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SILAGE YIELD AND PROTEIN CONTENT OF FORAGELEGUMES INTERCROPPING WITH CEREALS

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ABSTRACT

Intercropping of most annual legumes with winter cereals is a very common practice for forage production in many countries. The aim of this study was to determine the effect of intercropping cereals with forage legumes on silage yield and protein content. The completely randomized design was applied with three replications and the experiment was established in the farm of the Western Macedonia University in Florina. Particularly, common vetch, forage pea and faba beans were used as forage legumes, and barley, bread wheat and triticale were used as cereals, which were grown individually as well as intercropped with each other in mixed rows in a sowing ratio 65:35. The plots consisted of seven rows five meters long of which the five inner were harvested. A total of 45 experimental plots was installed. The field was fertilized only with base fertilization. All the cultural practices used by farmers were applied. The plants were harvested when the legumes were at the end of the flowering period and were dried naturally for the formation of hay. The plants were separated by hand to determine the weight of fresh matter for each species. Samples of 100 g of hay from each experimental plot were used to calculate the dry matter and to determine the total N using the Kjeldahl method and subsequently the total protein content. In most cases differences were found between the treatments concerning the dry matter and the protein content giving a better proportion in the mixtures.

Key words: *intercropping, dry matter, protein content.*

INTRODUCTION

Legumes are very important crops in Greece, because both hay (dry grass) and seed are considered to be high-nutrient feed, due to their high protein content (30-35%), inorganic minerals calcium and phosphorus and vitamins. In addition, legume proteins are characterized as proteins of high biological value, which makes them an essential component of animal feed, as a supplement to cereals. Intercropping of most annual legumes with winter cereals is a very common practice for animal feed production in many countries (Qamar et al., 1999; Clergue et al., 2005). One of the

most widely used legumes in intercropping systems in the Mediterranean region is common vetch (*Vicia sativa L.),* an annual plant that contains high levels of protein and is grown with cereals to produce hay or seed. Another livestock feed that could also be used in mixtures is faba beans (*Vicia faba L.*), an annual well-adapted legume in Greece, due to the high content of their seed in protein (26.5%). According to research data, intercropping of legumes with cereals provides stable biomass yields and forage quality, (Lithourgidis et al., 2007; Galanopoulou et al., 2019) and has a positive effect to soil properties, to efficient competition with weeds, and extension of harvest time (Banik et al. 2006,Vasilakoglou et al. 2008). There are also some, biological and ecological advantages in intercropping over mono-cropping (Mohammed et al., 2008, Jensen et al. 2020). However, it has been found that the competition of cultivated plants in water, nutrients and light usually reduces the yield of the mixture compared to monoculture (Lithourgidis et al., 2008, Lithourgidis and Dordas 2010, Menber et al., 2015). So, mush careful considerations are needed in order to select the proper intercropping system. The objective of this study was to determine the effect of intercropping cereals with forage legumes on silage yield and protein content under the special climatic conditions of the Florina area.

MATERIALS AND METHODS

In the farm of the University of Western Macedonia in Florina, the cultivation season 2019-2020, Greek varieties of livestock legumes and cereals were intercropped. Particularly, common vetch, forage pea and faba beans were used as forage legumes, and barley, bread wheat and triticale were used as cereals, which were grown individually as well as intercropped with each other in mixed rows in a sowing ratio 65:35.Thus 15 different treatments were created and a total of 45 experimental plots was installed. The examined genotypes were sown in early November 2019 in a field, that had been cultivated with cereals the previous season, in a sandy loam soil. The plots consisted of seven rows five meters long of which the five inner were harvested. The distances between rows were 0.25m. The completely randomized design with three replications was used. The field was fertilized only with diammonium phosphate (20-10-0) before sowing so that 80 and 40 kg ha^{-1}, Nitrogen and P_20_5 respectively were added into the soil. The crop was kept free of weeds by hand hoeing when necessary. The total chloromass was harvested around the end of the legume flowering period (late May - early June) and dried naturally to form hay. The plants were separated by hand to determine the fresh weight of each species. Samples of 100 g of hay from each experimental plot were placed at 65oC for 96h to calculate the dry matter, and in addition to determine the total N using the Kjeldahl method and subsequently the total protein content. Data were statistically analyzed and the means were compared according to LSD test at p=0.05.

RESULTS AND DISCUSSION

Significant differences were recorded between the examined cultivars in fresh and dry weight (significant differences at p=5%, Table 1). Fresh weight ranged from 35940Kg/ha in mixture bread wheat+ forage pea to 11660 kg/ha in faba bean (monocropping) (Table 1).The mixtures triticale + forage pea and barley +forage pea and the monocropping forage pea showed high yield as well. Dry weight ranged from 12240Kg/ha in mixture bread wheat+ forage pea to 3120 kg/ha in faba bean (monocropping). So concerning the dry matter the mixture bread wheat+ forage pea is still more productive. The superiority of wheat as the cereal included in an intercropping system was stated also by Roberts et al. (1989). Nevertheless in this study the mixtures barley + vetch, barley + forage pea, triticale + vetch and triticale + forage pea had almost equally high yield as well. The above results suggest that the intercrops may have higher dry matter yield than the respective monocrops. The same was reported by Chapagain and Riseman, (2014) when barley is intercropped with pea in a sowing ratio 2:1. Nevertheless Javanmard et al. (2014) reported that the intercropping of barley with vetch and grass pea, resulted in reduced dry matter yield compared to their respective monocrops.

Table 1. The fresh weight, the weight of dry matter, the protein content % fresh weight, and the protein content % dry weight

GENOTYPE	Fresh Weight Kg/ha	Dry Weight Kg/ha	Protein % fresh weight	Protein % dry weight
Triticale	15340e	7380b	2.91gh	6.26g
Bread wheat	14340e	7980b	2.56h	4.87g
Barley	12660e	7660b	3.97efgh	6.43g
Forage Pea	28400abc	7840b	6abcd	20.18a
Vetch	17660de	6780bc	7ab	17.98abc
Faba beans	11660e	3120c	5.62abcde	19.85ab
Triticale + Forage Pea	29140ab	8600ab	5.26bcde	11.77def
Triticale+ Vetch	23540bcd	9840ab	6.53abc	14.84bcd
Triticale + Faba beans	20340cde	7920b	4.67defg	10.78def
Bread wheat + Forage Pea	35940a	12240a	4.23defgh	11.13def
Bread wheat + Vetch	20460bcde	8240b	4.78cdef	12.21de
Bread wheat + Faba beans	15660de	6500 bc	3.09fgh	7.84fg
Barley + Forage Pea	27600abc	8920ab	5.47abcde	14.02cd
Barley + Vetch	20260cde	9920ab	7.26a	14.14cd
Barley+ Faba beans	15540e	7900b	3.96efgh	8.68efg

Means in columns followed by different letters, are significantly different at $p<0.05$ by LSD test.

Regarding the protein content % fresh weight and protein content % dry weight, the differences were significant (Table 1). The protein content % fresh weight ranged from 7.26% in mixture barley + vetch to 2.56 in bread wheat. The protein content % dry weight ranged from 20.18% in forage pea to 4.87 in bread wheat. Faba beans and vetch did not differ significantly from the forage pea concerning the protein content % dry weight. The mixture triticale+vetch was the best among the mixtures following by the barley +forage pea and barley+vetch and all of them were significantly better than the cereals monocrops. The same was reported by Lauk and Lauk (2005) who concluded higher protein yield in intercropping legumes with cereals compared to respective monocrop of cereal. Lithourgidis et al. (2007) reported that intercropping common vetch with barley or winter wheat produced forage of higher quality than the other intercrops. In this study this is not entirely the case because the mixture wheat +vetch showed intermediate protein content % dry weight. Additionally, it should be mentioned that the most productive mixture bread wheat+ forage pea had intermediate protein content % dry weight and the mixtures that combine both high yield and high protein content are the triticale+ vetch and the barley intercropping with forage pea and vetch.

CONCLUSIONS

It was concluded that concerning the dry matter the mixture bread wheat + forage pea is more productive followed by the mixtures of barley and triticale intercropped with common vetch, and forage pea. Forage pea, faba beans and common vetch have higher protein content % dry matter compared to other monocrops and the mixtures. Among the mixtures the triticale + vetch and the intercrop of barley with forage pea and common vetch had higher protein content % dry matter and therefore were the ones that could produce forage of high quality. A first estimate of these results leads to the conclusion that promising mixtures for production of high quality forage are the mixture triticale + common vetch and the intercrop of barley with forage pea and common vetch. However, further research, including several seeding ratio and different spatial arrangement of the individual crops, is needed to confirm the results of the present study.

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