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EFFECT OF WEED CONTROL METHODS ON HAY YIELD, BOTANICAL COMPOSITION AND FORAGE QUALITY OF A MOUNTAIN PASTURE

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ABSTRACT

This research was conducted to determine the effect of control methods on the weed composition of a pasture located at high altitude zone of the Cukurova Region, Turkey. The experiment was designed as randomized complete block with three replicates for three years. The mowing, fertilization, applications of 2.4-D, Picloram+2.4-D, Paraquat and Glyphosate were studied as weed control methods. The highest dry matter yield was obtained from the Picloram+2.4-D treatments. Dry matter yields in all treatments were greater as compared to the control. Grass contribution to the hay yield in the Picloram+2.4-D application was statistically significant (P<0.01) higher than the other treatments. Paraquat and glyphosate decreased the crude protein yield, while glyphosate increased higher crude protein and relative feed value contents compared with the other treatments.

Key words: botanical composition, pasture, weed control, yield and quality

INTRODUCTION

Rangelands are the most important feed sources of animal husbandry in Turkey. Arable land area had sharply increased between 1950 and 1960 in the county, this situation negatively affected the rangelands due to decline in the rangeland areas. The increased number of livestocks along with the decreased rangeland area led to overgrazing and deterioration of rangeland botanical composition. Mismanagement of rangelands caused 90% loss of the original vegetation on rangelands in Turkey (Genckan et al., 1990). Decline in pastures due to the heavy grazing and mismanagements has to be controlled by proper rehabilitation and management techniques in order to meet the needs of increased population in Turkey.

The consequence of mismanagement of pastures in Turkey invaded weeds. Weeds reduce feed quality, animal production, and in some cases lead to the poisoning. Thus weed populations in rangelands should be controlled and reduced. Several weed control methods are widely practiced on pasture such as mowing (Vallentine, 1980; Tanner et al., 1988; Mc Daniel and Taylor 2003), chemical applications (Passera et al., 1992; Gokkus and Koc, 1996) and fertilization (Jacobs and Sheley, 1999; Altin, 1992; Altin et al., 2005; Vallentine, 1980). However, very few research studies have been done to improve such lands in our region. Researches for weed control with herbicides, mowing and fertilization were very limited in Turkey. Therefore, this study was conducted to determine the effects of different weed control treatments on a mountain pasture.

MATERIAL AND METHODS

Experimental Area

A field experiment was conducted for 3 consecutive years during 2007-2010 on a natural pasture at Karakilic village of Karaisalı town in Adana province of Turkey. The altitude of experimental area was 1530 m (37°19 N, 34°56 E) and topography was flat. Soil texture was silty clay with slightly alkaline. The experiment was established in a clay soil with pH 6.87, organic matter content 4.7%, available P content 7.6 ppm and Zn 0.7 ppm (Anonymous, 2007).

The climate is Mediterranean climate with hot and dry summer and heavy precipitation during winter. The coolest month is January with a monthly mean temperature of 8.9 ºC and the hottest month is August with 27.6 ºC. The lowest total precipitation during experiment was in 2008 (393.0 mm) and highest was in 2009 (954.0 mm). The long term average annual precipitation of the study area is 871.1 mm. The mean values of temperature and relative humidity during the experimental period were close to the long-term averages (Anonymous, 2012).

Forage Yield, botanical composition and quality

The experiment design was completely randomized block with three replications. Seven treatment plots were inserted to each block. Treatments included control, mowing, fertilization, 2.4-D, Picloram+2.4-D, Paraquat and Glyphosate. Phosphorus (50 kg ha^{-1}) and nitrogen (100 kg ha^{-1}) were applied to all plots except control plots (Altin et al., 2005).

Mowing was applied at budding or blooming stage of weeds (Altin et al., 2005). Herbicides, 2.4-D amine (3200 ml ha^{-1}), Picloram +2.4-D amine (1000 ml ha^{-1}), Paraquat (5000 ml ha^{-1}) and Glyphosate (15000 ml ha^{-1}) were applied at the 3-5 leafs stage of the weeds (Vallentine, 1980). The 2.4-D and Picloram +2.4-D were applied to all experimental plots whereas Paraquat and Glyphosate were only to the target plants (Darrell and Leon, 2005). Herbicides were applied in the first and second years of the experiment as one application per year.

The plot sizes were 20 m^2 (4 x 5 m) and 1.5 m space were given between the plots. Four permanent quadrates (70 cm x70 cm=0.5 m^2 in size) were randomly placed in each plot, and the data were obtained from these quadrates. The samples were hand-separated, dried at 70 ^oC for 48 h and weighed. Samples were analyzed for crude protein contents (CP), neutral detergent fiber (NDF) and acid detergent fiber (ADF) (Van Soest et al., 1985). The ADF values were used to predict the digestible dry matter with the following formula;

Digestible Dry Matter (DDM) = ((88.9-0.779) x % ADF))

Neutral detergent fiber (NDF) was used to predict dry matter intake with the formula described below.

Dry Matter Intake (DMI) = (120 / % NDF).

Relative feed value (RFV) is calculated by multiplying digestible dry matter by dry matter intake and then dividing by 1.29 (Schroeder, 1994).

Statistical analyses

Data were analyzed using MSTATC (V.1.2, Michigan State University, USA). The differences between means were separated by Duncan multiple range test ($P \leq 0.05$), however means of years were compared with the least significant difference (LSD) test ($P \leq 0.05$)

RESULTS AND DISCUSSION

Dry matter yield

The variation in the total precipitation during the experiment resulted significant differences in dry matter yields among the years. Since the total precipitation (954 mm) in the third year was significantly higher than the other two years (558 and 393 mm), the average dry matter yield in the third year was significantly higher compared to the first two years. The average dry matter yield in the second year was significantly lower than that in the first and third years (Table 1).

The weed control methods had significant effects on the dry matter yield. Mowing, 2,4-D and fertilization applications in the first year yield significantly higher dry matter compared with the other treatments. Application of herbicides Picloram+2,4-D along with Paraquat did not significantly change the dry matter yield. The Glyphosate application gave significantly lower dry matter yield compared with the control plots (Table 1).

Table 1. Dry matter yields (kg ha^{-1}) obtained from different treatments

Treatment	Dry matter yield (kg ha^{-1})			
	1st year	2st year	3st year	Means
Control	1014.0 c*	669.0 bc	1627.0 cd	1103.3 c
Mowing	1521.0 ab	1407.0 ab	2485.0 bc	1804.3 ab
Fertilization	1811.0 a	1600.0 a	2333.0 c	1914.7 a
2.4-D	1830.0 a	914.0 abc	3195.0 ab	1979.7 a
Picloram+2.4-D	1213.0 bc	1612.0 a	3382.0 a	2069.0 a
Paraquat	812.0 cd	511.0 c	1945.0 c	1089.3 c
Glyphosate	490.0 d	158.0 c	1023.0 d	557.0 c
Mean	1241.6 B+	981.6 C	2284.3 A	

*,+Values within rows and columns with different letters differ significantly ($P \leq 0.05$)

Increase in dry matter yield by the fertilization was also reported by different researchers (Gokkus, 1990; Buyukburc, 1991; Koc et al., 1994; Hatipoglu et al., 2001; Cinar et al., 2005; Hatipoglu et al., 2005). Application of herbicides such as Picloram+2.4-D, Paraquat and Glyphosate affected not only weeds but also valuable pasture plants. Therefore, dry matter yields of with herbicide application exception of 2.4-D were lower compared to the plots with only fertilization or 2.4-D applications. Due to high effectiveness of Picloram+2.4-D on the plants comparing the 2.4-D (Hickman et al., 1990), the plots with 2,4-D gave higher dry matter yield than the plots with Picloram+2,4-D. In the second year of the experiment, the treatments of Picloram+2.4-D, fertilization, mowing and 2,4-D significantly increased the dry matter yield of the pasture. Other treatments did not change the dry matter yield of the pasture compared with the control. In the third year, application of 2.4-D and Picloram+2.4-D significantly increased the dry matter yield.

The treatments significantly increased the dry matter yield of the pasture except Paraquat and Glyphosate. Similar results were also reported by Bovey et al., (1972), Nichols and Mc Murphy, (1969) Gokkus and Koc, (1996) and Roger et al., (2000).

Botanical composition

Contributions of plants with the exception of legumes to the dry matter yield of the pasture significantly changed depending on the years (Table 2).

The average rate of the grasses was significantly higher in the third year compared to the other two years while the other family plants were significantly lower in the third year. The highest grass rates were determined with the Picloram+2.4-D treatments. According the mean values, the highest grass rates were obtained from the Picloram+2.4-D application during the experiment (88.3%, 100.0%, 99.0%, respectively).

Table 2. Ratios of legumes, grasses, and others family plants botanical composition with different treatments (%)

Treatment	Grasses				Legumes				Others Family Plants			
	1st year	2 styear	3 styear	Means	1st year	2 styear	3 styear	Means	1st year	2 styear	3 styear	Means
Control	30.0 bc*	26.7 de	56.3 d	37.7 de	7.7	12.0	11.0	10.2	62.3 bc	61.3 bc	32.7 c	52.1 bc
Mowing	54.7 b	58.0 bc	78.0 bc	63.6 bc	4.3	3.0	1.3	2.9	41.0 c	39.0 cd	20.7 cd	33.6 cd
Fertilization	34.3 bc	33.3 cd	63.7 cd	43.8 cd	5.3	4.3	5.0	4.9	60.4 bc	62.4 bc	31.3 c	51.4 bc
2,4-D	49.7 bc	79.7 ab	89.7 ab	73.0 b	1.3	0.0	0.3	0.5	49.0 bc	20.3 de	10.0 cd	26.4 de
Picloram+2,4-D	88.3 a	100.0 a	99.0 a	95.8 a	0.0	0.0	0.0	0.0	11.7 d	0.0 e	1.0 d	4.2 e
Paraquat	26.3 cd	13.7 de	24.3 e	21.4 ef	3.3	10.3	5.0	6.2	70.4 b	76.0 ab	70.7 b	72.4 b
Glyphosate	0.7 d	3.0 e	3.3 f	2.3 f	2.3	10.0	2.0	1.4	97.0 a	87.0 a	94.7 a	96.2 a
Mean	40.6 B+	44.9 B	59.2 A		3.5	5.7	3.5		55.9 A	49.4 A	37.3 B	

*,+Values within rows and columns with different letters differ significantly (P≤0.05)

The rates of grasses were steadily increased. The average rates of other family plants were steadily decreased on the years. Grasses rates in the botanical composition increased with the decrease in the others family plants (Table 2).

Picloram +2.4-D and 2.4-D applications resulted in increase of grasses rates with the decreased rate of others family plants (Bovey et al., 1972; Gokkus and Koc, 1996; Masters et al., 2002; Ferrell et al., 2004; Grekul et al., 2005).

Crude protein, Crude protein yield

The crude protein ratio of pastures significantly changed depending on the years (Table 3). The averaged crude protein ratio in second year was significantly higher than those in the first and third years.

Table 3. Crude protein ratio (%) and crude protein yield (kg ha^{-1}) obtained from different treatments

Treatment	Crude Protein Ratio (%)				Crude Protein Yield (kg ha^{-1})			
	1st year	2 styear	3 styear	Means	1st year	2 styear	3 styear	Means
Control	10.3 d*	13.2 e	10.1 d	11.2 d	104.4 bc*	88.3 b	164.3 d	119.0 bc
Mowing	12.7 c	16.2 c	11.4 c	13.4 c	193.2 a	227.9 a	283.3 bc	234.8 a
Fertilization	13.0 c	15.4 cd	11.6 c	13.3 c	235.4 a	246.4 a	270.6 bc	250.8 a
2.4-D	13.0 c	14.2 de	11.2 c	12.8 c	237.9 a	139.8 ab	357.8 ab	241.8 a
Pic+2.4-D	13.7 bc	14.3 de	13.1 b	13.7 bc	166.2 ab	230.5 a	443.0 a	279.9 a
Paraquat	15.0 ab	19.3 b	12.7 b	15.7 b	121.8 bc	98.6 b	247.0 cd	155.8 b
Glyphosate	16.7 a	21.2 a	14.5 a	17.5 a	81.8 c	33.5 b	148.3 d	87.9 c
Mean	13.5 B+	16.3 A	12.1 B		167.5 B+	160.1 B	276.4 A	

*,+Values within rows and columns with different letters differ significantly (P≤0.05)

The crude protein contents of the pastures were significantly affected by various weed control treatments tested. However the effects of treatments on crude protein ratio significantly changed depending on the years. Glyphosate and Paraquat application of the first year caused significantly higher crude protein ratio than all other treatments. The treatments of Glyphosate in all years significantly increased the crude protein rate of the pasture compared all the applications. The variation in the crude protein ratio by year was due to the variation in the botanical composition of the legume (Table 2). Broad-leaved species have higher crude protein content compared to the others family plants (Vallentine, 1980).

The averaged values of three years indicated that the crude protein ratio was significantly increased with all of the treatments compared to control. Since fertilization is reported the main reason for an increase in crude protein ratio (Gokkus and Koc, 1995, Cinar et al., 2005, Hatipoglu et al., 2005, Mut et al., 2010), the results obtained in the current study can also be attributed to the fertilization.

The crude protein (CP) yield of the pasture significantly changed depending on the years. The averaged crude protein yield in third year was significantly higher than those in the first and second years. The variation in the crude protein yield of the pasture depending on the years was due to the variation in dry matter yield (Table 1) and crude protein ratio.

Nutrient values of hay relatively depend on the botanical composition and harvesting time. The results indicated that CP contents of hay in pastures were lower than 16-18% which requires supplementary feeding to obtain high performance from milk cows (Conrad and Martz, 1985).

Crude protein yield ranged from 81.8 to 237.9 kg ha^{-1} in the first year, from 33.5 to 246.4 kg ha^{-1} in the second year and from 148.3 to 443.0 kg ha^{-1} in the third year. The highest average crude protein yield was obtained from the Picloram+2.4-D, fertilization, 2.4-D and mowing respectively. Crude protein yield depends on dry matter yield and crude protein ratio. Therefore, applications that have a high dry matter yield and crude protein content have higher crude protein yield. Similar results were also found by Ozaslan (1996), Gokkus and Koc (1995), Roger et al., (2000).

ADF, NDF and RFV

The analysis of variance suggested that applications of herbicides had no significant impact on ADF contents, however there were significant differences on ADF contents among means of treatments (Table 4). ADF ranged from 32.0 to 34.2% in the first year, from 31.6 to 33.8% in the second year, from 31.8 to 35.0% in the third year. The highest mean ADF ration was obtained from the control treatment with 33.9%. According to the averaged values of three years, the ADF contents were decreased in all treatments compared with control. Because fertilizer is given to all applications except the control. Fertilization decreases the rate of the ADF (Cinar et al., 2005, Hatipoglu et al., 2005, Mut et al., 2010).

Table 4. % ADF, % NDF and RFV obtained different treatments

	ADF (%)				NDF (%)				RFV			
Treatment	**1st year**	**2 st year**	**3 st year**	**Means**	**1st year**	**2 st year**	**3 st year**	**Means**	**1st year**	**2 st year**	**3 st year**	**Means**
Control	34.2	33.8	33.7	33.9 a	48.4	50.2	52.1	50.2 bc	119.7 c	115.9 c	111.9 b	115.8 c
Mowing	33.3	33.4	33.7	33.5 b	51.0	52.2	54.6	52.6 b	114.8 c	112.1 c	106.7 c	111.2 c
Fertilization	33.4	32.8	33.8	33.3 b	48.0	51.6	52.4	50.7 bc	121.9 bc	114.2 c	111.1 b	115.7 c
2.4-D	33.2	33.0	33.4	33.2 b	51.2	52.7	55.4	53.1 b	114.5 c	111.5 c	105.6 c	110.5 c
Pic+2.4-D	33.0	31.6	31.8	32.1 b	57.0	58.4	62.0	59.1 a	103.1 d	102.4 d	96.2 d	100.6 d
Paraquat	32.1	33.0	35.0	33.4 b	43.4	42.3	54.3	46.7 c	137.0 b	139.0 b	105.6 c	127.0 b
Glyphosate	32.0	33.8	33.7	33.2 b	40.8	39.4	39.4	39.9 d	145.9 a	147.7 a	147.9 a	147.2 a
Mean	33.0	33.1	33.6		48.5 B+	49.5 B	52.9 A		122.4 A+	120.4 A	112.1 B	

*,+Values within rows and columns with different letters differ significantly ($P \leq 0.05$)

Linn and Martin (1999), reported that legumes have higher CP contents and lower ADF and NDF contents compared with grasses therefore digestibility is closely related to cellulose and lignin content of ADF. Caddel and Allen (2012), stated that the most important factor of hay quality is the development stage of hay at harvest. ADF contents varied with species and families in mixtures and the development time and additionally the ratio of ADF affects the digestibility.

The applications of herbicides didn't statistically affect the NDF contents, but the effects of years were found statistically different on NDF contents ($P<0.05$). Average NDF contents of harvested hay samples for each year for different applications were briefly illustrated in Table 3. The average NDF contents in the third year was significantly higher than the first two years. The variation in the NDF contents of the pasture depending on the years might be due to the variation in ratio of the grasses The ratio of grasses (59.2%) in the third year was significantly higher than those (40.6% and 44.9%) in the other two years. Grasses have higher NDF content than other plant families (Pearson and Ison, 1987).

NDF ranged from 40.8 to 57.0% in the first year, from 39.4 to 58.4% in the second year, from 39.4 to 62.0 % in the third year and from 39.9 to 59.1 % in the three year means. The highest NDF ratio was obtained from the Picloram+2.4-D with 59.1, the lowest NDF ration was obtained from the Glyphosate with 39.9 %. Picloram+2.4-D applications increased the rate of the NDF. NDF ratio in grasses is higher than legumes and other plant families (Pearson and Ison, 1987). Glyphosate applications decreased the rate of NDF. NDF values is lower in broad leaved species is lower than grasses NDF (Pearson and Ison, 1987).

The analyses of variance indicated that treatments generated statistically significant RFV values in the first and second year and as well as for average of all three years. Besides, RFV exhibited statistically significant result depending on the years (Table 3). RFV ranged from 103.1 to 145.9 in the first year, from 102.4 to 147.7 in the second year, from 96.2 to 147.9 in the third year and from 100.6 to 147.2 in the three year means. The results of three years mean values showed that the highest RFV (147.2) was obtained from the Glyphosate treatment while the lowest RFV (100.6) was obtained from the Picloram+2.4-D with.

RFV is an important quality character and measures the overall feed value of forages. RFV is used to compare quality of forage based on the maturity of the plant when harvested. The higher the RFV in all forages is the more digestible and palatable (Schroeder, 1994; Mut et al., 2010). The RFV values in third y compared to the first and second year were lower.

The RFV is an index that is used to predict the intake and energy value of the forages and it is derived from the digestible dry matter (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. Experiment, the RFV value was higher Glyphosate treatment than in the other treatments. The lowest RFV was obtained from the Picloram+2.4-D. Since RFV value was calculated from ADF and NDF, the observed differences were reflective of previously described ADF and NDF differences (Mut et al., 2010).

RFV of Glyphosate and Paraquat treatments are premium. RFV of Picloram+2.4-D treatment is poor. RFV of other treatments are fair.

CONCLUSION

The result demonstrated that applications of Picloram+2.4-D, 2.4-D, fertilization and mowing increased the dry matter yields of the pasture according to averages of three years. Picloram+2.4-D applications increased the grasses and decreased the legumes. Glyphosate applications increased the crude protein ratio. Applications increased the crude protein yield with the exception Paraquat and glyphosate and control. Applications of Glyphosate decreased the NDF content and increased the RFV.

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