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Determination of Macronutrient Contents of Dry Grass of Some Vetch Species in Different Mixing Ratios with Barley

Abstract

This research was carried out to determine the macronutrient content in dry grass of barley, which is mixed with common vetch and hairy vetch in different proportions. Field trials were conducted at Siirt University (Turkey) for two years in the winter season of 2017-18 and 2018-19. Common vetch (YF), hairy vetch (TF) and barley (A) plants were grown sole, and each vetch species was grown mixed with barley in four different mixing ratios (80:20, 60:40, 40:60, 20:80). Phosphorus (P), potassium (K), calcium (Ca) and magnesium (Mg) ratios were determine in the harvested grass. As the average of two years; the highest Ca content (1.08%) was obtained by the "20 YF + 80A" mixture, whereas the highest K content (4.50%) was obtained from the "sole common vetch", the highest Mg content (0.21%) was obtained from the "80YF + 20A" mixture and the highest P content (0.34%) was obtained from the "20TF + 80A" mixture. It is found that the grass of these legumes in sole and their mixture with barley are at a sufficient level in terms of Ca and K; but in terms of Mg and P, they were found below the required limit value for feed rations. It was concluded that the Ca / P ratio of hay obtained from both sole and mixed cultivation poses a risk for animal health. According to these results; it is proposed to add Mg and P-containing substances to the studied grasses. Or mixing them with Mg and P-rich feeds might be a good option.

INTRODUCTION

Hairy vetch (*Vicia villosa* Roth) is widely grown as a legume cover crop throughout the U.S.A., with biological nitrogen fixation (BNF) through symbiosis with Rhizobium leguminosarum (Mothapo et al., 2013). It is an important cover crop and green manure in dryland cropping system of Mediterranean regions, too. A delay in the onset of rainfall during autumn can inhibit hairy vetch seed germination, which exposes its early growth stages to low-temperature stress (Yusefi-Tanha et al., 2019). In China, smooth vetch is one of the most important widely grown green manure crop (Yan et al., 2019). It is a winter annual legume cultivated for pasture and hay with the capability for natural reseeding. *Vicia villosa* increases N concentrations in the soil, thus contributing to the sustainability of semiarid regions (Renzi et al., 2018). The hairy vetch is a climbing, prostrate or trailing legume (Aasim et al., 2011). Seed coat of it is very thick and hard, and difficult to absorb water during germination. It requires much time that cotyledon comes out from seed coat (Kim et al., 2013). Leguminous cover crops like hairy vetch is generally grown as winter cover crop in the rice paddy fields of tropical countries like South Korea and Japan (Pramanik et al., 2013). It is often cultivated in mixture mainly with oats for the production of green forage or silage (El-Bok ve et al., 2019). Intercropping legumes with cereals for forage production is a sustainable technique showing several environmental benefits (Ben-Youssef et al., 2019). In a study, the effect of barley-vetch intercropping on the yields and yield components were searched in Iran. Nine mixed treatments were; densities of 250 vetch plants + 300 barley plants, 250 vetch plants + 500 barley plants, 250 vetch plants + 700 barley plants, 450 vetch plants + 300 barley plants, 450 vetch plants + 500 barley plants, 450 vetch plants + 700 barley plants, 650 vetch plants + 300 barley plants, 650 vetch plants + 500 barley and 650 vetch plants + 700 barley plants per square meter and sole cropping of barley (350 plants per m^2) and vetch (250 plants per m^2). The highest land equivalent ratio (LER), based on seed yield (1.20) and biological yield (1.48), belonged to 250 vetch + 500 barley plants treatment, which indicate the usefulness of this intercropping treatment, as compared to the sole cropping of these two plant (Kahraryan et al., 2019). In the North China, *Vicia sativa* L. and *Vicia villosa* Roth were compared the for their adaptation difference to the phosphorus deficiency stress. The adaptation of *Vicia sativa* L. to P deficiency stress was dominantly dependent on enhanced H+-release rate and acid phosphatase activity on the root surface in comparison to adequate P supply treatments. In contrast, H^+-release rate of *Vicia villosa* Roth did not change, but the plant significantly increased the root-shoot ratio and the biomass of the roots under the P-deficient conditions. The results suggest that *Vicia sativa* L. and *Vicia villosa* Roth.have different strategies to adapt the low P stress environment by coordinating root morphological and physiological plasticity (Lu-Yang et al., 2011). Common vetch (*Vicia sativa*) is widely used as green manure, pasture, silage, hay and for grain for livestock feed (Fernandez-Aparicio et al., 2009). Common vetch is a viny, succulent, annual legume and grows taller when planted with a tall companion crop that provides structural support for climbing (Sattell et al., 1998). Common vetch is a high-quality alternative forage legume in rainfed areas of the Mediterranean basin (Caballero et al., 1996). In the study of Sobkowicz (2001), P, K and Ca content in plants and their uptake with plant dry matter yield of spring triticale and common vetch were determined in sole and intercrop. Grow in mixture increased potassium content in plant dry matter of each species compared to pure stands. The highest K ratio in triticale and Ca in vetch plants were observed in plants from the lowest yielding treatments. However nutrient uptake was highly correlated with dry matter yield of plants of these two species. This research was carried out to determine the macronutrient content in dry grass of barley, which is mixed with common vetch and hairy vetch in different proportions.

MATERIALS and METHODS

This research was conducted in Siirt University, Faculty of Agriculture, Field Crops Experiment Area for two years in the 2017-18 and 2018-19 growing period in Turkey. Some physical and chemical properties of the research soils are given in Table 1. Soil properties of the trial areas were found similar to each other. In both years, it was determined that the soils are salt-free, slightly alkaline, moderately calcareous, sufficient in potassium content, low in organic matter content and very low in available phosphorus content.

Table 1. Soil properties of trial field

Soil properties	Unit	Value	
		2017-2018	2018-2019
Clay	%	55.80	55.35
Sand	%	36.30	37.80
Silt	%	7.90	6.85
pH		7.98	7.90
Lime	%	13.0	12.5
Organic matter	%	1.31	1.28
Available phosphorus	kg P_2O_5/ha	43	41
Available potasium	kg K_2O/ha	1150	1160

Some climatic data for the research area are given in Table 2. It was observed that the average temperature and relative humidity values were similar in both seasons, whereas the total amount of precipitation was higher in the 2018-19 season than in the 2017-18 season (Anonymous, 2016).

Table 2. Some climate data for the long years and study seasons of the research

Year	January	February	March	April	May	June	July	August	September	October	November	December	Aver./Total
Average Temperature ºC													
2017	3.0	2.7	9.6	14.0	19.5	26.9	32.3	32.0	28.4	18.4	11.2	8.0	17.2
2018	5.7	8.2	13.7	16.8	19.8	27.4	32.3	32.1	27.9	20.2	11.0	6.7	18.4
2019	4.0	5.8	8.3	11.9	21.9	29.1	30.2	31.8					17.9
Long years	2.8	4.4	8.7	14.1	19.5	26.2	30.6	30.1	25.2	18.1	10.3	4.7	16.2
Total precipitation (mm)													
2017	46.4	29.0	118.4	132.8	74.6	0.0	0.0	0.4	0.0	5.2	97.0	48.2	552.0
2018	56.4	74.2	47.6	61.6	139.6	10.0	0.6	1.6	0.0	100.6	88.6	177.6	758.4
2019	96.2	103.2	182.0	175.6	64.4	1.2	0.0	0.0					622.6
Long years	72.9	89.9	98.9	96.7	59.5	9.7	3.1	2.3	4.7	47.9	77.8	83.6	647.0
Relative Humidity (%)													
2017	65.9	64.9	63.9	59.5	51.7	29.5	19.0	19.0	19.1	34.6	64.4	65.2	46.4
2018	70.5	67.7	55.9	47.6	59.2	31.7	20.1	21.4	23.0	47.8	76.	82.0	50.2
2019	72.5	66.9	63.5	66.8	41.8	26.5	23.0	20.5					47.7
Long years	70.5	65.6	60.3	57.3	49.2	34.0	26.8	26.1	31.0	47.2	62.2	70.1	50.0

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Common vetch (*Vicia sativa*) variety "Alınoglu-2001", hairy vetch (*Vicia villosa*) variety "Selcuklu-2002" and barley (*Hordeum vulgare*) variety "Samyeli" were used as research materials. Field trials were set up with three replications based on the Randomized Blocks Trial pattern. In both years, 40 kg / ha N and 100 kg / ha P_2O_5 equalent fertilizer were applied as base fertilizer prior to planting in autumn. Planting was completed in the second week of November, in both years. The determination of the seed quantity for sole planting and mixtures were adopted by the germination test results and the seed purity vaues, where seeding rates were 120 kg/ha for common vetch, 130 kg / ha for hairy vetch and 220 kg/ha for barley. The amount of seed per hectare was determined by multiplying the amount of seed in the sole planting of the species by the rates in the mixture. Sowing was carried out in two meter long plots, on six rows, at 25 cm interrow distance. Rows were opened with a marker, mixtures were mixed on the same row and sowings were conducted by hand, in accordance with Anonymous, (2019a). Common vetch (YF), hairy vetch (TF), barley (A) were planted in a single and quadruple mixture at the ratios of 80:20, 60:40, 40:60, 20:80. Harvestings were conducted at the beginning of flowering for sole legumes, during the heading stage for sole barley, and at the 10% flowering stage of legumes in mixtures. The harvested plants were subjected to pre-drying under room conditions before get dried in the oven at 70 ^{o}C until they reach constant weight. Dry samples were ground to a diameter of 1 mm in a grass mill before chemical analysis. P, K, Ca and Mg ratios in the samples were determined by NIRS (Near Infrared Reflectance Spectroscopy) device with "# IC-0904FE calibration set" (Anonymous, 2019b) in the Laboratory of the Eastern Mediterranean Agricultural Research Institute, according to the protocol of Brogna et al. (2009). The data obtained were subjected to variance analysis according to the randomized blocks trial design. According to the results of the F test, the differences between the groups were determined by the LSD test (Kalaycı, 2005).

RESULTS and DISCUSSION

All tested applications were statistically found significant in terms of Ca content (Table 3).

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Table 3. Ca and K contents detected in dry grass

Mixture	Ca			K		
	2018	2019	Average	2018	2019	Average
YF	1.13^{A}	0.87^{C-E}	1.00^{AB}	4.49	4.51	4.50
TF	1.07^{A-C}	0.61^{FG}	0.84^{C}	4.57	3.93	4.25
A	0.98^{A-D}	0.51^{G}	0.74^{CD}	4.13	3.97	4.05
80TF + 20A	1.08^{A-C}	1.06^{A-C}	1.07^{A}	4.34	3.87	4.11
60TF + 40A	0.98^{A-D}	0.27^{H}	0.63^{D}	4.57	3.59	4.08
40TF + 60A	0.94^{A-D}	0.79^{D-F}	0.87^{BC}	3.99	3.92	3.96
20TF + 80A	0.90^{B-E}	0.70^{E-G}	0.80^{C}	4.35	4.05	4.20
80YF + 20A	1.13^{A}	0.97^{A-D}	1.05^{A}	4.21	4.55	4.38
60 YF + 40A	1.07^{A-C}	0.63^{FG}	0.85^{BC}	4.34	3.96	4.15
40 YF + 60A	1.10^{AB}	0.55^{G}	0.83^{C}	4.22	3.99	4.10
20 YF + 80A	1.13^{A}	1.02^{A-C}	1.08^{A}	4.17	3.96	4.07
Average	1.05^{A}	0.73^{B}	0.89	4.30	4.03	4.17
CV (%)	12.77			9.36		
LSD	Year	0.06**		n.s		
	Mixture	0.14**		n.s		
	Interaction	0.22**		n.s		

Ca contents varied between 0.63-1.07%. The highest and lowest Ca ratio was obtained from the mixture of "80TF + 20A" and "60TF + 40A", respectively. The ratio of Ca mineral in roughages is required to be at least 0.3% for ruminants (Ayan et al. 2010; Başbağ et al. 2018). Ca content was higher than 0.3% in all applications in our study. Ca content was reported between 0.22-1.82% in *Salvia multicaulis* species collected from different locations by Başbağ et al. (2020), in some vetch genus 1.28-1.53% (Turan et al. 2018) and 0.52-0.58% in sorghum x sudangrass hybrid and sudangrass varieties at harvest time by Özyazıcı and Açıkbaş (2020). In the study, all applications were found to be statistically insignificant in terms of K content (Table 3). The critical value for K in feed rations is accepted as 1.0% (Muller, 2009). Accordingly, in our study, K values in all applications are at a good level. It was determined that the effect of the mixture ratios on Mg is statistically insignificant (Table 4).

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Table 4. Mg and P contents contents detected in dry grass

Mixture	Mg			P		
	2018	2019	Average	2018	2019	Average
YF	0.18	0.20	0.19	0.30	0.32	0.31
TF	0.22	0.15	0.18	0.33	0.33	0.33
A	0.18	0.13	0.16	0.32	0.34	0.33
80TF + 20A	0.19	0.15	0.17	0.31	0.31	0.31
60TF + 40A	0.23	0.12	0.18	0.33	0.28	0.31
40TF + 60A	0.23	0.12	0.18	0.33	0.34	0.33
20TF + 80A	0.21	0.18	0.19	0.32	0.35	0.34
80YF + 20A	0.18	0.24	0.21	0.31	0.32	0.31
60 YF + 40A	0.17	0.22	0.19	0.32	0.31	0.32
40 YF + 60A	0.19	0.22	0.20	0.31	0.29	0.30
20 YF + 80A	0.18	0.17	0.18	0.31	0.33	0.32
Average	0.20	0.17	0.19	0.32	0.32	0.32
CV (%)	16.60			6.45		
LSD	Year	n.s		n.s		
	Mixture	n.s		n.s		
	Interaction	n.s		n.s		

In our study, Mg concentration was between 0.16% and 0.20%. The minimum Mg content required in feed rations is 0.25% (Anonymous, 2001). Accordingly, it was determined that the mixtures in both years were insufficient to meet the needs of ruminants in terms of Mg. Muller (2009) reported that feed rations should contain at least 0.40% P in feed in order to meet the P requirement of animals at a minimum level. Considering this limit value, P content in sole and mixtures was determined below the limit value in our study (Table 4). Özyazici and Acikbaş (2019) attribute this situation to the high extractable Ca and Mg content in the cultivated soil which result with P retention in the soil and reduced P uptake by plants. Lindsay et al. (1989) reported that in soils with high Ca content and high pH, P get complexes into very low-soluble CaPO4. Ca and P constitute more than 70% of the mineral content of the animal body where they play a role in many metabolic activities, especially for the bone and skeletal system (Akdağ, 2017). In the diet of ruminants, as well as the Ca and P concentration, the ratio of these two minerals is of great importance (Selle et al., 2009: Han et al., 2016).

Çizelge 5. Calculated Ca/P and K/(Ca+Mg) rates detected in dry grass

Mixture	Ca/P			K/(Ca+Mg)		
	2018	2019	Average	2018	2019	Average
YF	3.79	2.66	3.23^{A-C}	3.41^{EF}	4.39^{C-F}	3.90^{C-E}
TF	3.27	1.92	2.60^{D}	3.61^{EF}	5.33^{BC}	4.47^{BC}
A	3.09	1.51	2.30^{DE}	3.54^{EF}	6.30^{B}	4.92^{B}
80TF + 20A	3.55	3.37	3.46^{A}	3.45^{EF}	3.21^{F}	3.33^{E}
60TF + 40A	2.30	0.98	1.99^{E}	3.77^{D-F}	9.14^{A}	6.45^{A}
40TF + 60A	2.89	2.32	2.61^{D}	3.46^{EF}	4.26^{C-F}	3.86^{C-E}
20TF + 80A	2.86	1.97	2.41^{DE}	3.93^{D-F}	4.95^{CD}	4.44^{BC}
80YF + 20A	3.66	3.09	3.37^{AB}	3.22^{F}	3.77^{D-F}	3.49^{DE}
60 YF + 40A	3.38	2.02	2.70^{CD}	3.50^{EF}	4.68^{C-E}	4.09^{B-E}
40 YF + 60A	3.58	2.02	2.80^{B-D}	3.27^{F}	5.43^{BC}	4.35^{B-D}
20 YF + 80A	3.67	3.10	3.39^{A}	3.19^{F}	$3.^{31F}$	3.24^{E}
Average	3.34^{A}	2.27^{B}	2.81	3.48^{B}	4.98^{A}	4.23
CV (%)		17.50			18.20	
LSD	Year	2.22^{**}			0.58^{**}	
	Mixture	0.57^{**}			0.89^{**}	
	Interaction	n.s			1.25^{**}	

Many researchers emphasized that Ca: P ratio in feeds is of great importance, this ratio should be between 1: 1 and 2: 1 and exceeding ratio of 2 will lead to poisoning in animals (Albu et al., 2012; Grzegorczyk and et al., 2017, Başbağ et al., 2018; Özyazıcı and Açıkbaş, 2019). When Table 5 is examined, it can be seen that the Ca: P ratio in mixing ratios varied between 1.99-3.46% which is far above the acceptable limit of 2:1. This can make these grasses risky when used without mixing with other types of feeds. It is emphasized that the K / (Ca + Mg) ratio of feed consumed in ruminant feeding should be less than 2.2 (Grunes and Welch, 1989; Kidambi et al., 1989; Mayland et al., 1992). When Table 5 is examined, it is seen that the K / (Ca + Mg) ratio of all applications in the research is higher than 2.2. The high K / (Ca + Mg) ratio is known to be the most important mineral imbalance in animal nutrition sourcing from feeding (Bakoğlu et al., 1999). It has been reported that the risk of grass tetanus (tetany disease) is increased when this ratio is 2.2 or higher (Elkins et al., 1977; Crawford et al., 1998).

CONCLUSIONS

It is found that the grass of common vetch and hairy vetch legumes in sole and their mixture with barley are at a sufficient level in terms of Ca and K; but below the required limit value for Mg and P content for direct use in feed rations. Also the Ca / P ratio of hay obtained from both sole and mixed cultivation are high and poses a risk for animal health. To diversify the crops in cycles in artificial agroecosystem has many benefits for ecosystem and for the sustainability of farmer communities. From this approach, using these species by feed producers will add many benefit to their feed production system. According to these results; it is proposed to add Mg and P-containing substances to the studied grasses or mixing them with Mg and P-rich feeds as an option with these species.

LITERATURES

Aasim, M., Şahin Demirbağ, N., Khawar, K. M., Kendir, H., Özcan, S. 2011. Direct axillary shoot regeneration from the mature seed explant of the hairy vetch (*Vicia villosa* Roth).

Akdağ, A. 2017. Farklı kalsiyum ve fosfor düzeyli karmalarla yemlenen etlik piliçlerin büyüme performansı, et kalitesi ve bazı kan, kemik ve dışkı parametreleri. Yüksek lisans tezi, Eskişehir Osmangazi Üniversitesi Fen Bilimleri Enstitüsü, Eskişehir.

Albu A, Pop IM, Radu-Rusu C. 2012. Calcium (Ca) and Phosphorus (P) concentration in dairy cow feeds. Lucrări Ştiinţifice- Seria Zootehnie. 57(17): 70-74.

Anonymous, 2001. Nutrient Requirements of Dairy Cattle. Seventh Revised Edition. (http://books.nap.edu/openbook.php?record_id=9825&page=110), (Erişim tarihi: 15.04.2020).

Anonymous, 2016. Siirt İli Bazı İklim Verileri. T.C. Tarım ve Orman Bakanlığı Meteoroloji Genel Müdürlüğü, Ankara.

Anonymous, 2019. WinISI 4 Calibration Software:Ground, Expandable Equation Packages, (http://www.winisi.com/product_calibrations.htm), (Erişim tarihi: 20.05.2019).

Ayan, İ, Mut, H., Önal-Ascı, Ö., Basaran, U., Acar, Z. 2010. Effects of manure application on the chemical composition of rangeland hay. Journal of Animal and Veterinary Advances. 9(13): 1852-1857.

Bakoğlu, A., Koç, A., Gökkuş, A., 1999. Dominant mer'a bitkilerinin biomas ve kimyasal kompozisyonlarının büyüme dönemindeki değişimi, II. Kimyasal kompozisyondaki değişimler, Türk Tarım ve Ormancılık Dergisi, 23(Ek Sayı 2): 495-508.

Başbağ, M., Çaçan, E., Sayar, M.S. 2018. Bazı buğdaygil bitki türlerinin yem kalite değerlerinin belirlenmesi ve biplot analiz yöntemi ile özellikler arası ilişkilerin değerlendirilmesi. Tarla Bitkileri Merkez Araştırma Enstitüsü Dergisi, 27(2): 92-101.

Başbağ, M., Sayar, M.S., Çaçan, E. 2020. Determining Forage Quality Values of Salvia multicaulis VAHL. Species Collected From Different Locations of the Southeastern Anatolia Region of Turkey, Turkish Journal of Agriculture - Food Science and Technology, 8(7): 1492-1496

BenYoussef, S., Kachout, S. S., Abidi, S., Saddem, B., Ismail, J., & B Salem, H. (2019). Effect of Different Levels of Nitrogen Fertilization on Forage Yields and Quality of Hairy Vetch (Vicia villosa, Roth) Triticale (Xtritcosecale, Witmack) Mixtures. The Open Agriculture Journal, 13(1).

Brogna, N., Pacchioli, M.T., Immovilli, A., Ruozzi, F., Ward, R., Formigoni, A., 2009. The use of nearinfrared reflectance spectroscopy (NIRS) in the prediction of chemical composition and in vitro neutral detergent fiber (NDF) digestibility of Italian alfalfa hay. Italian Journal of Animal Science, 8(Suppl. 2): 271-273.

Caballero, R., Barro, C., Rebolé, A., Arauzo, M., & Hernaiz, P. J. (1996). Yield components and forage quality of common vetch during pod filling. Agronomy journal, 88(5), 797-800.

Crawford, R.J., Maisse, M.D., Sleper, D.A., Mayland, H.F., 1998. Use of an experimental high-magnesium tall fescue to reduce grass tetany in cattle. Journal of Production Agriculture, 11: 491-496.

El-Bok, S., Jabri, C., Omrani, W., Nsibi, K., Zoghlami-Khélil, A. 2019. Molecular and cytogenetic description of Vicia villosa Roth. Pakistan Journal of Agricultural Sciences, 56(1).

Elkins, C.B., Haaland, R.L., Honeland, C.S., 1977. Tetany potential of forage species as affected by soil oxygen. Proceedings of the XIII International Grassland Congress, pp. 1505-1507.

Fernandez-Aparicio, M., Sillero, J. C., Rubiales, D. 2009. Resistance to broomrape species (Orobanche spp.) in common vetch (Vicia sativa L.). Crop Protection, 28(1), 7-12.

Grunes, D.L., Welch, R.M., 1989. Plant contents of magnesium, calcium, and potassium in relation to ruminant nutrition. Journal of Animal Science, 67: 3485-3494.

Han, J., Wang, J., Chen, G., Qu, H., Zhang, J., Shi, C., Yan, Y., Cheng, Y. 2016. Effects of calcium to nonphytate phosphorus ratio and different sources of

E-ISSN:2717-7238
www.ispecjournal.com

vitamin D ongrowth performance and bone mineralization in broiler chickens. Revista Brasileira de Zootecnia, 45(1): 1-7.

Kahraryan, B., Farahvash, F., Mohammadı, S., Mırshekarı, B., Rashıdı, V. 2019. Evaluation of Barley (Hordeum vulgare L.) and Vetch (Vicia villosa Roth) Intercropping. Journal of Crop Ecophysiology (Agriculture Science), 12(4): 651-670.

Kalaycı, M. 2005. Örneklerle jump kullanımı ve tarımsal araştırma için varyans analizi modelleri, Anadolu Tarımsal Araştırma Enstitüsü Müdürlüğü Yayınları, yayın no:21.

Kim, M. T., Lee, Y. H., Jeon, W. T., Kim, S. J., Yun, D. H., Ku, J. H., Kang, H. W. 2013. Effects of water-soaking and mechanical and chemical scarifications on seed germination of hairy vetch (Vicia villosa Roth). Korean Journal of Soil Science and Fertilizer, 46(1): 49-52.

Lindsay, W.L., Vlek, P.L.G., Chien, S.H., 1989. Phosphate minerals. J.B. Dixon and S.B. Weed (Eds.), Minerals in Soil Environments, Soil Science Society of America, Madison, WI, USA, pp. 1089-1130.

Lu Yang, C.W.D., Ke, H.U.A.N.G., Xiao-qing, L.I., Wei-dong, C. A. O., Jian-bo, S.H.E.N. 2011. Comparison of rhizosphere processes of Vicia sativa and Vicia villosa in response to phosphorus deficiency. Plant Nutrition and Fertilizer Science, (3), 23.

Mayland, H.F., Hasay, K.H., Clark, D.H., 1992. Seasonal trends in herbage yield and quality of Agropvrons. Journal of Range Management, 45: 369-374.

Mothapo, N. V., Grossman, J. M., Maul, J. E., Shi, W., Isleib, T. 2013. Genetic diversity of resident soil rhizobia isolated from nodules of distinct hairy vetch (Vicia villosa Roth) genotypes. Applied soil ecology, 64: 201-213.

Muller, L.D., 2009. Dietary Minerals for Dairy Cows on Pasture. (www.das.psu.edu/researchextension/dairy /.../pdf/mi neralsforpasture. pdf.), (Erişim tarihi: 25.10.2018).

Özyazıcı, M.A., Acikbas, S., 2019. Kaba yem amacıyla yetiştirilen sorgum (Sorghum sp.) ve mısır (Zea mays L.) çeşitlerinin mineral içeriklerinin değişimi. International Journal of Scientific and Technological Research, 5(12): 227-237.

Özyazıcı, M.A., Açıkbaş, S. 2020. Sorgum x Sudanotu Melezi ve Sudanotu Çeşitlerinde Hasat Zamanının Makro Besin Maddeleri Konsantrasyonlarına Etkisi, Türkiye Tarımsal Araştırmalar Dergisi, 7(1):47-58.

Pramanik, P., Haque, M. M., Kim, P. J. 2013. Effect of nodule formation in roots of hairy vetch (Vicia villosa) on methane and nitrous oxide emissions during succeeding rice cultivation. Agriculture, ecosystems & environment, 178, 51-56.

Renzi, J. P., Chantre, G. R., Cantamutto, M. A. 2018. *Vicia villosa* ssp. Roth field emergence model in a semiarid agroecosystem. Grass and Forage Science, 73(1): 146-158.

Sattell, R., Dick, R., Luna, J., McGrath, D. M., Peachey, R. E. 1998. Common vetch (*Vicia sativa* L.).

Sobkowicz, P. 2001. Phosphorus, potassium and calcium uptake with spring triticale and common vetch in pure and mixed stand. Zeszyty Naukowe Akademii Rolniczej we Wroclawiu. Rolnictwo (Poland).

Turan, N., Özyazıcı, M.A., Açıkbaş, S., Seydoşoğlu, S. The determining of some macro element contents in genotypes of vetch species. III. Uluslararası Meslek ve Teknik Bilimler Kongresi. 3705-3712.

Yan, Z. C., Zhang, W. Z., Duan, T. Y. 2019. First Report of Leaf Spot Caused by Stemphylium vesicarium on *Vicia villosa* in China. Plant Disease, 103(5):1039-1039.

Yusefi-Tanha, E., Fallah, S., Pessarakli, M. 2019. Effects of seed priming on growth and antioxidant components of hairy vetch (*Vicia villosa*) seedlings under chilling stress. Journal of Plant Nutrition, 42(5): 428-443.