



Evaluation of Growing Some Legume Forage Crops as Second Crop

Ali ÖZEL^{1,*}, Ramazan ACAR²

¹Selçuk University, Institute of Science, Department of Field Crops, Konya, Turkey

²Selçuk University, Faculty of Agriculture, Department of Field Crops, Konya, Turkey

ARTICLE INFO

Article history:

Received date: 14.12.2021

Accepted date: 27.01.2022

Keywords:

Legumes

Second Crop

Common Vetch

Field Pea

Green Yiled

ABSTRACT

Aim of the present research was evaluation of growing some legume forage crops as second crop following to cereal harvest under irrigated conditions. Field trial was realized under Seydişehir Town – Konya City / Turkey ecological conditions for 2 years during the both vegetation periods of 2019-2020 years by 4 replications according to randomized blocks design. As material; forage pea (*Pisum sativum L.*), soybean (*Glycine max. L.*), hairy vetch (*Vicia villosa Roth.*), common vetch (*Vicia sativum L.*), and fenugreek (*Trigonella foenum-graecum L.*) were used. According to the results of the research, statistically significant differences were found for plant height and green herbage yield as mean of the years. The obtained data also showed that the highest plant height and green herbage yield were taken from forage pea and common vetch. Additionally, plant height was between 126.76-117.94 cm values for pea and common vetch, while green herbage yield was 3085.50⁻¹ and 2788.63 kg da⁻¹ for pea and common vetch, respectively. Consequently, legume forage crops as second crop following to the harvest of cereals may be successfully grown under irrigated conditions.

1. Introduction

Legume forage crop growing is essential to decrease the feeding costs that approximately 70% in livestock enterprises (Parlak and Sevimay 2007; Alçiçek et al 2010; Sabancı et al 2010, Özkan and Demirbağ 2016). In some cases, roughage is indispensable for livestock enterprises which is provided from pastures that has low yield, the hay of main crops, straw, and stem (Açıkgöz et al 2005; Özkan and Demirbağ 2016). According to various reports, the productivity potential of livestock consuming these kind of forage crops is low (Alçiçek et al 2010; Göçmen and Parlak 2017) and excessive usage of concentrated feed is increased the feeding costs (Açıkgöz et al 2005). In recent years, there is a need for farmers to produce their feed in closed system livestock (Sabancı et al 2010).

Previous studies that forage crops can be successfully grown as the main crop and second crop as well under several ecological conditions (Açıkgöz et al 2005; Acar et al 2007). Nevertheless, non-competitive forage crops comparing to other crops are more grown as a by-product, second crop or intercropping (Açıkgöz et al

2005; Alçiçek et al 2010). Deep root system and legumes performing high biomass that is quite important by view of agriculture welded by their benefits like protecting and improving the soil and increasing organic matter of the soil, in addition to production of forage (Anonymous 2000; Çeçen et al 2005; Zai et al 2008; Özyazıcı et al 2009; Ceyhan et al 2014; Kahraman 2017). Therefore, the ratio of forage crops should be increased to provide the need of desired quality roughage and also protect the health of soil. These crops should be concentrated on their cultivation opportunities as a by-product, second crop, or intercropping to increase the cultivation area of non-competitive forage crops compared to other crops (Açıkgöz et al 2005). In particular, agricultural lands that have the opportunity to irrigate remains fallowing lands for 3-4 months after the barley harvest in Konya (Özer 1992; Acar 1995; Acar et al 2007; Parlak and Sevimay 2007; Kahraman and Onder 2018). In this period, pastures are the inefficient period in similar ecologies (Özer 1992; Acar 1995), when it is hard to find out green fodder (Sabancı et al 2010).

Growing legume forage crops as the second crop after harvesting of cereals have been extensively examined by many researchers as Özer (1992), Acar (1995), Kerimbek and Mülayim (2003), Aşıcı (2006), Taşpınar

*Corresponding author email: aliozel42@gmail.com

et al (2009), Dereli (2015), İleri et al (2020). For instance, Özer (1992) suggested that legumes can be successfully grown by direct sowing in the July-October period after wheat harvest in Konya ecological conditions. Another similar study by Acar (1995) recommended fenugreek, common vetch, and mixtures of field pea+oat in irrigable fields in the July-October period after barley harvest under conditions of Konya and similar ecologies in an attempt to produce high-quality roughage. Report by Kerimbek and Mülayim (2003) implicated that maize alone or a mixture of maize, common vetch and peas can be grown after grain harvest in Konya conditions to obtain green herbage yield and silage. Additionally, Asıcı (2006) implied that growing of pea can be arranged after wheat harvest in Seydişehir Town – Konya City ecological conditions in an attempt to produce high-quality roughage. The study of Taşpınar et al (2009) reported 400 kg da⁻¹ green yield of common vetch after cereal harvest under conditions of Eskişehir. In a recent study, Dereli (2015) emphasized that annual forage legumes can be grown in the July-October period after barley harvest in Eskişehir conditions. A recently study by İleri et al (2020) reported the possibility of the cultivation of annual forage legumes after wheat harvest under conditions of Eskişehir. In light of the mentioned studies, it is possible to grow short-vegetation forage legumes under irrigated conditions in this period (Acar 1995; Kerimbek and Mülayim 2003; Çeçen et al 2005; Acar et al 2007; Parlak and Sevimay 2007).

For the mentioned reasons above, aim of the present research is to determine the most suitable legume forage crop that can be grown for roughage as a second product in the period after the grain harvest in irrigated agricultural lands in Konya - Turley ecological conditions. Therefore, the results of the present research will contribute to the scientific literature by providing the roughage demand for the livestock enterprises. Furthermore, evaluation of legume forage crops as second crop will add new knowledge to the literature and new insights to the relative researchers.

2. Materials and Methods

Present research was conducted to determine the best legume forage crops as the second crop after harvesting of cereal (barley) under irrigated conditions, between July and September for 2 years during both 2019 and 2020 vegetation periods. Field experiment was realized in a farmer's field under the ecological conditions of Seydişehir Town of Konya City in Turkey. Field trial was set up according to randomized blocks design with 4 replications, by each experimental plot covering 8 m² (4m x 2m) total area. Each plot consisted from 10 rows by 20 cm of spaces.

According to long-term (1964-2021) climate data (data collected from: Konya Meteorology 8th Regional Directorate), the average of total annual rainfall of Seydişehir is 742.9 mm, the average temperature is 10.8°C and the average relative humidity is 62.1%. Similar with the long term climatic period, 279.4 mm, 15.6°C, and

56.9 % were detected respectively during the period of experiment in 2019 year. Total rainfall, relative temperature, and relative humidity were 585.6 mm, 12.4°C, and 58.7 % respectively during the period of experiment in 2020 year. Experiment soil was characterized as follows: loamy structure, neutral reaction (pH 7.27), lower level of organic matter (0.88 %), enough level of phosphorus (17.07 kg da⁻¹), higher content of potassium (109.71 kg da⁻¹), and a higher level of lime (2.34%). The aim of present research is the determination of the most suitable legume forage crop that can be grown for desired roughage qualifications as a second product in the period after the grain harvest in irrigated agricultural lands in Konya conditions.

As material of the study, Özkaynak cultivar of forage pea (*Pisum sativum L.*), Yemsoy cultivar of soybean (*Glycine max. L.*), Munzur-98 cultivar of hairy vetch (*Vicia villosa Roth.*), Kubilay-82 cultivar of common vetch (*Vicia sativum L.*), and population of fenugreek (*Trigonella foenum-graecum L.*) were used. Sowing of the seeds were made by hand in the first week of July in each experimental year (2019 and 2020). Seeding rates were applied that 15 kg da⁻¹ for forage pea (Turgut et al 2005), 8 kg da⁻¹ for fenugreek (Acar 1995), 12 kg da⁻¹ for common vetch (Ay and Mut 2017), 12 kg da⁻¹ for hairy vetch, 10 kg da⁻¹ for soybean (Bilgili et al 2005). Fertilizer was applied that before sowing at the rate of 4 kg da⁻¹ N with 20.20.0 fertilizer (Ülger et al 1999; Polat and Almaca 2006). Depending on soil and plants conditions, irrigations were done 5 times in total for both of the experiment years. Weed control was done by hand. Legume forage crops were harvested by hand in mid-September in each experimental year.

In the research, plant height (cm) was calculated by measuring and get average the heights from the soil surface to the plant top point of 10 plants in total (Doğan and Terzioğlu 2019). In experimental plots, 50 cm sides from the two rows and the two ends of the rows were taken as side factor and ignored for all the measurements, observations and analysis. Harvesting was performed on a remaining area of 1 m² and samples from each plot were weighed to get green forage yields. Plot yields were converted into yields per decare (Acar 1995; Çeri and Acar 2019). Green forage samples (1 kg from each plot) were dried at 70°C for 48 hours and weighed to get hay yields. Then, yields were converted into hay yields per decare (Anonymous 2019).

The investigated data were subjected to variance analysis by computed based statistical program "MSTAT-C" by randomized blocks design with 4 replications. According to the analysis of variance results, statistically significant factor means were compared by the LSD test (Çeri and Acar, 2019). Grouping test was realized according to significance level.

3. Results and Discussion

3.1. Plant Height (cm)

Analysis of variance results related to plant height is given in Table 2. As it is shown in Table 2, according to legume plant species there were statistically significant differences at 1% level for plant height. Statistically

insignificant differences were found for year and year x plant interactions.

Table 2
Analysis Of Variance Regarding Plant Height Values In Legumes

Source of variation	Degrees of freedom	Sum of squares	F value
Replication	3	75.089	1.2384
Year (A)	1	104.763	1.7277
Plant (B)	3	4246.772	70.0377 **
Year x Plant	3	77.994	1.2863
Error	21	60.636	-
General	31		-

CV %: 7.54, (**) shows that the difference between treatments is significant at the 1% level.

According to the year factor of present research, average values and LSD groups found for plant height are given in Table 3. According to these results, the highest

value was obtained with 126.76 cm and 117.94 cm from forage pea and common vetch respectively while the lowest plant height was obtained with 90.90 cm and 77.34 cm from soybean and fenugreek respectively.

Table 3
Plant Height Values in Legumes (cm)

Plants	Years		Average
	I. Year	II. Year	
Common vetch	119.93	115.95	117.94 a
Fenugreek	75.63	79.05	77.34 c
Field pea	127.88	125.65	126.76 a
Soybean	96.75	85.05	90.90 b
Average	105.04	101.43	103.23

LSD_{Plants}: 11.02, Lettering was done according to the significance in the analysis of variance.

The plant height of common vetch was measured 115.95-119.93 cm respectively in 2019 and 2020 research years. The average plant height of common vetch also was measured 117.94 cm in our study (Table 3). Özer (1992), Acar (1995), and Kerimbek and Mülayim (2003) reported the plant height of common vetch that cultivated after cereal harvest, as 58.00 cm, 116.44 cm, 63.24 cm respectively under the conditions of Konya. Dereli (2015) detected that the plant height of common vetch cultivated after cereal harvest ranged between 72.21-83.00 cm under the conditions of Eskişehir. According to these results, the results of Acar (1995) are similar to the findings in our investigation. On the other hand, our research findings are higher than those of Özer (1992), Kerimbek and Mülayim (2003), Dereli (2015).

According to Table 3, the plant height of fenugreek was measured as 75.63-79.05 cm in 2019 and 2020, respectively. The average plant height of fenugreek also was measured as 77.34 cm in our study (Table 3). Acar (1995) reported the plant height of fenugreek that cultivated after cereal harvest, as 75.55 cm under the conditions of Konya. Boran (2011) detected that the plant height of fenugreek was 36.58 cm under the conditions of Ankara. Hosamath and Hedge (2018) reported the plant height of fenugreek ranged between 72.21-83.00 cm under the conditions of India. In another study conducted by Alp (2019), the plant height of fenugreek was determined that range between 20.47-

38.63 cm conditions of Şanlıurfa. Our results related to a plant height of fenugreek were similar to values reported by Acar (1995), Hosamath, and Hedge (2018). But it is higher than those reported by Boran (2011), Alp (2019).

Present research showed the plant height values of forage pea as 127.88 cm in the first research year, as 125.65 cm in the second research year. The average plant height of forage pea also was measured at 126.76 cm in our study (Table 3). Özer (1992), Acar (1995), and Kerimbek and Mülayim (2003) reported the plant height of forage pea cultivated after cereal harvest, as 53.00 cm, 109.44 cm, 81.27 cm respectively under the conditions of Konya. In the similar study conducted under conditions of Seydişehir, Aşıcı (2006) reported the plant height of forage pea ranged between 72.21-83.00 cm. Also, the plant height of forage pea cultivated as the second crop in conditions of Konya was measured by Özdemir (2019) between 43.3-105.0 cm. On the other hand, Dereli (2015) and İleri et al (2020) reported the plant height of forage pea cultivated after cereal harvest, as 119.8 cm and 114.78 cm, respectively under the conditions of Eskişehir. According to these results, the results of Acar (1995), Aşıcı (2006), Dereli (2015), Özdemir (2019), and İleri et al (2020) are similar to the findings in our investigation. But it is higher than those reported by Özer (1992), Kerimbek, and Mülayim (2003).

Table 3 presents that, the plant height of soybean was measured as 96.75-85.05 cm in 2019 and 2020, respectively. The average plant height of fenugreek also was detected as 90.90 cm in our study (Table 3). Ada et al (2009) reported that the plant height of soybean was 76.8 cm in their study under the conditions of Konya. In the study that carried out on soybean in conditions of Bursa, plant height was measured as 98.3 cm by Sincik et al (2009), while Şenbek and Açıkgöz (2019) reported plant height as 81.2 cm under similar conditions. On the other hand, Erdoğan et al (2013) determined 52 cm plant height from soybean under the conditions of Ankara, while Şahar (2017) reported that plant height soybean that cultivated as a second crop under the conditions of Adana, ranged from 110.5-158.0 cm. Plant height of soybean was reported that ranged from 91.40-114.97 cm by Boydak et al (2018) under the conditions of Bingöl. According to the results obtained in these studies, our research findings are higher than those of Ada et al (2009) and Erdoğan et al (2013), while being lower than those of Şahar (2017), and also Boydak et al (2018) as well. On the other hand, the results of Sincik et al (2009), Şenbek and Açıkgöz (2019) are similar to the findings in our investigation. It was indicated that; in general, plant height of forage type soybeans cultivars is much higher than soybean genotypes (Şenbek and Açıkgöz 2019; Açıkgöz et al 2020).

Table 4
Analysis Of Variance Regarding Green Yield Values In Legumes

Source of variation	Degrees of freedom	Sum of squares	F value
Replication	3	529110.417	3.0429
Year (A)	1	499500.125	2.8726
Plant (B)	3	1356779.417	7.8027 **
Year x Plant	3	651517.042	3.7468 *
Error	21	173885.012	
General	31		

CV %: 16.04 (*) while showing that the difference between treatments is significant at the 1% probability limit. (**) shows that the difference between treatments is significant at the 5% probability limit.

Data of the present research showed that, average values of green herbage yields and LSD groups found for green herbage yields are given in Table 5. According to these results, the highest green herbage yield of the legumes was obtained with 3085.50 kg da⁻¹ from forage

Table 5
Green Herbage Yields Of Legumes (kg da⁻¹)

Plants	Years		Average
	I. Year	II. Year	
Common vetch	2762.00 ab	2815.25 ab	2788.63 ab
Fenugreek	2138.50 cd	2506.50 bc	2322.50 b
Field pea	3341.00 a	2830.00 ab	3085.50 a
Soybean	2654.25 bc	1744.50 d	2199.38 b
Average	2723.94	2474.06	2599.00

LSD_{Plants}:11.02, LSD_{Ym}: 613.2, Lettering was done according to the significance in the analysis of variance.

As the first and second years of the present study, the green herbage yield of common vetch was obtained that 2762.00 kg/ In our research in the first and second years, the green herbage yield of common vetch was obtained

Data of the present research showed that higher value of plant height from forage pea and common vetch compared with other plants in our study. In general for forage crops, due to the close relationship between green herbage yield and plant height, high plant height is a desirable characteristic (Özköse 2017).

As a comparison of present data, it can be seen that different results have been obtained. It is thought that the differences between our research findings and the findings in the literature are due to the ecological conditions in which the experiments were carried out, the genetic structure of the varieties, agricultural practices, and the purpose of cultivation.

3.2. Green Herbage Yield (kg da⁻¹)

Variance analysis results related to green herbage yields of legumes is given in Table 4. As it is appeared in Table 4, according to legume plant species there were statistically significant differences at 5 % level between green herbage yields, while according to year x plant interactions there were statistically significant differences at 1 % level between green herbage yields. Statistically significant differences were not observed between green herbage yields of legumes, in terms of years.

pea and it was followed by common vetch by 2788.63 kg da⁻¹. The lowest green herbage yield was obtained from soybean by 2199.38 kg da⁻¹, while the green herbage yield of fenugreek was observed at 2322.50 kg da⁻¹ (Table 5).

that 2762.00 kg da⁻¹ and 2815.25 kg da⁻¹ respectively. The average green herbage yield of common vetch also was measured at 2788.63 kg da⁻¹ in our study (Table 5). Some researchers have determined different values for

green herbage yield of common vetch that cultivated after cereal harvest. For example, Özer (1992), Acar (1995), Kerimbek and Mülayim (2003) reported that the green herbage yields of common vetch that cultivated after cereal harvest, as 2297.3 kg da⁻¹, 2128.55 kg da⁻¹, 1204.0 kg da⁻¹ respectively under the conditions of Konya. Also, in the studies conducted after cereal harvest under the conditions of Eskişehir, green herbage yield of common vetch was detected by Dereli (2015) and Taşpınar et al (2009), between 352.8-552.3 kg da⁻¹ and 400 kg da⁻¹, respectively. According to these results, while the average green herbage yield of common vetch was similar to the values found by Özer (1992) and Acar (1995) it was higher than the values reported by the researchers of Kerimbek and Mülayim (2003), Dereli (2015), Taşpınar et al (2009).

As it seen on Table 5, green herbage yield of fenugreek were measured as 2138.50-2506.50 kg da⁻¹ in 2019 and 2020, respectively. The average green herbage yield of fenugreek also was detected as 2322.50 kg da⁻¹ in our study (Table 5). Acar (1995) reported the green forage yield of fenugreek that cultivated after cereal harvest, 2871.97 kg da⁻¹ under the conditions of Konya. Karadağ and Büyükburç (1999) were determined the herbage yield as 1006.77 kg da⁻¹ from fenugreek that is grown as a spring crop in Tokat. In other research, Alp (2019) obtained ranging from 60.04-2156.50 kg da⁻¹ green herbage yield from fenugreek under the conditions of Şanlıurfa. In different studies that related to the herbage yield of fenugreek were obtained different results. For example, in Western Canada, between 795.7-1644 kg da⁻¹ green herbage yield was obtained from fenugreek (Basu et al 2009), while in Iraq, 1483-2040 kg da⁻¹ green herbage yield was obtained from fenugreek (Said et al 2019). It is seen that in the other studies, there was a significant variation in the green herbage yield of fenugreek. According to these results, our findings that for green herbage yield of fenugreek were higher than the values reported by the researchers Basu et al (2009), Alp (2019), Said et al (2019), while our findings were lower than those of Acar (1995).

Present research showed that, the green herbage yield of forage pea was determined as 3341.00 kg da⁻¹ in the first research year, as 2830.00 kg da⁻¹ in the second research year. The average green herbage yield of forage pea also was measured at 3085.50 kg da⁻¹ in our study (Table 5). Özer (1992), Acar (1995), and Kerimbek and Mülayim (2003) reported the green herbage yield of forage pea that cultivated after cereal harvest, as 1503.50 kg da⁻¹, 2031.51 kg da⁻¹, 1416.50 kg da⁻¹ respectively under the conditions of Konya. In the similar study conducted under conditions of Seydişehir, Aşıcı (2006) reported the green herbage yield of forage pea ranged between 2191.80-5191.20 kg da⁻¹. On the other hand, Dereli (2015) and İleri et al (2020) reported the green herbage yield of forage pea cultivated after ce-

real harvest, as 1606.60 kg da⁻¹ and 850.14 kg da⁻¹, respectively under the conditions of Eskişehir. Also, the green herbage yield of forage pea cultivated as the second crop in conditions of Antalya was measured by Çeçen et al (2005) as 1219 kg da⁻¹. According to these results, the results of Aşıcı (2006) are similar to the findings in our investigation, while our research findings are higher than those of Özer (1992), Acar (1995), Kerimbek and Mülayim (2003), Çeçen et al (2005), Dereli (2015) and İleri et al (2020).

According to Table 5, the green herbage yield of soybean was measured as 2654.25-1744.50 kg da⁻¹ in 2019 and 2020, respectively. The average green herbage yield of soybean also was detected as 2199.38 kg da⁻¹ in our study (Table 5). Erdoğan et al (2013) was determined the herbage yield as 2101 kg da⁻¹ from soybean that grown on irrigable lands in Ankara. Kökten et al (2014) obtained ranging from between 1204.7-1652.7 kg da⁻¹ green herbage yield from soybean under the conditions of Bingöl. In different studies that related to the herbage yield of soybean were obtained different results. For example, in Bursa, ranged between 1204.7-1652.7 kg da⁻¹ green herbage yield was obtained from soybean that grown as a second crop (Açıkgöz et al 2015), while in Adana, ranged between 1904.2-4529.5 kg da⁻¹ green herbage yield was obtained from soybean that grown as a second crop (Şahar 2017). On the other hand, Akıncı (2019) was determined the herbage yield of soybean between 826.39-1199.17 kg da⁻¹ from soybean under the conditions of Kayseri, while Şenbek ve Açıkgöz (2019) was obtained as 4177.8 under the conditions of Kayseri. According to these results, our findings that for green herbage yield of soybean were higher than the values reported by the researchers Kökten et al (2014) Akıncı (2019), while our findings were lower than those of Açıkgöz et al (2015), Şenbek ve Açıkgöz (2019). Also, the results of Erdoğan et al (2013) with Şahar (2017) are similar to the findings in our investigation.

By view of the green herbage yield of legume forage crops, there are differences between the findings in our investigation and the results of previous studies in the literature. This can be attributed to the different cultivars used in this study, the different ecological conditions in which the experiments were carried out, and possibly to the different agricultural practices as compared with the other studies.

3.3. Hay Yield (kg da⁻¹)

Variance analyze results related with hay yields of legumes is given in Table 6. As it is appeared in Table 6, according to year x plant interactions there were statistically significant differences at 1 % level between hay yields. On the other hand, statistically significant differences were not observed between the hay yield of plants, in terms of year and legume plant species.

Table 6
Analysis Of Variance Regarding Hay Yield Values In Legumes

Source of variation	Degrees of freedom	Sum of squares	F value
Replication	3	22220.769	1.8304
Year (A)	1	10.465	0.0009
Plant (B)	3	5710.915	0.4704
Year x Plant	3	64380.551	5.3033 **
Error	21	12139.606	
General	31		

CV %: 17.01, (**)shows that the difference between treatments is significant at the 1% probability limit.

According to the two-year average results of our research, although legume plant species hadn't a significant statistically effect on hay yield production, while the highest hay yield was obtained from common vetch

(678.68 kg da⁻¹), this was followed by field pea (660.74 kg da⁻¹), soybean (629.40 kg da⁻¹) and fenugreek (621.68 kg da⁻¹) respectively (Table 7).

Table 7
Hay Yield Values Of Legumes (kg da-1)

Plants	Years		Average
	I. Year	II. Year	
Common vetch	625.63 ab	731.73 a	678.68
Fenugreek	538.68 ab	704.68 ab	621.68
Field pea	680.55 ab	640.93 ab	660.74
Soybean	747.93 a	510.88 b	629.40
Average	648.19	647.05	647.62

LSD_{int}: 220.6, Lettering was done according to the significance in the analysis of variance.

Common vetch produced hay 625.63-731.73 kg da⁻¹, respectively period of experiment in 2019 and 2020. Also, according to the two-year results of our research, Common vetch produced hay average of 678.68 kg da⁻¹ (Table 7). In previous studies that were conducted on irrigable lands after cereal harvest under the conditions of Konya, the values hay yield of common vetch were determined ranged between 291.6-494.8 kg da⁻¹ (Özer 1992; Acar 1995; Kerimbek and Mülayim 2003). On the other hand, the hay yield of common vetch that cultivated as the second crop in conditions of Antalya was measured by Çeçen et al (2005) 561 kg da⁻¹. Our research findings are higher than those of this study. In addition to these, Açıkgöz and Çelik (1986) reported as 803.2 kg da⁻¹ the hay yield of common vetch that cultivated on drylands under the conditions of Bursa. While Eğritaş (2014) determined ranged between 362.70-667.13 kg da⁻¹ the hay yield of common vetch under the conditions of Ordu, Kavut (2016) reported that as 875 kg da⁻¹ under the conditions of İzmir. According to these results, our research findings are lower than those of Açıkgöz and Çelik (1986) with Kavut (2016), while being similar to the finding of Eğritaş (2014).

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Previous research implied that, hay yield values of forage pea were determined as 680.55 kg da⁻¹ in the first research year, as 640.93 kg da⁻¹ cm in the second research year. The average hay yield of forage pea also was measured as 660.74 kg da⁻¹ in our study (Table 7). In previous studies that were conducted on irrigable lands after cereal harvest under the conditions of Konya, the values hay yield of forage pea were determined ranged between 297.2-321.08 kg da⁻¹ (Özer 1992; Acar 1995; Kerimbek and Mülayim 2003). On the other hand, the hay yield of forage pea cultivated as the second crop in conditions of Antalya was measured by Çeçen et al (2005) 317 kg da⁻¹. Present research findings are higher than those of this study. In addition to these, Açıkgöz and Çelik (1986) reported as 764.0 kg da⁻¹ the hay yield of forage pea that cultivated on drylands under the conditions of Bursa. While Uzun et al (2011) determined

ranged between 653.3-794.7 kg da⁻¹ the hay yield of forage pea under the conditions of Bursa, Koçer (2011) reported that as 642 kg da⁻¹ under the conditions of Isparta. Doğan (2013) reported as 944.93 kg da⁻¹ the hay yield of forage pea under the conditions of Kırklareli. According to these results, while our findings were lower than those of Açıkğöz and Çelik (1986), Doğan (2013), are similar to the findings of Koçer (2011).

In Table 7, the hay yield of soybean was measured as 747.93-510.88 kg da⁻¹ in 2019 and 2020, respectively. The average hay yield of soybean also was detected as 629.40 kg da⁻¹ in our study (Table 5). In different studies that related to the herbage yield of soybean were obtained different results. For example, in Gümüşhane, ranged between 356-555.60 kg da⁻¹ hay yield was obtained from soybean (Okcu 2015), while in Adana, ranged between 442.9-1523.3 kg da⁻¹ hay yield was obtained from soybean that grown as a second crop (Şahar 2017). Kökten et al (2014) obtained ranging from between 524.6-703.1 kg da⁻¹ hay yield from soybean under the conditions of Bingöl. On the other hand, Başaran et al (2019) was determined the herbage yield of Yemsoy cultivar ranged between 255-284 kg da⁻¹ under the conditions of Yozgat, while Akıncı (2019) was obtained from soybean ranged between 247.71-357.90 kg da⁻¹ under the conditions of Kayseri. According to these results, our findings that for hay yield of soybean were higher than the values reported by the researchers Okcu (2015), Başaran ve ark. (2017), Akıncı (2019). Also, the results of Kökten et al (2014) and Şahar (2017) are similar to the findings in our investigation.

Green hay yield of legume forage crops, there are differences between findings in our investigation and the results of previous studies in the literature. This can be attributed to the different cultivars used in this study, the different ecological conditions in which the experiments were carried out, and possibly to the different agricultural, practices as compared with the other studies.

4. Conclusion

Present research was realized to the aim of determination the possibilities of growing some legume forage crops as second crop after harvesting of cereal harvest under the conditions of Seydişehir Town of Konya City in Turkey during both vegetation periods of 2019 and 2020 year.

According to the statistical analysis, significant differences were found for green herbage yield and plant height of legume forage crops. Additionally, the forage pea and common vetch presented higher green herbage yield and hay yield compared to soybean and fenugreek. The highest green herbage yield was obtained from forage pea (3085.50 kg da⁻¹), which was followed by common vetch by (2788.63 kg da⁻¹). Similarly, highest plants height value was detected as 126.76 cm and 117.94 cm on the forage pea and common vetch, respectively. Although statistically insignificant differences, the highest hay yield was found in the common vetch by

678.68 kg da⁻¹ value, while it was followed forage pea by 660.74 kg da⁻¹ value. Based on these results, the forage pea and common vetch can be recommended to grow in similar ecological conditions due to their high green herbage and hay yield.

In the light of present findings, it may be concluded that the fodder pea and common vetch may be recommended for purpose of producing roughage after cereal (barley) harvest. Therefore, these crops can be considered to satisfy the forage demand in livestock farming. Future studies should focus on investigation the possibility of more productive legume forage crops after cereal harvest in different ecological conditions. Consequently, researches about the other suitable forage crops in the same or different regions during similar periods will add new knowledge to present knowledge to provide the forage demand for livestock farming.

5. Acknowledgements

This study is a part of Ali ÖZEL's PhD thesis. Also, Ali ÖZEL was supported by Scientific Research Projects (BAP) Coordinatorship with their projects no 19201003.

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