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A RESEARCH ON DETERMINATION OF HAY YIELDS AND SILAGE QUALITIES OF SOME VETCH+CEREAL MIXTURES

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ABSTRACT

The hay yields and silage qualities of the mixtures of common vetch and hungarian vetch with rye, barley, wheat, oat and triticale were investigated under Isparta conditions, during the 2006-2007 and 2007-2008 growing seasons. The highest hay yield (9.08 tons ha^{-1}) and crude protein yield (1.11 tons ha^{-1}) were obtained from hungarian vetch+rye mixture. The least NDF and ADF contents (50.11% and 31.92%, respectively) were achieved in common vetch+oat mixtures. Silages from the mixtures of common vetch, barley and oat, and hungarian vetch, barley, oat and wheat were rated very good, and all other vetch and cereal silages were rated good according to fleig scores. All silage combinations, with the exception of common vetch and rye silage, were rated very good based on physical analysis.

Keywords: vetch; cereals; mixture; forage yield; silage

INTRODUCTION

Animal enterprises must be engaged different production systems in order to improve yield and quality. In this way, they can be providing the highest level of earnings is possible. Winter season cereals include barley, wheat, rye, oat and triticale are used in the animal's daily ration as hay or silage (Chapko et al. 1991, Mustafa et al. 2000). In forage-animal production system, legumes are preferred owing to several advantages over monocultures (Tuna and Orak, 2007). In general, legumes are rich in protein while grasses are rich in carbohydrates. Cereals constitute forages relatively low in protein (Anil et al. 1998; Lauriault and Kirksey, 2004), and animals usually require some form of relatively costly protein concentrate supplementation. The production of high-protein and more nutritious hay of mixtures (Papastylianou, 1990, Anil et al. 1998; Lithourgidis et al. 2006).

The objective of the present research study was to determine hay yield and silage quailty of different winter cereals and some vetch mixtures.

MATERIAL and METHODS

Experimental area

The research was performed at Isparta (37º 45' N, 30º 33' E, elevation 1035 m) located on the Mediterranean region of Turkey during 2006 - 2007 and 2007 - 2008 growing season. Total precipitation and average temperature are presented in Table 1. The major soil characteristics, based on the method described by Kacar and İnal (2008) were found to be as follows; the soil texture was clay; organic matter was 1.1% by Walkley-Black method; total salt was 0.3%; lime was 7% by Schiebler calcimeter, extractable P by 0.5N $NaHCO_3$ extraction was 3.3 mg kg^{-1}; exchangeable K by 1N NH_4OAc was 117 mg kg^{-1}; pH was 7.7 in soil saturation extract. Soil type was calcareous fulvisol (Akgül and Başayiğit, 2005).

Table 1. Climatic values of study area.

Months	Precipitation (mm)			Temperature °C		
	1975-2008	2006-2007	2007-2008	1975-2008	2006-2007	2007-2008
October	40.4	141	25.0	13.1	13.4	14.4
November	44.4	80.0	91.4	7.9	6.1	7.4
December	100.0	0.00	69.6	3.6	2.2	2.7
January	90.0	43.4	3.2	1.7	1.1	1.2
February	76.3	41.9	7.4	2.8	3.1	0.9
March	61.9	33.8	51.4	5.8	7.1	8.4
April	51.0	14.8	49.2	10.7	9.5	11.5
May	59.7	13.4	24.6	15.4	17.5	14.4
Total	523.7	368.3	321.8	-	-	-
Mean	-	-	-	7.63	7.50	7.61

Experimental design and planting

The experiments were established in a randomized complete block design with three eplications. Sowing was done by hand on 17 and 23 October in 2006 and 2007, respectively. Prior to planting, 80 kg of phosphorus (triple superphosphate 44%) and 60 kg of nitrogen (21% ammonium sulfate) fertilizer in per hectare were applied in land. During the period of get up off the grasses, 60 kg of nitrogen (21% ammonium sulfate) fertilizer was applied to land. The folloving plants were subject to research; common vetch (CV) (Albayrak), hungarian vetch (HV) (Tarm beyazi), rye (Aslım-98), wheat (Gün-91), barley (Kral-1997), oats

(Population) and triticale (Tatlıcak-97). A mixture of 1:1 ratio utilized and 200 kg of seeds applied in per hectare, while 120 kg and 100 kg of in hungarian vetch and common vetch of seeds were calculated, respectively. The row spacing was 20 cm and seeds were sown in the same rows. The plot area was 2 x 5 = 10 m^2 and 10 rows were established each plot.

Green and Hay yields values

When the plants had full flowering stage (in May), the plots were harvested for forage yield. Subsamples were dried at 70 °C for 48 h to determine dry matter yield (Bozkurt and Kaya, 2010). Crude protein content was calculated by multiplying Kjeldahl nitrogen concentration by Kacar and inal (2008). 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 and NDF analysis in this study (Anon, 2009).

Silage Values

After the harvest of green plants, mixtures of vetch and cereal were taken with 1:1 ratio and put in 3 lt glass jars with the pieces of 1-3 cm in size with the addition of 1% salt were closed and compressed. At the end of the fermentation period of two months silages obtained from the jar, Kilic's (1986) classification method were utilized for some physical classification such as; smell, color and some structural analysis. As a result of physical analysis; for silage with a score of 16-20 points, "very good", 10-15 points "good'', 5-9 points," medium "and 0-4 score in the" useless ". The silage dry matter and pH values were determined in laboratory conditions (Akyildiz, 1984) and these values were put into the Kilic's (1986) specified formula and feed fleig points calculated as follows;

Flieg Score = 220 + (2 x% Dry Matter - 15) - 40 x pH

In silage samples, according to fleig score as the physical analysis, qualitative categories have been determined. As specified formula, for silage with a score 81-100 points "very good", 61-80 points "good", 41-60 points "satisfactory", 21-40 points "medium" and 00-20 points "bad" quality were classified into (Kilic, 1986). In silage samples, as mentioned in above for dried samples, cude protein, NDF and ADF ratios were determined (Kacar and Inal, 2008; Anon. 2009).

Statistical analysis

The test results of hay and silage quality of vetch-cereal mixtures were examined by using "randomized complate block experimental design" to analysis of variance at 1% and 5% significance level. However, for determining different groups, the level of significance 5% of LSD test was used. All calculations were conducted by computer SAS (1998) statistic program.

RESULTS AND DISCUSSION

Green forage yield

Green forage yield was found to be statistically significant differences at 5% level, first year yield was around 16.33-25.17 tons ha^{-1} and second year yield was around 18.00- 27.16 tons ha^{-1} (Table 2).

The average green forage total yield of two years was found to be hungarian vetch+rye (26.17 tons ha^{-1}), common vetch+rye (25.18 tons ha^{-1}) and hungarian vetch+triticale mixtures (23.58 tons ha^{-1}), respectively (Table 2). Due to this research conducted in ecological semi-arid climate, it is well known that rye and triticale mixtutres with vetch species have better adapted to this climate region and result found in this constituent with literature findings (Caballero and Goicoechea, 1986, Thompson et al. 1992; Lithourgidis et al. 2006; Yolcu et al. 2009). It can be clearly seen that the cereals in mixture were determining factor for herbage yield. In addition, it is well known that rye and triticale mixtures are well adapted in winter, so these gave highest herbage yield whereas the lowest herbage yield was found to be oats mixtures that are typically sensitive to low-temperature environment.

Hay yield

The similar results were found for hay yield as observed in green forage yield in above, for the vetch+cereal mixtures. The hay yield was found to be statistically significantly different at 5% level (Table 2). In the second year of study, the average hay yield was found to be 6.96 tons ha^{-1} whereas the average hay yield of 6.47 tons for per hectare was obtained in the first year, This can be explained that March, April and May of 2008 had higher rain during get off at the circuit compare to in the same period of 2007. Hay yield of the two year average, the highest yield were found for HV+rye (9.08 tons ha^{-1}), CV+rye (8.14 tons ha^{-1}) and HV+triticale (8.09 tons ha^{-1}), respectively. However, the lowest yield were found to the mixtures of CV+oat (4.81 tons ha^{-1}) and CV+oat (5.17 tons ha^{-1}), respectively. Celik and Bulur (1996) proposed that rye should be preferred rather than barley and oats in cold and poor soil regions, In fact, it was reported that the mixtures of vetch and peas with barley and oats gave higher hay yield than the mixtures of rye, wheat and triticale (Lauriault and Kirksey, 2004), The result found in this study consistent with these findings.

Crude protein content of hay and silage

It was found that crude protein content in both hay and silage and the average of both years were found to statistically different at 5% level (Tables 2 and 3). In hay, two year's average, especially for oat, vetch and hungarian vetch and their mixtures were found to be highest in terms of crude protein content (16.22% and 15.25%), respectively. However, the highest crude protein content was determined with common vetch+barley mixture of 15.31% which was statistically the highest crude protein ratio in the group took place. For silage, the highest crude protein content were found to be mixtures of CV+oat (16.11%), HV+oat (15.37%), CV+barley (15.06%) and HV+barley (14.72%), respectively. The crude protein content values in the silage mixtures were similar to crude protein content of hay. Lithourgidis et al. (2006) reported that crude protein content of common vetch+oat mixtures were higher than the crude protein content of common vetch+triticale mixtures. This is another reason for high rate of vetch hay in a mixture of oats

Table 2. Yield and quality variables of different vetch+cereal mixtures.

Mixtures	Green forage yield (tons ha^{-1})			Hay yield (tons ha^{-1})		
	2007	2008	Mean	2007	2008	Mean
1-CV+rye	25.03 a	25.33 ab	25.18 a	7.92 a	8.35 ab	8.14 b
2-CV+barley	20.50 bc	21.67 bd	21.08 bc	6.01 bc	6.56 ce	6.29 cd
3-CV+wheat	19.33 dc	19.66 cd	19.50 cd	5.59 cd	5.79 df	5.69 de
4-CV+oat	16.33 d	18.00 d	17.17 d	4.58 d	5.03 f	4.81 e
5-CV+triticale	20.83 bc	21.63 bd	21.23 bc	6.68 b	7.14 bd	6.91 c
6-HV+rye	25.17 a	27.16 a	26.17 a	8.56 a	9.60 a	9.08 a
7-HV+barley	20.33 bc	22.67 ad	21.50 bc	6.17 bc	7.09 bdc	6.63 c
8-HV+wheat	20.17 bc	21.67 bd	20.92 bc	6.06 bc	6.64 ce	6.35 cd
9-HV+oat	17.18 dc	18.33 cd	17.75 d	4.98 cd	5.37 de	5.17 e
10-HV+triticale	23.83 ab	23.33 ac	23.58 ab	8.18 a	8.00 bc	8.09 b
Mean	20.87	21.95	21.41	6.47 B	6.96 A	6.72
VK (%)	9.79	12.26	11.16	9.99	11.43	10.79
Mixtures	Crude protein ratio (%)			Crude protein yield (tons ha^{-1})		
	2007	2008	Mean	2007	2008	Mean
1-CV+rye	13.07 cd	11.78 de	12.43 de	1.05 ab	0.98 ab	1.01 ab
2-CV+barley	15.87 ab	14.74 ab	15.31 ab	0.95 ac	0.96 ab	0.96 ac
3-CV+wheat	14.80 ad	13.71 ad	14.26 bc	0.83 ac	0.79 b	0.81 cd
4-CV+oat	16.69 a	15.76 a	16.22 a	0.76 c	0.79 b	0.77 d
5-CV+triticale	13.31 cd	10.85 e	12.08 de	0.89 ac	0.77 b	0.83 cd
6-HV+rye	12.53 cd	12.13 ce	12.33 de	1.07 a	1.16 a	1.11 a
7-HV+barley	15.05 ac	13.47 ad	14.26 bc	0.92 ac	0.95 ab	0.94 bd
8-HV+wheat	13.78 bd	12.75 be	13.27 cd	0.83 ac	0.84 b	0.84 cd
9-HV+oat	15.92 ab	14.58 ac	15.25 ab	0.79 bc	0.78 b	0.79 cd
10-HV+triticale	12.26 d	10.57 e	11.42 e	1.00 ac	0.84 b	0.92 bd
Mean	14.33 A	13.03 B	13.68	0.91	0.88	0.90
VK (%)	9.34	10.15	9.73	15.08	14.15	14.64
Mixtures	NDF (%)			ADF (%)		
	2007	2008	Mean	2007	2008	Mean
1-CV+rye	54.94 a	56.76 ab	55.85 ab	35.74 ab	37.18 ab	36.46 ab
2-CV+barley	50.95 ab	51.89 bc	51.42 de	31.92 de	33.97 ab	32.94 de
3-CV+wheat	51.67 ab	52.94 ac	52.31 ce	32.89 ce	34.79 ab	33.84 ce
4-CV+oat	49.30 b	50.91 c	50.11 e	31.07 e	32.77 b	31.92 e
5-CV+triticale	52.91 ab	55.04 ac	53.97 ad	34.71 bd	35.58 ab	35.14 ac
6-HV+rye	55.03 a	57.99 a	56.51 a	36.95 a	38.73 a	37.84 a
7-HV+barley	52.50 ab	52.81 ac	52.66 be	32.91 ce	36.02 ab	34.47 bd
8-HV+wheat	52.47 ab	53.78 ac	53.13 be	33.34 ce	35.08 ab	34.21 be
9-HV+oat	50.86 ab	51.93 bc	51.39 de	32.02 de	33.56 b	32.79 de
10-HV+triticale	53.90 a	55.72 ac	54.81 ac	34.75 bc	36.63 ab	35.69 ac
Mean	52 45 B	53.98 A	53.22	33.63 B	35.43 A	34.53
VK (%)	4.09	5.27	4.73	3.60	6.90	5.59

The means with the same letter were not significantly different at p= 0.05 level.

and barley besides a thin bodied, loose-leaf form (Celik and Bulur 1996).

Crude protein yield in hay

The average crude protein yield was found to be significantly different in annually as well as in both years but not significant between years (Table 2). In the first year of research, crude protein yield obtained from the mixtures of oat with vetch species were found to be lower compare to other mixtures (0.76-0.79 kg ha^{-1}). However, in in the second year, oats with wheat and triticale mixtures were also found to be low yield as well. In contrast, the average two year crude protein yield, the highest values was obtained the mixtures of HV+rye (1.11 tons ha^{-1}), CV+rye (1.017 tons ha^{-1}), and CV+barley (0.96 tons ha^{-1}), respectively. The close relationship between hay yield and crude protein suggested that the crude protein yield is more associated with the hay yiled in this study. Indeed, Lauriault and Kirksey (2004), reported that the mixtures of rye, barley and triticale with feed peas and hairy vetch had higher crude protein yield than wheat and oats mixtures.

NDF and ADF contents in hay and silage

The insoluble fiber ratio in neutral solvents (NDF) and insoluble fiber ratio in acid solvents (ADF) for both years and average years were found to be statistically different at 5% for vetch+cereal mixtures (Table 2). For two years average, the lowest NDF and ADF ratios were determined in the CV+oat and HV+oat (50.11-51.39%) and CV+oat and HV+oat mixtures (31.92-32.79%), respectively (Table 2).

The ensiled mixtures were faund statically different at 5% level in NDF and ADF ratios (Table 3.). The lowest ADF and NDF ratios were found in the mixtures of CV+oat (49.89% and 32.36%), respectively. Lauriault and Kirksey (2004) was calculated the NDF ratio in the rye, barley, wheat, triticale and oats mixture with hairy vetch 59.5%, 54.7, 57.7, 58.3 and

Table 3. Some features of different vetch+cereal mixtures silage.

Mixtures	Crude protein ratio (%)			Dry matter ratio (%)		
	2007	2008	Mean	2007	2008	Mean
1-CV+rye	14.69 ac	13.02 ac	13.85 bd	33 bd	35 bc	34 b
2-CV+barley	15.17 ab	14.95 ab	15.06 ab	31 ce	32 de	32 cd
3-CV+wheat	14.49 ac	13.68 ac	14.09 bd	31 ce	31 de	31 cd
4-CV+oat	16.40 a	15.81 a	16.11 a	30 e	30 e	30 d
5-CV+triticale	13.96 bc	12.09 bc	13.03 cd	34 bc	34 bc	34 b
6-HV+rye	12.74 c	12.81 bc	12.78 d	36 ab	38 a	37 a
7-HV+barley	15.52 ab	13.92 ac	14.72 ac	32 ce	33 cd	32 c
8-HV+wheat	14.18 ac	13.77 ac	13.97 bd	32 ce	32 de	32 c
9-HV+oat	16.24 a	14.51 ab	15.37 ab	30 e	31 de	31 cd
10-HV+triticale	13.30 bc	11.53 c	12.42 d	37 a	36 ab	36 a
Mean	14.67 A	13.61 B	14.13	33	33	33
VK (%)	7.93	10.89	9.42	4.09	3.68	3.89
Mixtures	NDF (%)			ADF (%)		
	2007	2008	Mean	2007	2008	Mean
1-CV+rye	54.07	57.78 ab	55.93 ab	35.87	37.25	36.56 a
2-CV+barley	51.68	51.45 c	51.57 cd	33.07	36.39	34.73 ac
3-CV+wheat	51.20	53.46 ac	52.33 cd	34.53	36.54	35.53 ac
4-CV+oat	49.82	49.97 c	49.89 d	30.42	34.30	32.36 c
5-CV+triticale	54.27	55.27 ac	54.77 ac	34.66	36.97	33.81 ab
6-HV+rye	56.16	58.59 a	57.38 a	36.86	39.10	37.98 a
7-HV+barley	52.32	53.76 ac	53.04 bd	34.51	37.85	36.18 ab
8-HV+wheat	55.04	54.63 ac	54.83 ac	33.29	37.24	35.27 ac
9-HV+oat	52.26	52.23 bc	52.24 cd	32.32	33.85	33.09 bc
10-HV+triticale	56.24	57.60 ab	56.92 a	34.64	36.29	35.47 ac
Mean	53.31	54.47	53.89	34.02 B	36.58 A	35.30
VK (%)	4.88	5.36	5.13	8.20	5.82	7.03
Mixtures	pH			Flieg score*		
	2007	2008	Mean	2007	2008	Mean
1-CV+rye	5.24 ab	5.28 a	5.26 a	61.93 e	63.00 b	62.47 c
2-CV+barley	4.27 e	4.47 d	4.37 e	96.73 a	89.67 a	93.20 a
3-CV+wheat	4.92 bc	4.90 b	4.91 b	70.33 ce	71.00 b	70.67 c
4-CV+oat	4.45 de	4.44 d	4.45 de	86.87 ab	87.40 a	87.13 ab
5-CV+triticale	5.20 ab	5.23 a	5.22 a	64.47 de	64.33 b	64.40 c
6-HV+rye	5.27 ab	5.40 a	5.34 a	65.53 de	64.33 b	64.93 c
7-HV+barley	4.49 de	4.59 cd	4.54 ce	88.87 ab	87.40 a	88.13 ab
8-HV+wheat	4.62 ce	4.71 bc	4.67 c	84.07 ac	80.73 a	82.40 b
9-HV+oat	4.69 cd	4.57 cd	4.63 cd	78.73 bd	84.20 a	81.47 b
10-HV+triticale	5.40 a	5.30 a	5.35 a	62.33 e	65.00 b	63.67 c
Mean	4.86	4.89	4.87	75.99	75.71	75.85
VK (%)	4.04	2.50	3.36	10.99	6.97	9.21

The means with the same letter were not significantly different at p= 0.05 level.

*81-100 scores; very good, 61-80 scores; good, 41-60 scores; satisfactory, 21-40 scores; middle, 0-20 scores; bad.

49.3, respectively. The results found in this study were confirmed our results. We were calculated the lowest NDF ratio for barley, wheat and oats with mixtures hairy vetch. However, the NDF ratios were lower than Lauriault and Kirksey (2004)'s report but close to Edmisten et al. (1998) and Collins et al. (1990) findings for similar materials. This case can be explained with the ratio of vetch species in mixtures as well as the development state of cereal. Indeed, Collins et al. (1990), reported that the NDF ratios are higher during the heading stage compared to the previous stages.

Silage pH, dry matter ratio, Fleig score and physical analysis

In both years of research and the average of each year, the pH values, dry matter ratio and fleig points of the silage

samples were observed to be statistically significantly different at 5% level (Table 3). As the average silage pH values for both years, the mixture of vetch species with rye and triticale had the highest pH value (5.22 to 5.35). In contrast vetch species in the mixture with barley and oats were lower pH values (4.37 to 4.63). In the two years of study and the average of the years, the highest rates of dry matter were calculated from the mixtures of hungarian vetch with rye (37%) and triticale (36%).

Fleig score values in terms of mixtures of silages were evaluated, the highest two-year average of fleig points determined for CV+barley (93.20), HV+barley (88.13) and CV+oats (87.13) mixtures. However, according to fleig points, the best quality silages were found to be with barley and oat mixtures (Table 3).

The formation of a quality silage depend on lactic acid bacterias activity and to ensure fermentation and rich water soluble carbohydrate content in fodder crops (Altınok, 2002). Legume crops such as vetch species have high protein and low carbohydrate content effect difficulties for fermentation of silage. However, legumes have high-protein ratios and low carbohydrates capable to be buffer properties. So, proteins can be inhibit acid to neutralize and prevent the pH fallings (Acikgoz, 2001). In the study, quality classification of the silages with fleig scores the silages were prepared from mixtures of common vetch with the barley and oat, the hungarian vetch with the barley, oat and wheat have excellent class, all other silages that prepared from mixtures of vetch+cereal mixtures have good quality (Table 3).

The different vetch grain mixtures of prepared silages are given in Table 4. As Table 4 is examined, the mixtures of common vetch+rye silages have good properties in terms of physical analysis, while all other groups have in excellent silage group. In our study, silages prepared from mixture of grain legume crops have high quality silage properties and consistent with findings of Mustafa and Seguin (2004) and DePeters et al. (1989).

Table 4. Physical analyses of different vetch+cereal mixtures silage.*

Mixtures	2007				2008				Mean score
	Color	Smell	Structure	Total	Color	Smell	Structure	Total	
1-CV+rye	2	10	2	14	1	10	3	14	14.0
2-CV+barley	1	12	3	16	1	11	4	16	16.0
3-CV+wheat	2	14	3	19	2	12	4	18	18.5
4-CV+oat	2	14	4	20	2	14	4	20	20.0
5-CV+triticale	2	12	4	18	2	12	3	17	17.5
6-HV+rye	1	12	2	15	1	12	4	17	16.0
7-HV+barley	1	12	2	15	3	10	4	17	16.0
8-HV+wheat	1	14	3	18	2	14	4	20	19.0
9-HV+oat	2	14	3	19	2	14	4	20	19.5
10-HV+triticale	2	11	3	16	2	12	4	18	17.0

*16-20 scores very good-good, 10-15, satisfactory, 5-9 middle, 0-4, bad.

CONCLUSIONS

According to the data obtained from this research work, it was realized that rye, triticale, barley and wheat can be planted succesfully with common vetch and hungarian vetch for herbage and hay production in Isparta or similar area conditions. However, the use of oat mixtures is more suitable for summer plantings in Isparta conditions. It was also determined that high-quality hay production can be possible from all vetch+cereal mixtures. Moreover, vetch and cereal mixtures can be succesfully ensiled and obtained high quality silages without any additive compounds.

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