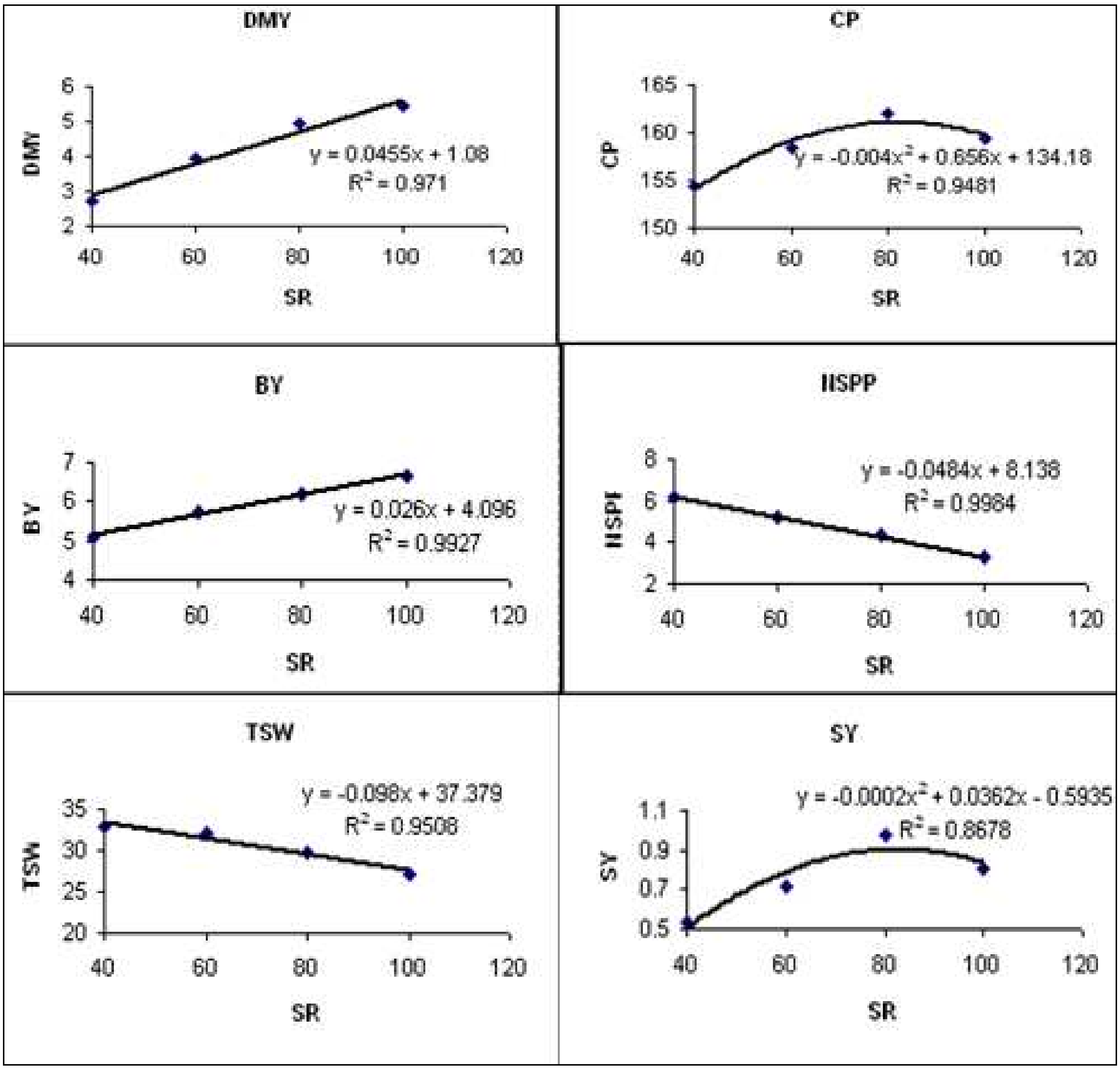
Means followed by the same letters are not significantly different.

*, **: at p<0.05 and 0.01 levels; ns: not significance. RS: Row spacing, SR: seeding rates

Seed yield was directly related to seeding rate. Seed yield and biomass yield increased as seeding rate increased, with the highest seed yield being obtained at 80 kg ha^{-1} seeding rate. When seeding rate was doubled from 40 to 80 kg ha^{-1}, about a 85% increase in seed yield in hungarian vetch. In contrast, number of pods, number of seed per pod, 1000-seed weight and harvest index decreased with increasing seeding rate (Table 3).

Linear regression models and equations were shown for seeding rate treatments in Figure 1. In present study, DM yield and biomass yield increased linearly (P<0.01) while number of pods, number of seed per pod and thousand seed weight decreased linearly (p<0.01) by increased seeding rate. Seed yield, crude protein content and harvest index had a quadratic effect (Figure 1).

Figure 1. Regression models of dry matter yield (DMY), crude protein content (CP), biomass yield (BY), seed yield (SY), number of pods (NP), number of seed per pod (NSPP), thousand seed weight (TSW) and harvest index (HI) with seeding rate (SR) in hungarian vetch.



The decrease in number of pods at the high seeding rate was attributed to increased competition between plants for growth factors, which finally reduced the number of effective branches. A reduction in branching produced by increasing seeding rate has been reported previously (Uzun *et al*. 2004; Turk *et al*. 2003). The increase in seed yield with increasing seeding rate at sowing was due to more pods being produced as a result of more plants being established. The influence of seeding rate on seed yield was through the increased production of pods per unit area (Table 3) and not through the increased production of pods per plant (Turk et al. 2003).

CONCLUSION

The present study indicated that row spacing and seeding rate affected yield and yield components of hungarian vetch under rainfed conditions in the Mediterranean region of Turkey. For dry matter yield 17.5 cm and for seed yield 35 cm row spacing with 80 kg ha^{-1} seeding rate can be recommended for high forage and seed yield in Hungarian vetch under similar environmental conditions of Turkey and neighboring countries.

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