The Effects of Different Row Spaces and Seeding Rates on the Hay and Crude Protein Yields of Sainfoin (*Onobrychis sativa* Lam.)*

Mevlüt TÜRK[1]   Necmettin ÇELİK[2]

Abstract: The study was carried out to investigate the effects of different row spaces (15, 30, 45, 60 and 75 cm) and seeding rates (40, 80, 120, 160 and 200 kg ha^{-1}) on the hay and crude protein yields of sainfoin at the Agricultural Research and Experiment Center of Agriculture Faculty, Uludag University in 1999-2002. The field experiments were established in a split plot design with four replications. Plant height, stem number per m^2, green matter yield, hay yield and crude protein yields were determined. The results suggested that sainfoin should be planted with 15-30 cm row spaces and at 160-200 kg ha seeding rate for hay production in Southern Marmara Region or in regions with similar ecological conditions.

Key Words: Sainfoin, row space, seeding rate, hay yield, crude protein yield

Farklı Sıra Aralıkları ve Tohum Miktarlarının Korunganın (*Onobrychis sativa* Lam.) Kuru Ot ve Ham Protein Verimi Üzerine Etkileri

Öz: Bu araştırma, korungaya uygulanan değişik sıra aralıkları (15, 30, 45, 60 ve 75 cm) ve tohumluk miktarlarının (40, 80, 120, 160 ve 200 kg ha^{-1}) kuru ot ve ham protein verimine etkilerini belirlemek amacıyla Uludağ Üniversitesi Ziraat Fakültesi Tarımsal Araştırma ve Uygulama Merkezinde 1999-2002 yılları arasında yürütülmüştür. Araştırma tesadüf bloklarında bölünmüş parseller deneme desenine göre dört tekrarlamalı olarak kurulmuştur. Araştırmada bitki boyu, m^{2}'de sap sayısı, yeşil ot verimi, kuru ot verimi ve ham protein verimi tespit edilmiştir. Elde edilen sonuçlara göre, Güney Marmara Bölgesi'nde korungada ot üretimi için 15-30 cm sıra aralığı ve 160-200 kg ha^{-1} tohum miktarının kullanılması gerekmektedir.

Anahtar Kelimeler: Korunga, sıra aralığı, tohum miktarı, kuru ot verimi, ham protein verimi

Introduction

Turkey shows a great inadequacy in terms of animal feed. Sainfoin (*Onobrychis sativa* L.) is an important forage legume for Turkey. It is a native, widely grown perennial legume well adapted to the highland farming system under the dryland conditions of Central and Eastern Anatolia. Sainfoin is a very palatable forage plant, and has the advantage of not inducing bloating as an animal feed over alfalfa. Therefore, it renders green forage suitable for strip grazing. It is capable of improving soil organic matter and nitrogen content by fixing nitrogen in the root system of the plant through *Rhizobium* bacteria. It has the advantage of root growth to a greater depth than most annual legumes. The roots penetrate through the deeper layers of the soil and supply a great amount of organic matter when plants are under the soil. This organic matter is very important, particularly under dryland conditions due to the difficult of producing large amounts of vegetation. Moreover, sainfoin is beneficial in agricultural rotations under Anatolian conditions. It is valuable for erosion control and grows well in intercropping systems with forage grasses. Honey bees visit sainfoin flowers very frequently, collecting pollen grains and nectar, producing honey with special aroma and taste. Additionally, sainfoin flowers set large numbers of seeds (Elçi et al. 1995).

Sainfoin is a perennial forage legume characterized by a high competition index. This crop's competitiveness is manifested both in its competition for vegetative space with other crop species (when grown as a mixed crop) and competition within the

species itself (when grown as a pure crop). These are particularly pronounced when sainfoin is grown in a dense stand. Thin stands, on the other hand, result in yield losses. Thus it is of particular importance to determine optimum row space and seeding rate as this is a prerequisite for a high, stable and profitable sainfoin production (Cupina and Eric 1999).

Recommendations in the literature for optimum row space and seeding rate ranges from 15 to 60 cm and from 15 kg ha^{-1} to 200 kg ha^{-1} respectively depending on whether seeds or single-seed pods are used for sowing. It is reported that, sainfoin produces the largest hay yield when row spaces are 15-30 cm (Cupina et al. 1998, Serin and Tan 1997, Soya et al. 1997, Tuna 1994, Akdeniz and Andiç 1998, Andiç 1995). However, Hanna et al. (1972), Altın (1982), Kantar et al. (2000), Kadıoğlu (1977), Açıkgöz (2001) report that the largest sainfoin hay yields are produced from plants with a row space of 30–60 cm. Depending on whether the seed or fruit (a single-seeded pod) is used for sowing, different seeding rates are also recommended in the literature: 15-20 kg ha^{-1} of seed (Hanna et al. 1972) 30-40 kg ha^{-1} of seed (Glover and Melton 1991, Cash et al. 1993), 79-100 kg ha^{-1} of fruit (Ivanovski et al. 1998, Serin and Tan 1997, Malanusenko et al. 1974, Kasymov and Khodzhaev 1977) and 100-200 kg ha^{-1} of fruit (Eraç and Ekiz 1985, Jensen and Sharp 1968, Hakyemez 2000). In practice, however, it is the fruit that is most often used for sowing, since under favourable conditions the seeds germinate and emerge from the fruit coating unimpeded. In sainfoin, therefore, what is botanically the fruit actually represents the seed in agricultural terms. The seeding rate in this crop species is also significantly affected by agroecological growing conditions (Cupina and Eric 1999).

The objective of our study was to monitor the effects of different row spaces and seeding rates on yields of hay and crude protein in sainfoin.

Materials and Methods

The research was performed at the Agricultural Research and Experiment Station of Agriculture Faculty, Uludag University in 1999-2002. Sainfoin seeds used in the research was obtained from the Agriculture Faculty of Suleyman Demirel University.

The experimental soil was clayey, non saline, poor in lime and organic matter, rich in potassium and had a neutral pH (Anonymous 1999). Average temperature, relative humidity and precipitation were 14.6 ^{o}C, 68.4 % and 706.3 mm in 2000; 15.9 ^{o}C, 53.7 % and 649.2 mm in 2001; 12.5 ^{o}C, 68.3% and 395.1 mm in 2002 (January-June); 14.8 ^{o}C, 68.9% and 698.9 mm in long term (1928-1999) averages, respectively (Anonymous 2002).

The field experiments were established in a split plot design with four replications on 02.11.1999. Five different row spaces (15, 30, 45, 60 and 75 cm) and five different seeding rates (40, 80, 120, 160 and 200 kg ha^{-1}) were used in the experiment. Row spaces and seeding rates were main plots and subplots respectively. Plot length was 5 m, plot width ranged from 2.4 to 3 m according to row spaces. In 1999, 60 kg ha^{-1} nitrogen and 60 kg ha^{-1} phosphorus was applied at the November. In 2000 and 2001 only phosphorus (60 kg ha^{-1}) was applied.

In the first year of the study a standard cutting was applied on June 21 2000. Therefore, measurements were not taken in 2000. In 2001, first and second cuttings were performed on May 1st and July 3rd respectively. On the other hand, in 2002, first and second cuttings were done on May 8th and June 17th respectively. The cutting was performed with a scythe at the 10 % flowering period of sainfoin plants.

After harvest, plant samples were dried in an oven at 70 ^{o}C to a constant weight for dry matter content. Dried samples were grounded and the amount of N was determined using kjehldal method. Crude protein content was calculated by multiplying the amount of N from each sample by 6.25.

Plant height, number of stems per square, green matter yield, hay yield and crude protein yields were determined in this research. The data obtained over 2 years (2001 and 2002) were combined and subjected to variance analyses. The data were analysed using Minitab Programs.

Results and Discussion

Plant height: The effects of row spaces, seeding rates and their interactions on plant height were statistically significant (Table 1). The tallest plants were obtained from 15 and 30 cm row spaces (79.10 and 77.47 cm, respectively) while the shortest plants were obtained from 45, 60 and 75 cm row spaces (74.34, 72.54 and 71.92 cm, respectively) in averages of two years. This can be explained by the fact that plants has to grow longitudionally to benefit from sunlight in conditions of the availability of adequate plant nutrients, since there are more plants per unit area in narrow row spaces. In wise row spaces, the number of plants per unit area is less and plants grow horizontally and develop more branches. Our results

TÜRK, M. and N. ÇELİK, "The effects of different row spaces and seeding rates on the hay and crude protein yields of sainfoin (*Onobrychis sativa* Lam.)"

177

are in agreement with Hakyemez (2000), Türk (2005) but not with Andiç (1995).

As shown in Table 1, the tallest plants were obtained with 40 and 80 kg ha^{-1} seeding rates (80.81 and 79.18 cm, respectively) while the shortest plants were obtained from 160 and 200 kg ha^{-1} seeding rates (70.16 and 69.78 cm, respectively). These results are not in agreement with the findings previous (Hakyemez 2000, Tuna 1994, Tosun 1971). As seed rates increased, plant height declined due to increased plant density in a row, decreased plant growth space and increased competition among plants. The seeding rate in sainfoin is also significantly affected by agroecological growing conditions (Cupina and Eric 1999).

The effect of row spacing x seeding rates interaction on plant height was statistically significant (Table 1). The tallest plants were obtained from 30 cm row spacing and 40 kg ha^{-1} seeding rates combination (85.25 cm).

Number of stem per square: The effects of row spaces, seeding rates and row spaces x seeding rates interactions on stem number per m^2 in averages of two years were statistically significant (Table 2). The highest stem number per m^2 was obtained from 15 cm row spaces (372.0). The increase in row spaces resulted in a decrease in stem number per m^2. The lowest stem number per m^2 was determined in 75 cm row spaces (149.3). In wide-row space sowings with the same seeding rates, the competition among plants increases due to high plant densities on rows and thus natural eliminations are observed. This reduces the number of plants at wide-row spaces. Our results are in agreement with the findings of Hakyemez (2000).

The highest stem number per m^2 was achieved with 200 kg ha^{-1} seeding rate (251.2) while the lowest stem number per m^2 was obtained from 40 kg ha^{-1} seeding rate (205.4) in averages of two years (Table 2), possibly due to the increase in seedling number per

unit area. Our results are in agreement with Hakyemez (2000) but not with Jusupov (1972).

The effect of row spacing x seeding rates interaction on number of stem per square was statistically significant (Table 2). The highest stem number per m^2 was obtained from 15 cm row spacing and 80 kg ha^{-1} seeding rates combination (428.2 cm).

Green matter yield: The effects of row spaces, seeding rates and their interactions on green matter yield were statistically significant (Table 3). The highest average green matter yield were achieved with 15 cm row spaces (45.55 t ha^{-1}), while the lowest green matter yields were obtained from 60 and 75 cm row spaces (31.29 and 29.17 t ha^{-1}). Results of the present study are in general agreement with the results of several previous studies (Grosew 1959, Jargiello 1964, Zatko 1969, Akdeniz and Andiç 1998, Tosun 1988, Tosun et al. 1988, Tuna 1994, Andiç 1995, Cupina et al. 1998, Hakyemez 2000).

The increase in seeding rates resulted in an increase in green matter yield. The highest green matter yield was obtained from 200 kg ha^{-1} seeding rate (39.53 t ha^{-1}). The differences among 40, 80, 120 and 160 kg ha^{-1} seeding rates were not statistically significant (Table 3). These results were in accordance with the results reported by Maslinkov and Kostov (1967), Ivanovski et al. (1998), Cupina and Eric (1999), Hakyemez (2000). On the other hand, Kadıoğlu (1977), Glover and Melton (1991), Cash et al. (1993) proposed lower seeding rates for the highest green matter yield. Tosun (1971) reported that effect of seeding rates on green matter yield was not significant.

The effect of row spacing x seeding rates interaction on green matter yield was statistically significant in average of two years (Table 3). The highest green matter yield was obtained from 15 cm row spacing 200 kg ha^{-1} seeding rates combination (52.28 t ha^{-1}).

Table 1. Average values of plant heights in sainfoin planted in different row spaces and seeding rates (cm)

Row Spaces (cm)	Seeding Rates (kg ha^{-1})					
	40	80	120	160	200	Means
15	80.97 a-d	81.44 a-d	77.67 c-f	79.28 c-e	76.16 d-g	**79.10 a**
30	85.25 a	81.25 a-d	77.45 c-f	67.39 jk	76.00 d-g	**77.47 a**
45	80.62 b-d	76.14 d-g	76.53 d-g	67.55 i-k	71.13 g-j	**74.34 b**
60	78.09 c-f	82.96 a-c	72.61 f-j	66.51 j-k	62.50 k	**72.54 b**
75	79.13 c-e	74.10 e-h	73.17 f-i	70.07 h-j	63.12 k	**71.92 b**
Means	**80.81 a**	**79.18 a**	**75.48 b**	**70.16 c**	**69.78 c**	

Different letters indicate the significant differences at p ≤0.01 in LSD test.
LSD (0.01): Row spaces: 2.936, Seeding rates: 2.518, Row spaces x Seeding rates:5.630

Table 2. Average values of number of stem per square in sainfoin planted in different row spaces and seeding rates.

Row Spaces (cm)	Seeding Rates (kg ha^{-1})					
	40	80	120	160	200	Means
15	336.2 cd	428.2 a	354.2 c	392.6 b	348.8 c	**372.0 a**
30	204.8 h-k	255.9 ef	245.0 e-g	260.7 e	308.4 d	**255.0 b**
45	185.6 j-m	189.7 i-m	222.6 h-k	221.4 g-i	223.9 f-h	**208.7 c**
60	161.7 m-o	174.2 k-n	197.6 h-l	181.5 k-n	218.4 g-j	**186.6 d**
75	138.6 o	136.3 o	149.5 no	165.5 l-o	156.6 m-o	**149.3 e**
Means	**205.4 c**	**236.9 ab**	**233.8 b**	**244.3 ab**	**251.2 a**	

Different letters indicate the significant differences at p ≤0.01 in LSD test.
LSD (0.01): Row spaces:19.25, Seeding rates:16.52, Row spaces x Seeding rates:29.46

Table 3. Average values of green matter yields in sainfoin planted in different row spaces and seeding rates (t ha^{-1})

Row Spaces (cm)	Seeding Rates (kg ha^{-1})					
	40	80	120	160	200	Means
15	37.09 e-h	42.95 cd	46.10 bc	49.84 ab	52.28 a	**45.55 a**
30	50.65 ab	35.52 f-j	41.86 c-e	36.14 f-k	49.78 ab	**42.79 b**
45	32.60 g-l	33.52 f-k	37.51 e-g	37.96 d-f	37.62 e-g	**35.87 c**
60	27.13 m	35.97 f-l	29.74 k-m	32.26 h-l	31.37 i-m	**31.29 d**
75	30.82 j-m	29.03 k-m	26.71 m	31.70 i-m	27.65 lm	**29.17 d**
Means	**35.66 b**	**35.40 b**	**36.41 b**	**37.68 b**	**39.53 a**	

Different letters indicate the significant differences at p ≤0.01 in LSD test.
LSD (0.01): Row spaces: 2.687, Seeding rates: 2.272, Row spaces x Seeding rates:5.079

Hay yield: The effects of row spaces, seeding rates and their interaction on hay yield were highly significant (Table 4). As shown in Table 2, the increase in row spaces caused decreases in hay yield. The highest hay yields were obtained from 15 and 30 cm row spaces (11.82 and 11.15 t ha^{-1}), while the lowest hay yields were obtained from 60 and 75 cm row spaces with 8.27 and 7.62 t ha^{-1} in averages of two years. Hay yields obtained from 15 cm row spaces increased 55.1 % in averages of two years to the compared to that obtained from 75 cm row space. A number of studies (Tuna 1994, Serin and Tan 1997, Akdeniz and Andiç 1998, Andiç 1995, Soya et al. 1997, Cupina et al. 1998, Hakyemez 2000, Türk 2005) recommended narrow row spaces (15-30 cm) for the highest hay yield in agreement with our findings. On the other hand, Hanna et al. (1972), Altın (1982), Kantar et al. (2000), Kadıoğlu (1977) proposed wider rows (30-60 cm) for the highest hay yield.

The increase in seeding rates resulted in an increase in hay yield. The highest hay yield was achieved with 200 kg ha^{-1} seeding rate in average of two years (10.50 t ha^{-1}). 40 kg ha^{-1} seeding rate gave the lowest hay yield (8.76 t ha^{-1}). The difference between the lowest and the highest seeding rates was 19.8 % in terms of hay yield (Table 4).

Depending on whether seed or fruit used for sowing, different seeding rates were recommended: 15-20 kg ha^{-1} of seed (Hanna et al., 1972), 30 kg ha^{-1} of seed (Glover and Melton, 1991), 40 kg ha^{-1} of seed (Cash et al. 1993), 79 kg ha^{-1} of fruit (Ivanovski et al. 1998), 80 kg ha^{-1} of fruit (Serin and Tan 1997), 100 kg ha^{-1} of fruit (Malanusenko et al. 1974, Kasymov and Khodzhaev 1977), 100-150 kg ha^{-1} of fruit (Eraç and Ekiz 1985), 165 kg ha^{-1} of fruit (Jensen and Sharp, 1968) and 200 kg ha^{-1} of fruit (Hakyemez 2000). The variability observed from these studies suggests that the seeding rate in this crop species is significantly affected by agroecological growing conditions.

The effect of row spaces x seeding rates interaction on hay yield was statistically significant in

Table 4. Average hay yields of sainfoin planted in different row spaces and seeding rates (t ha^{-1})

Row Spaces (cm)	Seeding Rates (kg.ha^{-1})					
	40	80	120	160	200	Means
15	9.74 f-i	10.74 d-f	12.13 bc	13.26 ab	13.23 ab	**11.82 a**
30	11.49 c-e	9.11 g-l	11.56 cd	9.94 f-h	13.66 a	**11.15 a**
45	8.62 i-n	8.89 h-m	9.76 f-i	10.31 e-g	9.44 g-j	**9.40 b**
60	6.96 q	9.41 g-k	7.75 m-q	8.37 j-o	8.86 h-m	**8.27 c**
75	7.01 pq	8.06 l-q	7.50 n-q	8.21 k-p	7.32 o-q	**7.62 c**
Means	**8.76 d**	**9.24 cd**	**9.74 bc**	**10.02 ab**	**10.50 a**	

Different letters indicate the significant differences at p ≤0.01 in LSD test.
LSD (0.01): Row spaces: 0.765, Seeding rates: 0.542, Row spaces x Seeding rates:1.213

average of two years (Table 4). While there were no statistically significant difference between 160 and 200 kg ha^{-1} seeding rates in 15, 45, 60 and 75 cm row spaces, there was a significant difference between 160 and 200 kg ha^{-1} seeding rates in 30 cm row space.

Crude protein yields: The crude protein yields exhibited a similar trend to hay yields. The increase in row space caused a decrease in crude protein yield. While the highest crude protein yield was obtained from 15 and 30 cm row spaces (1.73 and 1.70 t ha^{-1}), the lowest crude protein yield was obtained from 60 and 75 cm row spaces (1.20 and 1.13 t ha^{-1}) in averages of two years (Table 5).

Crude protein yield increased 53.4 % in averages of two years as the row space decreased from 75 cm to 15 cm. Our results are in agreement with the findings of Akdeniz and Andiç (1998), Tosun (1988), Altın and Tuna (1996), Andiç and Günel (1996), Cupina et al. (1998), Cupina and Eric (1999), Hakyemez (2000), Türk (2005). On the other hand, Serin and Tan (1997) reported that while the highest crude protein yield (0.72 t ha^{-1}) was obtained in 48 cm row spacing, the lowest crude protein yield (0.60 t.ha^{-1}) was produced in 12 cm row spacing in Erzurum conditions.

In averages of two years, the lowest seeding rate (40 kg ha^{-1}) gave the lowest crude protein yield (1.35 t ha^{-1}), and the highest seeding rate (200 kg ha^{-1}) gave the maximum crude protein yield (1.55 t ha^{-1}).

In a study performed in Yugoslavia Cupina and Eric (1999) reported that the highest crude protein yield was obtained from 180 kg ha^{-1} treatment in 1995 and 1996 and from 140 kg ha^{-1} in 1997. Results of another study carried out with four seeding rates (40, 80, 120 and 160 kg ha^{-1}) in Erzurum conditions, showed that while the lowest crude protein yield was obtained from 40 kg ha^{-1} treatment, the highest crude protein yield was obtained from 80 kg ha^{-1} treatment (Serin and Tan 1997).

The results of a research conducted with 100, 150 and 200 kg ha^{-1} seeding rates, showed that the highest crude protein yield was achieved with 150 kg ha^{-1} treatment in first year, and 200 kg ha^{-1} treatment in second year (Hakyemez 2000), confirming our findings.

The effects of row space x seeding rate interaction on crude protein yields were statistically significant in averages of two years. The reason for the significance of interaction is that while there were not significant differences between 160 and 200 kg ha^{-1} treatments in other row spaces, there were highly significant differences between 160 and 200 kg ha^{-1} treatments in 30 cm row spacing (Table 5).

Correlation coefficients among characters in sainfoin: Simple correlation coefficients among the examined characters are shown in Table 6. Positive and significant relationships existed between hay yield and all its components. Similar results were reported by other researchers (Tuna 1994, Andiç 1995, Cupina and Eric 1999, Hakyemez 2000).

Conclusion

In conclusion, the results suggest that sainfoin should be planted with 15-30 cm row spaces and at 160-200 kg ha^{-1} seeding rate for hay production in Southern Marmara Region or in regions having similar ecological conditions.

Table 5. Average values of crude protein yields in sainfoin planted in different row spaces and seeding rates (t ha^{-1}).

3	Seeding Rates (kg.ha^{-1})					
	40	80	120	160	200	Means
15	1.40 f-i	1.64 de	1.72 cd	1.96 ab	1.95 ab	**1.73 a**
30	1.92 a-c	1.47 e-h	1.76 b-d	1.33 g-l	2.03 a	**1.70 a**
45	1.34 g-l	1.34 g-k	1.41 f-i	1.55 d-f	1.49 e-g	**1.43 b**
60	0.94 o	1.36 f-j	1.15 k-n	1.27 h-m	1.30 g-l	**1.20 c**
75	1.15 j-n	1.13 l-o	1.07 m-o	1.25 i-m	1.03 no	**1.13 c**
Means	**1.35 c**	**1.39 bc**	**1.42 bc**	**1.47 ab**	**1.55 a**	

Different letters indicate the significant differences at p ≤0.01 in LSD test.
LSD (0.01): Row spaces: 0.122, Seeding rates: 0.914, Row spaces x seeding rates:0.204

Table 6. Phenotypic Correlation Coefficients of Hay Yield Components in the Sainfoin

	HY	GMY	CPY	PH	SN per m^2
Hay Yield	1.000				
Green Matter Yield	0.889**	1.000			
Crude Protein Yield	0.888**	0.771**	1.000		
Plant Height	0.539**	0.532**	0.735**	1.000	
Stem Number per m^2	0.662**	0.639**	0.612**	0.436**	1.000

**Significant at 1% level of P

References

Açıkgöz, E. 2001. Yem Bitkileri (3. baskı). Uludağ Ü. Güçlendirme Vakfı, Yayın No:182, VIPAŞ AŞ Yayın No:58, Bursa, 584 s.

Akdeniz, H. ve C. Andiç. 1998. Korunga ile Karışıma Giren Kılçıksız Brom ve Mavi Ayrığın Değişik Ekim Şekillerindeki Kuru Ot ve Ham Protein Verimleri, Ham Protein Oranları ve Karışımların Botanik Kompozisyonları. Y.Y.Ü. Fen Bil. Enst. Tarla Bitk. Anabili Dalı, (Basılmamış Doktora Tezi).

Altın, M. 1982. Baklagil yembitkileri ile bunlarin karişimlarinin değişik ekim şekillerindeki kuru ot ve ham proteinleri ile türlerin ham protein oranlari ve karişimlarin botanik kompozisyonlari. Doğa, 6(2):93-126.

Andiç, N. 1995. Van Yöresi Kıraç Koşullarında Yetiştirilen Korunga (Onobrychis sativa L.)'ya Uygulanan Değişik Sıra Aralığı ve Fosforlu Gübrenin Ot, Tohum ve Ham Protein Verimlerine Etkileri Üzerine Bir Araştırma. Yüzüncü Yıl Üniv., Fen Bilimleri Enstitüsü, Tarla Bitkileri Ana Bilim Dalı (Yayınlanmamış Doktora Tezi), Van.

Anonymous 1999. Uludağ Üniv. Ziraat Fak. Uygulama ve Araştırma Çiftliği Deneme Alanı Toprak Analiz Sonuçları. Köy Hizmetleri 17.Bölge Müdürlüğü (Yayınlanmamış Kayıtlar), Bursa.

Anonymous 2002. Bursa Bölgesi İklim Verileri. Bursa Meteoroloji Bölge Müdürlüğü (Yayınlanmamış Kayıtlar), Bursa.

Cash, D., H. Bowman and R. L. Ditterline. 1993. Sainfoin. Field Crops C-11 (Forages) Issued October.

Cupina, B., P. Eric and V. Mihallovic. 1998. Potential Perennial Legumes as Forage Crops in the Vojvndina Province. In: B. Boller and F.J. Stodelmann (eds.): Breeding for a Multifunctional Agriculture. Swiss Federal Research Station for Agroecology and Agriculture. p. 64-66.

Cupina, B. and P. Eric. 1999. The effects of sowing Method and seeding rate on yield and quality of sainfoin (O. sativa L.) Forage. Scientia Agriculturae Bohemica 30: 107-114.

Elçi, Ş., H. Ekiz, O.Gürkan, S. P. S. Baniwal, C. Sancak ve H. Kendir. 1995. Sainfoin (Onobrychis spp.) Forage Crop For Anatolia. Deutsch-Türkische Agrarforschung., Ankara

Eraç, A. ve H. Ekiz. 1985. Yem Bitkileri Yetiştirme. Ankara Üniv. Ziraat Fak. Yayınları. Yayın No: 964, Ankara, 68 s.

Glover, C. and B. Melton. 1991. Sainfoin Production. Cooperative Extension Service. New Mexico State University. Guide A-311, 10 p.

Grosew, D. 1959. Versuche zur feststellung der gecignetsten saatmethode für die samen und futtergewinnung aus luzerne, rotkle Und esparsette in der umbedung von Sofia. Bul. Inst. Cult. Plantes Acad. Bulg Sci. 7: 129-136.

Hakyemez, B. H. 2000. Çok Yıllık Yonca, Korunga ve Nohut Gevendine Bitki Sıklığının Yem Verimine Etkileri. A.Ü.Fen Bil. Enst. Tarla Bitk. Anabilim Dalı (Yayınlanmamış Doktora Tezi), Ankara, 157 s.

Hanna, M. R., D. A. Cooke, S. Smoliak and B. P. Goplen. 1972. Batı Kanada'da Korunga. Kanada Tarım Bakanlığı, Yayın No: 1470. Çeviren Mehmet Munzur, 1977, Ankara, 14 p.

Ivanovski, P., T. Prentovic and Z. Dimov. 1998. Effect of sowing rate on sainfoin (o. sativa lam.) forage and seed yield. Proceedings of 2 nd Balkan Symposium on Field Crops, Vol. 2: Ecology and Physiology: Cultural Practices Novi Sad, Yugoslavia. p. 473-475.

Jargiello, J. 1964. Agrotechnical Studies on Sainfoin. Annls. Üniv. Marla Curie Sklodowska.

Jusupov, B. K. 1972. Der feldaufgang von esparsette in abhangigkeit von aus saat verfahren und aussaatnorm. Vestnik Se'skochoz. Nauki, Alma Ata, 15, 10: 35-37.

Jensen, E. H. and M. E. Sharp. 1968. Agronomic Evaluation of Sainfoin in Nevada Sainfoin Symposium, Montana. p. 34-37.

Kadıoğlu, F. 1977. Korungada Sıra Aralığının Ot Verimine Etkisi. Ankara Çayır-Mera ve Zootekni Araştırma Enstitüsü, Yayın No: 63.

Kantar, F., H. Özer ve A. Öztürk. 2000. Tarla Bitkileri Bölümü ve Doğu Anadolu Bölgesinde Tarla Tarımı. Atatürk Üniv.Ziraat Fak.Dergisi Özel Sayısı, Erzurum, s.59-60.

Kasymov, D. ve A. Khodzhaev. 1977. Effect of sowing dates and rates on yield of sainfoin. Sel'skoe Khozyaistvo Tadzhikistane. No:2. p. 57-58.

Malanusenko, G. G., V. P. Tochtarov and R. I. Panteleeva. 1974. Aussaatnormen Und Saattife Von Esparsetteim Volgograder Gebiet. Bjull. Vses. Nauc. İssl. İnst. Kukuruzy, Dnepropetrovsk.

Maslinkov, M. and K. Kostov. 1967. Untersuchung Über Die Saat Menge Beider Esparsette. Naucni Trudove, Viss Selskolstopanski Institut "Vasil Kalarov" Kn 1. Agromiceski Fakultet, Plovdiv 16. Nr. 1: 147-152.

Serin, Y. ve M. Tan. 1997. Tohum Miktarı, Sıra Aralığı ve Fosforlu Gübre Uygulamalarının Korungada Ot ve Ham Protein Verimi ile Otun Ham Protein Oranına Etkileri. Türkiye II. Tarla Bitkileri Kongresi, 22-25 Eylül 1997, Samsun s. 416-420.

Soya, H., R. Avcıoğlu ve H. Geren. 1997. Yem Bitkileri. Hasad Yayıncılık Ltd.Şti. s:106-111.

Tosun, F. 1971. The Effects of Time, Depth and Rate of Seeding Upon Number of Seedlings, Plant Height and Forage Yield of Sainfoin. Atatürk Üniv. Yay. No: 115, Ziraat Fak. Yay. No: 53, Araş. Seri. No: 29, 47 p.

Tosun, M., H. Soya ve E. Çelen. 1988. Farklı biçim uygulamaları ve sıra arası mesafelerinin korunga (*O. viciofolia* scop.)'da tohum verimi ve diğer bazı karakterlere etkisi. Ege Üniv. Ziraat Fak. Dergisi 25:184-194.

Tosun, M. 1988. Kuru ve Sulu Koşullarda Değişik Sıra Arası Mesafelerin ve Değişik Fosfor Dozlarının Korunganın Tohum Verimi ve Diğer Agronomik Özelliklerine Etkileri Üzerinde Araştırmalar. Ege Üniv. Ziraat Fak. Tarla Bitkileri Bölümü, Fen Bilimleri Enstitüsü (Doktora Tezi), İzmir, 135 s.

Tuna, C. 1994. Tekirdağ Koşullarında Yetiştirilen Korungada (*Onobrychis sativa* L.) Farklı Sıra Aralığı ve Ocağa Ekimin Ot ve Tohum Verimine Etkisi. Trakya Üniv. Fen Bilimleri Enstitüsü Tarla Bitkileri Anabilim Dalı (Yüksek Lisans Tezi), Tekirdağ, 60 s.

Türk, M. 2005. Farklı ekim sıklıklarının korunganın (*Onobrychis sativa* L.) kuru ot ve ham protein verimi üzerine etkisi. Ankara Üniv. Ziraat Fak. Tarım Bilimleri Dergisi 11: 292-298.

Zatko, J. 1969. Aussaat Und Reihenentfernung Beim Anbau Der Esparsette Als Grünfutter. Uroda, Praha. 18. Nr. 8: 303-305.

Correspodence address:
Mevlüt TÜRK
Süleyman Demirel University, Faculty of Agriculture, Department of Agronomy -Isparta