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Full Length Research Paper

Effects of the weed density on grass yield of Alfalfa (*Medicago sativa* L.) in different row spacing applications

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This study, in which the effects of different row spacing applications on weed density and on grass yield of *Medicago sativa* L. were investigated, was carried out in Van-Turkey from 2006 - 2008. Randomized blocks design was adopted with three replications. Row spacing applications of 20, 30, 40, 50, 60 and 70 cm were tested. The alfalfa plant height, yield of green herbage yield, dry matter yield, crude protein rate and crude protein yield were investigated. In addition, the weed densities at different row spacing distances were determined. The highest plant heights were obtained in 40 cm row spacing application in the first year and in 20 cm row spacing application in the second year. The highest dry matter and crude protein yields were obtained in 20, 30 and 40 cm row spacings in the first year and in 20 cm row spacing applications in the second year. The most intense weed was *Alopecurus myosuroides* Huds in 2007 and *Amaranthus retroflexus* L. in 2008. The least weed density was found in 20 cm row spacing during all three before cutting periods in the first year of study and this was found in 30 cm row spacing application in first before cutting period and in 20 cm row spacing application in the second and third before cutting periods in the second year.

Key words: Alfalfa, weed, row distance, yield.

INTRODUCTION

Alfalfa (*Medicago sativa* L.) is a perennial forage plant having deep and strong root system in the Fabaceae family (Davis, 1970). Alfalfa is fed as hay, silage, greenchop, pellets or cubes to a variety of livestock, but it is also grown for pasture and seed production (Fick and Mueller, 1989).

Alfalfa, demonstrating compliance with the different climatic and soil conditions can be planted in almost every region in Turkey. Alfalfa has an important place in culture plants cultivation with 444 thousand hectares of planting area and 282 thousand tons of hay in our country as of 2006 (Anonymous, 2008). In Turkey, 44.5% of alfalfa planting area and sainfoin and approximately 30% of animal species are located at the East Anatolia Region (Acikgoz et al., 2005). In 2007, alfalfa planting areas in Van has reached to 95 thousand hectares, while it was 60 thousand hectares in 2005 and 29 thousand hectares in 2000, and 569 thousand tons of hay was obtained (Anonymous, 2008).

In the world, the loss of cereal products due to diseases, pests and weeds is 132 million tons and 54 million tons of it is due to weeds (Ozer et al., 1998). In agricultural production, the loss caused by weeds is more than 10% (Stephenson, 2000). When no control methods are applied, it has been observed that this ratio varied between 45 and 90% depending on the ecological and climatic conditions in different crops (Ampong and Data, 1991; Moody, 1996). When weeds are present in an alfalfa field, they affect yield and quality because they compete with the alfalfa plants for light, nutrients and moisture (Oloumi-Sadeghi et al., 1989). Weeds affected alfalfa stands differently at various stages of alfalfa production: prior to establishment, in the seedling stage

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Table 1. Climate data for Van Province from 2006 - 2008, long term (LT) averages*.

Month	Temperature (°C)				Rainfall (mm)				Relative humidity (%)			
	2006	2007	2008	LT	2006	2007	2008	LT	2006	2007	2008	LT
January	-3.1	-4.6	-5.6	-3.6	90.4	18.1	12.5	35.4	73.7	68.0	62.6	68.0
February	-1.3	-0.9	-3.6	-3.2	47.7	10.6	31.0	32.5	74.2	69.7	73.6	69.0
March	3.0	3.0	5.8	0.9	45.7	35.0	31.5	45.7	77.5	67.1	55.5	68.0
April	9.8	5.9	10.5	7.4	39.6	86.8	248	56.6	66.5	68.0	52.2	62.0
May	14.6	15.7	12.3	12.9	35.4	27.3	39.9	46.3	54.0	60.5	51.1	67.0
June	21.5	19.9	19.5	17.8	0.1	9.1	2.1	18.4	41.9	56.6	41.9	50.0
July	22.3	22.7	22.7	22.0	22.4	28.6	11.1	5.1	47.5	54.5	32.8	44.0
August	24.1	21.8	23.9	21.5	2.4	7.2	6.8	3.9	40.0	51.5	37.3	42.0
September	18.0	17.8	18.3	17.0	0	0	44.7	13.0	46.2	45.4	39.6	43.0
October	11.6	12.2	11.0	10.6	46.9	7.6	56.6	45.3	56.5	58.1	60.5	58.0
November	3.0	4.2	4.9	4.4	49.3	75.2	21.0	47.9	61.2	65.6	60.5	66.0
December	-3.4	-2.0	-1.8	-0.8	44.2	51.3	36.7	37.3	66.7	63.4	62.6	69.0

* Data collected from Van Meteorological Station.

and in established stands (http://aces.nmsu.edu-2009).

In order to get good and efficient results from the combat against weeds, the issues should be very well known and accurate identification of them is needed. Wrong and unnecessary herbicide use is one of priority issues that must be resolved because of its adverse effects on plants, environment and human health. The row spacing distance affects weed density. The studies conducted on different plants have showed that the weed density was lower in the plantation with narrow row spacing (Mashingaidze et al., 2009; Uslu et al., 1998).

Soya et al. (1997) reported that the narrower row spacing facilitates competition of alfalfa with weeds and that the distance range of 14 - 20 cm would be appropriate for alfalfa hay yields, however, that the distance should particularly, not exceed 30 cm in irrigated environments. Acikgoz (2001) stated that the row spacing should be 15 - 20 cm in planting with rows, but that the row spacing should be increased up to 30 - 60 cm under the arid conditions. Klapp (1957) stated that the narrow distance planting is appropriate in the areas where there is no alfalfa planting problem and that the wide distance planting will be appropriate where there is problem to allow hoe process as required.

The aim of the study is to determine the effect of the density of weeds on alfalfa herbage yield planted with different row spacings.

MATERIALS AND METHODS

This study was conducted from 2006 - 2008 in Van Province in Eastern Turkey (N 38°-41', 31.4''; E 043° 22' 01.7'' 1741 m above sea level). The experimental area site was a sandy-clay texture with pH of 7.7 – 7.9, organic carbon of 0.6 – 0.6%, nitrogen 0.09 - 0.15%, high potassium 185 - 188 kg da^{-1} and medium phosphorus 5.3 - 5.8 mg kg^{-1} in a 0 – 20 and 20 - 40 cm soil profile. The region has a temperate climate. Table 1 shows the average temperatures, rainfall and humidity for the 2006, 2007 and 2008 years as well as long-term averages for the region.

Bilensoy alfalfa cultivar was used in the experiment. The experiment was established according to the randomized block design with three replications on May 12, 2006. Row distances were 20, 30, 40, 50, 60 and 70 cm. The plots were 4 x 5 m = 20 m^2 for row distances of 20 cm (20 rows) and 40 cm (10 rows), whereas they were 4.2 x 5 m = 21 m^2 for row distance 30 cm (14 rows), 60 cm (7 rows) and 70 cm (6 rows). By hand, 20 kg ha^{-1} was seeded. As basic fertilizer, first year, 40 kg ha^{-1} for nitrogen and 80 kg ha^{-1} for P_2O_5 were used. In the second and third year, 80 kg ha^{-1} for P_2O_5 fertilization was applied. The plants were irrigated when needed.

The measurements were determined in 2007 and 2008. Three cutting were taken in both years. Weed density and species composition were measured before every cutting. 1 m^2-quadrate was put twice on each of plots. The plant height, green herbage yield, the yields of dry matter and crude protein were recorded.

Data were analyzed using the general linear model of SPSS statistical software version 11.5. The analyses were performed according to randomized blocks design (Efe et al., 2000). Treatment means within each date were compared using Duncan's multiple range tests with a 0.05 level of significance (Duzgunes et al., 1987).

RESULTS AND DISCUSSION

In the study for investigating the effects of density of weeds on alfalfa yield criteria with different row spacing distances, most intensively *Alopecurus myosuroides, Cirsium arvense* and *Convolvulus arvensis* were observed in 2007 and *Amaranthus retroflexus, Alopecurus myosuroides* and *Cirsium arvense* were observed in 2008, respectively.

In the first year of the experiment, the least weed density was found in 20 cm row spacing applications during all three before cutting period and in the second year, least weed density was found in 30 cm row spacing applications first before cutting and in 20 cm row spacing applications before the second and third cutting (Tables 2

Table 2. The densities of weeds in alfalfa field with different row spacing distances (2007).

Weeds	Density (plant m^{-2})																	
	Before firs hoeing						Before second hoeing						Before third hoeing					
	20	30	40	50	60	70	20	30	40	50	60	70	20	30	40	50	60	70
Acroptylon repens (L.)DC.	-	4.0	10.7	-	6.7	10.0	-	-	-	-	-	-	-	-	-	2.7	1.7	-
Adonis aestivalis L.	-	-	2.0	-	4.7	2.7	-	-	-	-	-	-	-	-	-	-	-	-
Alopecurus myosuroides Huds.	-	-	-	-	-	-	-	35.3	139.7	140.7	86.7	172.7	-	-	-	12.7	19.7	3.3
Amaranthus retroflexus L.	-	-	-	-	-	-	-	-	-	-	-	2.0	-	-	-	-	-	-
Cardaria draba (L.) Desv.	2.0	0.7	3.3	4.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chenepodium album L.	-	3.3	-	4.7	-	2.7	20.3	0.7	5.3	18.7	5.7	10.7	-	-	-	-	-	-
Cirsium arvense (L.) Scop.	15.3	14.7	6.7	18.3	16.7	23.3	6.0	8.3	17.7	17.3	10.0	12.7	5.7	5.0	5.7	12.3	10.3	19.7
Convolvulus arvensis L.	10.7	8.7	12.7	6.0	5.3	4.7	8.7	5.3	8.0	5.0	2.7	10.3	-	2.7	-	-	1.7	-
Cuscuta approximata Bab.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.3	-	-	-
Plantago lanceolata L.	-	-	-	-	-	-	-	-	-	-	0.3	-	-	-	-	-	-	-
Polygonum aviculare L.	-	-	-	0.7	-	-	0.3	-	-	-	-	-	-	-	-	-	-	-
Senecio vulgaris L.	2	1.3	-	2.0	1.3	-	-	-	-	-	-	-	-	-	-	-	-	-
Tragopogon spp.	1.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Xantium strumarium L.	-	-	-	-	-	-	-	-	-	-	2.3	-	-	-	1.0	-	-	1.7
Total	31.3	32.7	35.4	36.4	34.7	43.4	35.3	49.6	170.7	181.7	157.7	208.4	5.7	7.7	6.7	27.7	33.4	24.7

and 3).

Planting maize at 60 cm row distance achieved higher yields and better weeds suppression than planting at 75 or 90 cm row distance (Mashingaidze et al., 2009). Weeding was more effective in curtailing weed seed production in the narrow row spatial arrangements than in the wide row planting. The results of these studies show that narrow row spacing may reduce weeding requirements and increase yields.

In Table 4, in the first year, the highest plant height was obtained in three cuttings with average 40 cm row spacing applications and no significant difference was found among 20, 30 and 50 cm applications. The lowest plant height was obtained in 70 cm row spacing application. In the second year (Table 5), the highest plant height was obtained in 20 cm row spacing and the lowest plant height was obtained in 50, 60 and 70 cm applications. Celen et al. (2006) examined the effects of 20, 30 and 40 cm row spacing on forage yield of clover. The highest plant height was obtained from the 20 cm row distance, whereas the lowest plant height was recorded from the 40 cm row distance.

In this study, the highest green herbage yield was obtained from the 20 and 30 cm row spacings in the first year and from 20 cm row spacing applications in the second year, the lowest green herbage yield was obtained from the 60 and 70 cm row spacings in both years (Tables 4 and 5).

The highest dry matter yield was obtained from the 20, 30 and 40 cm row spacings in the first year and from 20 cm row spacing in the second year. The lowest dry matter yield was obtained from 70 cm row spacing in the first year and from 60 and 70 cm row spacings in the second year (Tables 4 and 5). Temme et al. (1979) detected that lower quality of the untreated alfalfa in comparison with the herbicide treated alfalfa was attributed to the fact that weeds constituted 50% of the dry weight of the untreated alfalfa and substituted 50% of the dry weight of the treated alfalfa forage. Sabanci and Urem (1994), in their study on clover, investigated the effect of 20 and 40 cm row spacings on the green and dry herbage yield and they determined that the highest yield was in the 20 cm row spacing. The dry matter yield of clover was the highest in 20 cm row distance (Celen et al., 2006).

In both years of the experiment, the effect of row spacing on the crude protein rate was not significant. The highest crude protein yield was obtained from the 20, 30 and 40 cm row spacings

Table 3. The densities of weeds in alfalfa with different row spacing distances (2008).

Weeds	Density (plant m^{-2})																	
	Before first hoeing						Before second hoeing						Before third hoeing					
	20	30	40	50	60	70	20	30	40	50	60	70	20	30	40	50	60	70
Acroptylon repens (L.)DC.	9.3	6.0	-	-	-	-	-	-	-	2.3	-	2.7	-	-	-	-	3.3	1.7
Alopecurus myosuroides Huds.	-	-	-	-	-	-	15.3	30.3	70.7	37.3	49.7	-	-	3.3	1.0	-	11.7	13.3
Amaranthus retroflexus L.	20.3	26.0	36.7	43.3	48.0	72.7	2.0	-	29.0	18.3	23.3	19.7	-	-	-	-	-	-
Anchusa azurea Miller.	-	-	-	-	-	-	-	-	-	0.3	-	-	-	-	-	-	-	-
Chenepodium album L.	2.3	-	12.0	2.7	10	14.0	3.0	1.7	5.0	12.3	-	3.3	-	-	-	-	-	-
Cirsium arvense (L.) Scop.	9.7	3.3	11.0	19.3	7.3	16.7	1.7	6.7	5.0	7.0	3.3	4.3	5.7	6.0	7.0	12.7	9.7	13.3
Convolvulus arvensis L.	0.7	5.3	1.7	-	1.7	2.0	10.3	4.0	6.7	14.0	9.0	13.3	-	3.0	-	-	0.7	0.3
Cuscuta approximata Bab.	-	-	-	-	-	-	1.0	-	-	-	6.0	55.0	-	-	-	1.0	-	-
Plantago lanceolata L.	-	-	-	-	-	-	1.0	-	0.3	4.0	4.7	0.7	-	-	-	-	-	-
Polygonum aviculare L.	0.3	-	0.7	0.7	-	-	0.7	6.7	2.7	4.0	2.0	2.3	-	-	-	-	-	-
Rumex crispus L.	-	-	-	-	-	-	0.3	-	-	-	0.3	-	-	-	-	-	-	-
Sinapis arvensis L.	-	-	1	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Xantium strumarium L.	-	0.7	2.7	-	3.7	1.7	-	-	-	-	0.3	-	-	-	2.3	1.7	-	-
Total	42.6	41.3	65.5	66.3	70.7	107.1	34.3	49.4	119.4	99.5	98.6	101.3	5.7	12.3	10.3	15.4	25.4	28.6

in the first year and from 20 cm row spacing in the second year. The lowest crude protein yield was obtained from the 60 and 70 cm in the first year and from the 50, 60 and 70 cm row spacings in the second year (Tables 4 and 5).

In both years of the study, the decrease in crude protein yield was observed in parallel to the increase in the density of weeds (Tables 4 and 5). Mueller and Fick (1987) determined the highest crude protein value in alfalfa when they were combating with weeds. During the seedling stage, weeds exert their greatest impact. If competition from weeds is high enough, it can cause failure of crop establishment. In established stands of alfalfa, weeds reduce the quality of forage. A California study showed that in fields with high weed infestation, forage protein content was as low as 9%. However, when the weeds were controlled, alfalfa protein content increased to over 20%. Once a healthy alfalfa stand is established, problems associated with weeds lessen because the alfalfa becomes much more competitive (http://aces.nmsu.edu-2009).

In both years of the study, it has been identified that the weed densities were lower in the 20 and 30 cm row spacing applications and that the densities were increased as the row spacing distance was increased (Tables 2 and 3). Accordingly, it was determined that there was a reduction in alfalfa yield criteria.

Conclusions

In alfalfa yield, the row spacing is an important factor affecting the weeds intensity. In semi-arid climate and the irrigated alfalfa planting, the wider row spacing caused increase in the weed density and significant reductions in yield. The least weed density was encountered from the 20 cm row spacing in the first year and from the 20 and 30 cm row spacings in the second year. An increase in weed density was observed as the row spacing increased. These weeds had caused the strong competition with alfalfa for the water and nutrients in the soil and sunlight, and this led to significant reductions in yield in the wide row spacing. In this study, after the first year of plant vegetation, the highest yields were obtained in 20, 30 and 40 cm row spacings, respectively, in terms of plant length, dry matter yield and crude protein yield, and no statistically significant difference was found among them. However, the highest yield was obtained from the 20 cm row spacing in the second year. Although, the harvested alfalfa was a cultivated plant, the increases were observed in weed density every year due to the fact that there

Table 4. The yield and some characteristics of Alfalfa (*Medicag sativa* L.) for year 2007.

Parameters		Plant height (cm)		Green herb yield (t ha^{-1})		Dry matter yield (t ha^{-1})		Crude protein rate (%)		Crude protein Yield (t ha^{-1})	
Row distance	**Harvest time**	**Value**	**Mean**	**Value**	**Mean**	**Value**	**Mean**	**Value**	**Mean**	**Value**	**Mean**
20	1	85.1	74.8ab	40.0	30.2a	8.2	6.9a	14.7	15.4	1.2	1.1a
	2	73.7		26.1		5.9		15.8		0.9	
	3	65.6		24.5		6.5		15.6		1.0	
30	1	91.1	75.5ab	37.0	28.3a	7.7	6.5a	15.1	15.4	1.2	1.0a
	2	71.6		26.4		5.0		16.0		0.8	
	3	63.9		21.5		6.8		15.2		1.0	
40	1	94.8	78.7a	30.0	22.7b	7.0	6.0a	15.6	15.7	1.1	0.9a
	2	75.4		21.8		4.6		15.7		0.7	
	3	65.8		16.2		6.5		15.8		1.0	
50	1	87.8	75.2ab	29.5	21.9b	5.6	5.0b	15.0	15.3	0.8	0.8b
	2	69.1		22.3		3.6		15.7		0.6	
	3	686		13.8		5.9		15.1		0.9	
60	1	85.4	69.3bc	21.9	14.9c	5.2	4.3b	15.4	15.7	0.8	0.7bc
	2	62.6		13.5		3.7		16.7		0.6	
	3	59.9		9.3		3.9		15.0		0.6	
70	1	82.0	68.1c	18.0	13.6c	5.1	3.4c	14.7	15.0	0.7	0.5c
	2	63.0		14.0		2.8		14.8		0.5	
	3	59.3		8.7		2.4		15.6		0.4	

The level of significance 5 %.

Table 5. The yield and some characteristics of Alfalfa (*Medicag sativa* L.) for year 2008.

Parameters		Plant height (cm)		Green herb Yield (tha^{-1})		Dry matter yield(t ha^{-1})		Crude protein rate (%)		Crude protein yield (t ha^{-1})	
Row distance	**Harvest time**	**Value**	**Mean**	**Value**	**Mean**	**Value**	**Mean**	**Value**	**Mean**	**Value**	**Mean**
20	1	95.0	83.6a	40.0	32.2a	7.7	6.5a	16.3	16.0	1.3	1.1a
	2	77.0		27.0		6.0		15.7		1.0	
	3	78.8		29.6		5.9		16.2		1.0	
30	1	89.1	78.2b	36.8	27.8b	7.0	5.7b	15.6	15.5	1.1	0.9b
	2	75.4		24.0		5.0		15.2		0.8	
	3	70.1		22.5		5.3		15.7		0.8	
40	1	82.6	75.6b	31.1	21.9c	6.7	5.0c	15.5	15.6	1.1	0.8b
	2	74.5		20.0		3.7		15.6		0.6	
	3	69.7		14.5		4.5		15.6		0.7	
50	1	80.2	68.0c	28.6	20.2cd	5.1	3.6d	15.0	15.6	0.8	0.6c
	2	65.5		17.9		2.8		16.2		0.5	
	3	58.4		14.1		3.0		15.6		0.5	
60	1	75.1	67.0c	25.9	17.6de	4.3	3.3de	15.3	15.5	0.7	0.5c
	2	64.0		13.6		2.6		15.2		0.4	
	3	61.9		13.2		2.9		15.8		0.5	
70	1	77.7	65.6c	19.8	15.0e	4.5	3.0e	15.5	15.6	0.7	0.5c
	2	62.0		12.1		2.3		15.5		0.4	
	3	57.1		13.2		2.2		15.7		0.4	

The level of significance 5 %.

was no combat regarding weeds in the study. On the other hand, the highest yield was obtained from the narrowest row spacing in the second year. As a result of this study, it has been concluded that the row spacing is required to be kept between 20 and 40 cm in the alfalfa planted within the similar ecological conditions.

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