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RESEARCH ARTICLE

INTERCROPPING IN A TEMPERATE ENVIRONMENT FOR FORAGE PRODUCTION IN DRYLAND CONDITIONS.

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Abstract

The basic objective of the experiment was to determine vetch and cereal intercropping for forage yield in dryland conditions. The experiment was conducted under Tekirdag-Turkey ecological conditions during 2013-2015 years. Common vetch (*Vicia sativa* L.), Hungarian vetch (*Vicia pannonica* Crantz.), Narbon vetch (*Vicia narbonensis* L.), oat (*Avena sativa* L.), and barley (*Hordeum vulgare* L.) were used as plant material of vetch – cereal mixtures. Plant height, branch number per plant, fresh forage yield, and dry forage yield were determined. Significant differences were found among vetch – cereal mixtures for plant height, branch number per plant, fresh forage yield and dry forage yield. The two years average data showed that vetch – cereal mixture performed better under dryland conditions in terms of fresh and dry forage yield. Narbon vetch+oat, Hungarian vetch + barley double mixtures, and common vetch+Narbon vetch+barley triple mixture was recommended for forage production in Tekirdag-Turkey dryland conditions

Introduction:-

World population is still growing at about 80 million people a year. If current trends persist, there will be about 9,2 billion. High prices on food an economic problem have pushed 100 million more people than last year into hunger and poverty people. In addition climate change, rising energy prices, growing clean water problems and scarcity will make it harder. Animal productions from the conversation of human-enable materials to high quality human food. Projections about this subject indicate that large increases in per capita demand for animal products, generally developing countries. With industrial animal production, an increasing number of food animals raised on pastures and feedlots. Concern has arisen about this feeds as grain-diets can produce serious digestive problems in food animals such as cow, goats and sheep. These group animal stomachs are suited to digesting high-cellulose containing lands like forage grasses and legumes. Forage crops are important for animal feeding as plant materials having mostly high amounts of structured carbonhydrates. Cereals are wide spread used in livestock nutrition due to their high dry matter production and low cost. Cereal-based forages have a great potential to provide energy for animals. Unfortunately, cereals often include low protein and low forage quality. So that it is necessary to provide livestock with protein supplements. Combining the growth of cereal forage with other crops capable of increasing the protein content of the ration has great nutritional value. Combinations of cereals with legumes are seen as one way of achieving this goal (Lithourgidis et al., 2011).

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Mixtures of cool season cereals with legumes are considered good agricultural practice in many countries, (Watson et al., 2002; Knudsen et al., 2004) cultivation of mixtures causing an increase productivity and greater stability of yield (Niggli et al., 2008; Doré et al., 2011). In addition, the risk of lodging of legumes is significantly reduced. Legume mixed crops has a positive effect on soil fertility enriching it with nitrogen through a symbiosis of legumes with Rhizobium bacteria. And due to the huge amount of crop residue left behind (Staniak et al., 2014). Yielding of mixtures and crop quality mostly depends on the selection of genotypes and their participation. Since the arable croplands and ranges in the Trakya Region of Turkey have been diminishing intercropping system may create a better access for increasing forage yield per unit area. In such regions, legume and cereal mixture have shown significant potential for higher forage yield and soil conservation (Anil et al., 1998). In vetch – cereal intercropping, cereals provide structural support for vetch growth, improving light absorption and allowing mechanical harvest (Lithourgidis et al., 2006). Common vetch is a popular legume for fresh and dry forage and silage production in Turkey. Hungarian vetch is under increasing demand due to its winter resist and productivity especially in hard winter locations. Narbon vetch had high seed yield is increasing popularity mostly in Trakya Region for animal feeding.

Most researches focused on companion crop mixed growth advantage with that of pure stands. Mariotti et al., (2009) reported that competition had different effects on the different species and that the interaction between above- and below-ground competitions varied among species. Intercropping of barley and vetch was more productive than sole crop of either species (Mohsenabadi et al., 2008). Onal Asci and Egritas (2015) determined that hay and digestible dry matter yield of mixtures were higher than monocrops. Lithourgidis et al., (2007) proposed that the greatest dry matter yield was obtained with wheat and barley sole cropping, whereas the lowest was obtained with the common vetch sole crop. Common vetch intercrops with barley or winter wheat produced higher dry matter than common vetch sole crop. Mean dry matter yield of pure oat was 6,07 t ha^{-1} and that of pure vetch was 4,14 t ha^{-1}, with the highest yield (6,32 t ha^{-1}) in the oat and vetch mixture (45:55) (Erol et al., 2009). Ullah et al., (2015) stated that oat grown in mixture with vetch showed better forage yield (50,10 t ha^{-1}) than oat grown in pure stand (44,34 t ha^{-1}). Similarly, barley in combination with vetch resulted in higher forage yield (39,84 t ha^{-1}) than barley grown in pure stand (29,20 t ha^{-1}). Budaklı Carpıcı and Celik (2014) reported that the highest forage yield (15,21 t ha^{-1}) was obtain from % 50 common vetch+% 50 triticale mixture and forage yield of pure stand common vetch was 15,21 t ha^{-1}. Tuna and Orak (2007) determined that plant height, pod number and branch number of vetch in mixture was 57,8-89,8 cm, 6,3-8,6 and 1,5-2,0, respectively. The researchers reported that fresh forage yield and dry matter yield of common vetch – oat mixture was between 15,6–29,0 t ha^{-1} and 4,8–7,2 t ha^{-1}. Besides, plant height of oat was between 118,2 cm and 129,0 cm in common vetch-oat mixtures. Ansar et al., (2010) stated that in pure stand, plant height of oat, barley and common vetch were 79,75, 66,94 and 46,30 cm, respectively. The researchers reported that dry matter yield of barley and vetch were 9,64 and 7,71 t ha^{-1}, respectively. Fresh forage yield of oat, barley and vetch were 59,26 t ha^{-1}, 41,45 t ha^{-1} and 25,30 t ha^{-1} respectively.

The aim of this research was to determine forage potential of vetch (Common vetch, Hungarian vetch and Narbon vetch) and cereals (barley and oat) and their mixtures in dryland conditions of Trakya Region of Turkey.

Material and Methods:-

Site description, climatic and soil conditions:-

Experiments were conducted during the 2013-2014 and 2014-2015 growing seasons at the experimental area of Field Crops Department of Agricultural Faculty, Tekirdag Namik Kemal University, Turkey. Experimental area is located at 36° 15´N and 36° 30´ E direction and has a typical Mediterranean climate generally. The meteorological data of the experimental area during growing season from October to July was given at Table 1. It has a long-term rainfall of 477,9 mm during growing season. The total precipitation was 524,2 mm and 598,1mm during the 2013-2014 and 2014-2015 growing seasons, respectively. The average temperature of the first (13,8 °C) and second growing season (13,3 °C) was higher than the long-term average value (12,5°C).

Some important soil characteristics of the experimental area were determined before sowing. The soil had a clay-loam texture and moderate lime. Soil test values indicated a pH of 7,06 and 2,37 % $CaCO_3$, 77,5 kg ha^{-1} phosphorus, 887,4 kg ha^{-1} potassium and 1,16 % organic matter at the depth of 30 cm.

Table 1:- Climatic data of the mean temperature (°C) total precipitation (mm) location in 2013-2014 and 2014-2015 years and long-term average (1960-2014) at Tekirdag, Turkey.

	Mean temperature(°C)			Total precipitation (mm)		
Months	2013-2014	2014-2015	long-term	2013-2014	2014-2015	long-term
October	14,3	15,6	15,4	95,8	136,1	64,0
November	12,9	11,2	11,0	39,9	35,2	73,2
December	6,2	9,3	7,3	3,9	80,3	82,7
January	8,0	5,8	4,9	44,4	61,5	69,3
February	8,7	6,5	5,3	6,0	94,6	53,9
March	9,9	8,5	7,3	73,6	29,7	55,2
April	13,4	11,4	11,9	46,8	65,2	40,9
May	17,5	18,6	16,8	72,1	32,2	38,7
June	21,8	21,3	21,3	69,6	62,8	37,0
July	24,8	24,9	23,4	72,1	0,5	23,1
Total	--	--	--	524,2	598,1	477,9
Average	13,8	13,3	12,5	--	--	--

Materials and treatments:-

In the experiment, common vetch (*Vicia sativa* L.) *cv*. Orakefe (CV), Hungarian vetch (*Vicia pannonica* Crantz.) *cv*. Sarıefe (HV), Narbon vetch (*Vicia narbonensis* L.) *cv*. 570 as a candidate variety (NV), oat (*Avena sativa* L.) *cv*. Sebat (O), and barley (*Hordeum vulgare* L.) *cv*. Scarpia (B) were used as plant material of the research. These species were sown as pure stands, double and triple mixtures. The proportion of legumes–cereal mixtures were % 60 legumes, %40 cereals, while double and triple legumes – legumes mixtures were %50-%50, and %33.3-% 33.3, %33.3, respectively. Mixture combination was made differently according to harvesting time for each species. Mixture combinations are presented below.

1. Mixture treatments for common vetch; common vetch pure stand (CV), Narbon vetch (NV)–CV, Hungarian vetch (HV)–CV, oat (O)–CV, barley (B)–CV, HV-NV-CV, HV-B-CV and HV-O-CV.
2. Mixture treatments for Hungarian vetch; HV, NV–HV, CV–HV, O–HV, B–HV, CV-NV-HV, CV-B-HV and CV-O-HV.
3. Mixture treatments for Narbon vetch; NV, HV–NV, CV–NV, O–NV, B–NV, CV-HV-NV, CV-B-NV and CV-O-NV.
4. Mixture treatments for barley; B, NV–B, CV–B, HV–B, O–B, CV-NV-B, CV-HV-B and CV-O-B.
5. Mixture treatments for oat; O, NV–O, CV–O, HV– O, B–O, CV-NV-O, CV-HV-O and CV-B-O.

Before sowing, 50 kg ha^{-1} of N and 50 kg ha^{-1} of P_2O_5 were applied as a base fertilizer (Using complex fertilizer 20-20-0). The pure sowing rate of common vetch (CV), Hungarian vetch (HV), Narbon vetch (NV), barley (B) and oat (O) were 100, 80, 150, 180, and 180 kg ha^{-1}, respectively. Sowing was made by hand at row to row distance 25 cm in October of both years at same rate. Sowing rate of a mixture was calculated by multiplying mixture ratio and pure sowing rate of each species. The legume and cereals were seeded in the same rows. The size of each plot was 7,5 m^2 (1,5x5m). The research was carried out in dry conditions. The experiment was conducted in the randomized complete block design with a factorial arrangement; mainly 8 different combinations for 5 different species with three replications.

The harvest stage was determined by taking physiological periods of each species. Vetch species were harvested at lowest pod filling stage of vetch. Harvest time for cereals was % 50 flowering time. Fresh forage yield was recorded from 2,4 m^2 area for each plot and calculated as t ha^{-1}. 500 g fresh sample was taken from the harvested material, dried at 78 °C for 48 hours and weighed. Dry forage yield was calculated as dry weight percentage. Additionally; plant height, ratio and branch number per plant were determined for the species of harvest time in mixtures. Plant height was recorded in centimeter measured from base to the tip of its main stem. Branch number over main stem per plant was counted.

Analysis of variance of experimental results was calculated according to randomized complete block experimental design with three replications using MSTAT-C statistical software package (MSTAT-C, 1988). Significant differences among the mean values were compared by LSD test ($P < 0,05$) (Duzgunes et al., 1987).

Result and Discussion:-

Results of mixtures at common vetch harvest time:-

The yield and yield parameters of pure stand and mixture of common vetch averaged over-two-year data were present in Table 2. Plant height, common vetch ratio, branch number per plant, fresh forage yield and dry forage yield were significantly influenced by the different mixture combination of common vetch (Table 2).

Table 2:-Plant height, common vetch ratio, branch number per plant, fresh forage yield and dry forage yield of CV and its combination

Combination	Plant height (cm)	CV ratio (%)	Branch number/plant	Fresh forage yield (t ha^{-1})	Dry forage yield (t ha^{-1})
CV	93,10 d	---	2,67 d	26,21 d	8,09 bc
NV+CV	98,50 c	59,67 a	3,48 b	36,52a	9,17 a
HV+CV	105,06 a	61,33 a	3,52 b	29,10 cd	8,08 bc
O+CV	100,11 b	38,33 c	3,22 bc	32,01bc	7,80 c
B+CV	81,56 g	49,67 b	4,55 a	26,96 d	6,03 d
HV+NV+CV	87,50 e	31,67 de	2,85 cd	33,19 b	8,74 ab
HV+B+CV	85,22 f	34,00 d	3,23 bc	32,08 bc	8,50 ab
HV+O+CV	84,54 f	28,33 e	3,45 b	31,86 bc	8,69 bc
LSD %5	1,05	4,25	1,44	3,30	1,05

CV: common vetch, HV: Hungarian vetch, NV: Narbon vetch, O: oat, B: barley.

Plant height of pure stand and mixture of common vetch was between 81,56-105,06 cm (Table 2). With regard to different combination of CV, the highest plant height (105,06 cm) and the highest CV ratio (% 61.33) was observed at HV+CV combination; maximum branch number per plant (4,55) was determined from B+CV mixture. Fresh forage production is the important character for forage crops. Fresh forage yield was found between 26,21(t ha^{-1}) and 36,52(t ha^{-1}). Also, dry forage yield was recorded between 6,03(t ha^{-1}) and 9,17 (t ha^{-1}). The highest fresh forage yield (36,52 t ha^{-1}) and dry forage yield (9,17 t ha^{-1}) was obtained NV+CV combination. The results are in agreement with Budaklı Carpıcı and Celik (2014), Tuna and Orak (2007), Erol et al., (2009) and Lithourgidis et al., (2007). Moreover, Orak and Nizam (2012) also reported that fresh and dry forage yield of pure stand common vetch were 2231,92 kg da^{-1} and 434,48 kg da^{-1}, respectively, in the same study fresh and dry forage yield of common vetch mixtures with other vetch and barley were determined between 2735,72-3696,00 and 531,83-969,33 kg da^{-1}, respectively. Our finding were relatively similar to Mohsenabadi et al., (2008) and Ullah et al., (2015) who proposed that intercropping of vetch was more productive than sole crop of either species.

Results of mixtures at Hungarian vetch harvest time:-

The yield and yield parameters of pure stand and mixture of Hungarian vetch averaged over-two-year data were present in Table 3. Significant differences were found among the different mixture combination of Hungarian vetch for plant height, Hungarian vetch ratio, branch number per plant, fresh forage yield and dry forage yield (Table 3).

Table 3:- Plant height, Hungarian vetch ratio, branch number per plant, fresh forage yield and dry forage yield of HV and its combination

Combinations	Plant height (cm)	HV ratio (%)	Branch number/plant	Fresh forage yield (t ha^{-1})	Dry forage yield (t ha^{-1})
HV	112,67 a	---	2,85 c	27,99 e	8,80 b
NV+HV	105,17 b	45,33 a	2,77 c	47,35 a	11,37 a
CV+HV	91,50 c	38,67 b	3,33 b	35,41 cd	8,21 b
O+HV	86,83 d	26,50 c	3,58 b	34,83 cd	8,46 b
B+HV	78,86 f	36,33 b	4,85 a	49,53 a	12,04 a
CV+NV+HV	76,41 f	21,83 d	2,82 c	37,50 bc	8,65 b
CV+B+HV	81,83 ef	28,83 c	4,63 a	39,53 b	9,06 b
CV+O+HV	83,98 de	20,17 d	3,61 b	33,17 d	8,06 b
LSD %5	4,29	2,47	0,43	3,88	1,05

CV: common vetch, HV: Hungarian vetch, NV: Narbon vetch, O: oat, B: barley.

Plant height of HV was determined between 76,41 and 112,67 cm (Table 3). With regard to different combination of HV, the highest plant height (112,67 cm) was observed from sole crop HV sowing, the highest HV ratio (% 45,33) was observed at NV+HV combination. Minimum and maximum branch number of HV was found to be 2,77 and 4,85 respectively. Maximum branch number (4,85) was determined from B+HV mixture. Fresh forage yield was between 27,99-49,53 t ha^{-1} and dry forage yield was between 8,06-12,04 t ha^{-1}. Maximum fresh forage yield (49,53 t ha^{-1}) was obtained from B+HV combination; the highest dry forage yield (12,04 t ha^{-1}) was obtained B+HV combination. Nizam et al., (2011) reported that fresh forage yields of HV genotypes were 11951,91 -14902,71 kg ha^{-1} and dry matter yields of HV genotypes were 2884,69-3378,89 kg ha^{-1}. Orak and Nizam (2012) determined that fresh and dry forage yield of pure stand Hungarian vetch were 2474,45 and 516,76 kg da^{-1}, respectively. Additionally, fresh forage yield of Hungarian vetch mixtures with other vetch and barley were determined between 2386,95 and 4031,39 kg da^{-1} dry forage yield changed between 706,08 and 1082,63 kg da^{-1}, respectively. These results are lower from our findings. Differences may originate from location and mixture combination.

Results of mixtures at Narbon vetch harvest time:-

Narbon vetch is the native crop of Trakya Region generally using for cattle feeding. The yield and yield parameters of pure stand and mixture of Narbon vetch averaged over-two years data were present in Table 4. Plant height, Narbon vetch ratio, branch number per plant, fresh and dry forage yield were significantly influenced by the different mixture combination of Narbon vetch (Table 4).

Table 4:- Plant height, Narbon vetch ratio, branch number per plant, fresh forage yield and dry forage yield of NV and its combination

Combinations	Plant height (cm)	NV ratio (%)	Branch number/plant	Fresh forage yield (t ha^{-1})	Dry forage yield (t ha^{-1})
NV	128,00 a	---	2,83 a	25,64 d	9,37ab
HV+NV	105,83 b	40,50 e	2,35 bc	27,39 d	9,11 b
CV+NV	98,33 bc	55,17 b	2,43 bc	36,36 ab	10,35 ab
O+NV	95,83 cd	61,50 a	1,91 d	39,88 a	11,05 a
B+NV	94,83 cd	51,50 c	2,20 bc	29,99 cd	8,86 b
CV+HV+NV	92,33 cde	47,00 d	2,65 ab	26,36 d	8,67 b
CV+B+NV	87,33 de	34,33 f	1,62 d	38,35 a	9,50 ab
CV+O+NV	83,17 d	37,67 e	1,67 d	32,89 bc	9,02 b
LSD %5	9,60	3,23	0,34	3,30	1,91

CV: common vetch, HV: Hungarian vetch, NV: Narbon vetch, O: oat, B: barley.

Plant height of NV changed between 83,17 cm and 128,00 cm (Table 4). Maximum plant height (128.00 cm) was determined from pure stand Narbon vetch sowing. Orak and Nizam (2009) and Nizam et al., (2011 a) findings were reported that plant heights of NV genotypes were change between 43,00 cm and 102,28 cm in addition 43,02 cm and 78,85 cm, respectively. Our findings for plant height of NV are accordance with Orak and Nizam (2009) and Nizam et al., (2011). NV ratio was found highest (61,50 %) on O+NV mixture than the other combinations. Branch number per plant of NV was between 1,62-2,83. Maximum branch number per plant (2,83) was determined from sole NV plots. Similar results have been obtained by Nizam et al. (2011) that branch number of NV was changed between 1,40 and -3,17. Fresh forage yield and dry forage yield were between 2564,00-3988,33 kg da^{-1} and 902,50-1105,50 kg da^{-1}, respectively. In addition, the highest fresh forage yield (3988,33 kg da^{-1}) was determined from O+NV combination, maximum dry forage yield (1105,50 kg da^{-1}) was determined from O+NV combination. Our finding was relatively similar to Orak and Nizam (2012). The researcher reported that fresh and dry forage yield of pure stand Narbon vetch were 2826,86 and 501,52 kg da^{-1}, respectively. Additionally, fresh and dry forage yield of Narbon vetch mixtures with other vetch and barley were determined between 3293,71-3940,19 kg da^{-1} and 739,05-768,59 kg da^{-1}, respectively. Our results were found to be higher from previous studies. It can be caused by mixture combination, climate and soil conditions.

Results of mixtures at barley vetch harvest time:-

The vetch ratio in the mixtures can arise quality of harvested herbage. Barley is very important forage greens. Additionally, cereals are known intercropping of grows with legume provides structural support of climbing vetches and improves light interception. The yield and yield parameters of pure stand and mixture of barley averaged over

two-year data were present in Table 5. Significant differences were found among the different mixture combination of barley for plant height, barley ratio, fresh forage yield and dry forage yield (Table 5).

Table 5:- Plant height, barley ratio, fresh forage yield and dry forage yield of Barley (B) and its combinations

Combinations	Plant height (cm)	B ratio (%)	Fresh forage yield (t ha^{-1})	Dry forage yield (t ha^{-1})
B	99,33 bcd	---	33,62 b	8,73 b
NV+B	110,23 a	47,33 cd	28,19 c	7,73 bc
CV+B	97,17 cd	50,67 b	26,92 c	7,97 bc
HV+B	90,69 e	64,17 a	28,37 c	7,46 c
O+B	102,10 bc	49,7 bc	30,25 bc	8,04 bc
CV+NV+B	95,84 de	44,33 e	41,50 a	10,89 a
CV+HV+B	103,78 b	45,67 de	31,29 bc	7,83 bc
CV+O+B	100,82 bcd	37,00 f	27,03 c	7,79 bc
LSD %5	5,78	2,89	4,42	1,14

CV: common vetch, HV: Hungarian vetch, NV: Narbon vetch, O: oat, B: barley.

Plant height of barley was ranged between 90,69 and 110,23 cm (Table 5). Among the mixtures; maximum plant height (110,23 cm) obtained from NV+B combinations. Fresh and dry forage yield were between 26,92-41,50 t ha^{-1} and 7,47-10,89 t ha^{-1}, respectively. The highest fresh forage yield (41,50 t ha^{-1}) and dry forage yield (10,89 t ha^{-1}) were determined from CV+NV+B mixture. In addition, maximum barley ratio (64,7 %) was determined from HV+B combination. The results are in agreement with Ansar et al., (2010) and Lithourgidis et al., (2007).

Results of mixtures at oat harvest time:-

The yield and yield parameters of pure stand and mixture of oat averaged over-two years data were present in Table 6. Plant height, oat ratio, fresh forage yield and dry forage yield were significantly influenced by the different mixture combination of oat (Table 6).

Table 6:- Plant height, oat ratio, fresh and dry forage yield of oat (O) and its combination

Combinations	Plant height (cm)	O ratio (%)	Fresh forage yield (t ha^{-1})	Dry forage yield (t ha^{-1})
O	75,68 d	---	35,60 ab	8,92 ab
NV+O	83,83 b	59,33 b	37,42 a	9,49 a
CV+O	80,62 bc	58,33 bc	28,33 e	7,63 d
HV+O	83,63 b	73,67 a	24,51 f	6,01 e
B+O	75,69 d	56,00 c	31,83 cd	8,19 cd
CV+NV+O	79,28 bc	51,67 d	35,23 ab	8,22 c
CV+HV+O	103,29 a	49,33 d	33,35 bc	8,75 bc
CV+B+O	80,74b c	35,00 e	30,10 de	8,45 bc
LSD %5	5,48	3,27	2,96	0,58

CV: common vetch, HV: Hungarian vetch, NV: Narbon vetch, O: oat, B: barley.

Lowest and highest plant height of oat was found to be 75,68 cm and 103,29 cm (Table 6). Among the different mixture ratio of oat with the other legume and cereal; the highest plant height of oat (103,29 cm) was obtained from CV+HV+O mixture; the highest ratio of oat (73,67 %) was observed from HV+O combination. Fresh forage yield was between 24,51-37,42 t ha^{-1}. Also, dry forage yield was between 6,01-9,50 t ha^{-1}. Maximum fresh forage yield (37,42 t ha^{-1}) and dry forage yield (9,50 t ha^{-1}) were obtained from NV+O combination. The results are in line with the findings of Tuna and Orak (2007), Ullah et al., (2015) and Erol et al., (2009). Some results differ with the findings of Tuna and Orak (2007), who reported the highest plant height in pure stand.

Conclusion:-

This study showed that vetch – cereal mixture performed better under dryland conditions in terms of fresh and dry forage yield.

Plant height, common vetch ratio, branch number per plant, fresh forage yield and dry forage yield of mixtures of common vetch were 81,56-105,06 cm, % 28,33-61,33, 2,67-4,55, 26,21-36,52 t ha^{-1} and 6,03-9,17 t ha^{-1}, respectively.

Plant height, Hungarian vetch ratio, branch number per plant, fresh forage yield and dry forage yield of mixtures of Hungarian vetch were 76,41-112,67 cm, % 28,83-45,33, 2,77-4,85, 27,99-49,53 t ha^{-1} and 8,06-12,04 t ha^{-1}, respectively.

Plant height, Narbon vetch ratio, branch number per plant, fresh forage yield and dry forage yield of mixtures of Narbon vetch were 83,17-128.00 cm, % 34,33-61,50, 1,62-2,83, 25,64-39,88 t ha^{-1} and 9,03-11,06 t ha^{-1}, respectively.

Plant height, barley ratio, fresh forage yield and dry forage yield of mixtures of barley were 90,69-110,23 cm, % 37,00-64,17, 2691,67-41,50 t ha^{-1} and 7,47-10,89 t ha^{-1}, respectively.

Plant height, oat ratio, fresh forage yield and dry forage yield of mixtures of oat were 75,68-103,29 cm, % 35.00-73,67, 24,52-37,42 t ha^{-1} and, 6,02-9,50 t ha^{-1}respectively.

The highest dry forage yield was determined from NV+CV combination (9,17 t ha^{-1}) for common vetch harvest time, from B+HV combination (12,04 t ha^{-1}) for Hungarian vetch harvest time, from O+NV combination (11,06 t ha^{-1}) for Narbon vetch harvest time, from CV+NV+B combination (10,89 t ha^{-1}) for barley harvest time, from NV+O combination (9,50 t ha^{-1}) for oat harvest time.

In conclusion, mixtures with oat and Narbon vetch were in harmony for highest forage yield. Similarly, highest forage yield was obtained from mixture of Hungarian vetch and barley. Common vetch and Narbon vetch mixture has a good performance. Additionally, mixture with barley of these two-vetch species has increased even more forage yield.

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