Turkish Journal of Field Crops, 2012, 17(2): 101-104

MORPHOLOGICAL AND CHEMICAL CHARACTERS OF *Bituminaria bituminosa* (L) C.H. (Stirtion) GROWN NATURALLY IN THE MIDDLE BLACK SEA REGION

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Received: 09.05.2012

ABSTRACT

In this study, morphological and chemical characters were investigated in *Bituminaria bituminosa* (L.) C.H. Stirtion genotypes collected from 24 different locations Middle Black Sea Region Turkey. The experiment was established in Samsun ecological conditions and carried out for two years (2009-2010). The investigated characters were; plant height, shoot number, main stem diameter, leaflet width and length, leaf number, inflorescence number, flower number per inflorescence, seed width and length, a thousand seed weight, dry matter yield, crude protein content, ADF, NDF, ADP values, ash, Ca, Mg, P, K, Fe, Zn and Mn contents. Only one cut was done in the first year as plant growth was relatively slow. Two cuts were performed in the second year due to greater regrowth ability. Plant height was 88.4 cm in 2009 and, was 80.5 and 74.2 cm for the first and second cutting in 2010 year. Main stem diameter in three cut in both years were recorded as 5.2 cm, 6.3 cm and 3.6 cm, respectively Chemical characters of the genotypes were examined in both leaves and stems, separately. Protein ratios in the leaves were found as 24.30%, 24.60% and 19.61%, respectively, These protein ratios remarkably decreased in the stems; 13.28%, 13.58% and 8.99%.

Key words: *Bituminaria bituminosa*, morphological and chemical characters.

INTRODUCTION

In Turkey, despite the significant decrease in animal number, especially goats and sheep in recent years, there is still a gap in good quality forage (Sabancı et al. 2010). This gap is very high especially during summer period due to the low pasture yield.

In Turkey, cultivated forage crops and plants existing naturally in pastures are cool season plants. Pasture plants are dormant or dry, because of high temperature and drought in June-September period which is resulting serious forage gap for the animals grazing on pasture.

Psoralea genus is a legume that this genus has 150 species (Hooker and Jackson, 1960). *Bituminaria bituminosa* (*Bb*) is a perennial species within Psoralea genus. It's origin is natural distribution of this plant are in coastal cities, located north west and south Anatolia. (Davis 1988; Akcin et al. 2010, Peters and Korkmaz. 1990; Kilinc et al. 1998).

Bb is cultivated in the Canary Islands and Morocco. In general, it grows on road sides, in shallow soils, in woodland and forests (Davis 1988). It can resist to -10˚C (FAO 2010). Up to 1500 m altitude (FAO 2010). *Bb* is be able to green throughout the hot and dry summer period (Acar et al. 2001). *Bb* is a long day plant, flowering and set seeds mainly in the spring but flowering is going on the whole year except winter period (FAO 2010). *Bb* is improves the quality of pasture in the hot and dry periods that other species and grasses disappear or decrease their hay quality (Mendez and Fernandez, 1990).

According to global climate change scenario, Drought and high summer temperatures are expected in Turkey (Anon 2011). For this reason, we need new genotypes and plant cultivars which are resistant to summer drought and effective to increase pasture yield and quality. It is expected that *Bb* will be important for forage production and pasture improving in the future. However there are very few studies about its potential as forage and pasture plant in Turkey.

MATERIALS AND METHODS

This study was conducted for two years (2009-2010) in Experimental Field of Agriculture Faculty of Ondokuz Mayis University.

Plant Materials were collected from 4 provinces and 24 different locations; Samsun (Örencik, Kurupelit Kampüs 1 and 2, Kavak, Sarıyusuf Sapagı, Cataltepe, Cakallı, Nebyan 1 and 2, Atakent, Havza) , Sinop (Tangal, Gerze, Tıngıroglu, Ayancık and Yarımada), Ordu (Bacanak, Bolaman, Kumru 1 and 2, Kulak, Mesudiye, Caybası) and Zonguldak (Filyos) in 2008 and 2009. After

the collection, seeds were cleaned and dried at 30 ^{0}C (Walker et al. 2007).

Each seed material was firstly sown into seed trays then, seedlings transplanted to the field with in 50x50 cm distances (Pecetti et al. 2007). First year, 14 plant transplanted to the field, but only 7 for them investigated (others did not reached at bolting). These seen genotypes, Orencik, Kurupelit Kampus 1, Bacanak, Kumru 1, Kulak, Mesudiye and Caybası). Second year, new 10 genotypes were transplanted to the field, and measurements and observations were done on totally 24 genotypes. Only one cutting was done in the first year as plant growth was relatively slow. Two cuts were performed in the second year due to greater regeneration. Both for one year and two years old plants.

Soil was clay with 1.36 % organic matter and pH: 6.45. Long term (1974-2009) annual rainfall and mean temperature of experimental area were 680.9 mm and 14.3 °C, respectively. Average temperature and total rainfall in growing periods of 2009 and 2010 ranged between 12.2 and 12.9 °C, and 793.6 and 732.9 mm, respectively (Anonymous 2010).

Five plants were randomly harvested in each plot at the 50% flowering stage. Morphological characters; plant height, branch number, main stem , leaflet width and length, leaf number, seed width and length, a thousand seed weight were determined. Then plant samples (leaf and stem) were dried at 60 °C in oven till constant weight, and ground to pass through 1 mm screen and mixed, leaf samples also include flowers. Chemical characters; dry matter, crude protein, ADF, NDF, ADP, Ca, Mg, K, P content of samples were determined by using Near Infrared Reflectance Spectroscopy (NIRS, "Foss 6500") with software package program 'IC-0904F' and Fe, Zn and Mn content of samples were determined by using Atomic Absorption Spectrophotometer (Kacar 1972). All the data were given as a mean, standard error and CV. Principal component analysis (PCA) was carried out using the statistical software package PASW (18) Statistics Data Editor program.

RESULTS AND DISCUSSION

The values about morphological and chemical characters of *Bb* genotypes are given in Tables 1, 2 and 3. Plant height was 88.4, 80.5 and 74.2 cm in the first year and the second year (first and second cuttings), respectively. Our results were generally comparable to findings of Davis (1965) who found that plant height ranged between 20 –140 cm.

Average main stem diameter in the first and second (for the first and second cuttings) years were determined as 5.2, 6.3, 3.6 cm, respectively. Average branch numbers of *Bb* genotypes changed from 12.1 to 14.7 cm (Table 1).

Table 1. According to morphological characteristics of *Bituminaria bituminosa* genotypes mean, standard error (Se) and coefficient of variation (CV) in 2009 and 2010 years.

Morphological Features	First Year		Second year first cutting		Second year second cutting	
	Mean±Se	CV	Mean±Se	CV	Mean±Se	CV
Plant height (cm)	88.4±7.3	17.0	80.5±4.3	12.6	74.2±5	15.3
Mean branch diameter (mm)	5.2±0.4	20.0	6.3±0.4	16.0	3.6±0.3	18.5
Branch number	13.7±1.8	31.2	12.1±1.3	25.5	14.7±2.0	29.6
Leaflet width (cm)	2.1±0.2	16.5	2.4±0.2	15.1	1.9±0.1	15.9
Leaflet length (cm)	4.5±0.2	9.9	4.5±0.2	11.5	3.5±0.2	15.2
Leaf number	254.7±46.1	39.8	261.4±22.7	20.9	158.7±2.0	29.6
Inflorances number	64.7±15.4	58.9	69.6±10.6	35.6	119.0±29.6	51.3
Flower number/Inflorances	11.2±1.1	20.5	16.5±1.1	16.0	5.6±0.4	16.3
Seed length (cm)	14.5±0.8	12.5	14.6±0.7	11.3	14.1±0.4	2.7
Seed width (cm)	3.3±0.2	13.6	3.8±0.1	7.50	3.3±0.1	7.1
Thousand seed weight (g)	29.50±1.02	8.47	30.89±0.50	7.77	31.42±0.43	6.52

Average leaf numbers were 254.7 in 2009, and 261.4 and 158.7 cm for the first and the second cuts in 2010. Inflorescence numbers of *Bb* genotypes were 64.7 in 2009, 69.6 and 119 for the first and the second cuts in 2010. Average flower numbers per inflorescence were 11.2, 16.5 and 5.6 for the consecutive years and cuts. Davis, (1988) found that flower numbers per inflorescence of *Bb* genotypes changed between 7 and 30. Average seed length were 14.5 cm in 2009, and 14.6 first cut and 14.1 second cutting cm in 2010 respectively. Thousand seed weights were 29.5, 30.89, 31.42 g in 2009 and the first and the second cuts of 2010, respectively.

Bb plants are mostly evaluated for grazing. Livestocks preferably graze its leaves and fresh sprouts, so chemical properties of leaves and stems were analysed separately.

Average crude protein ratios of genotypes were 24.30 %, 24.60 %, 19.61 % for leaf and 13.28 %, 13.58 %, 8.99 % for stem according to years and cuts (Table 2).

In previous studies, it was reported that crude protein of *Bb* genotypes changed between 15.9 % and 24.30% (Ventura et al. 1999, 2004; Acar et al. 2001; FAO, 2010; Gulumser et al. 2010; Gulumser 2011). protein ratio was higher in leaf than stems in all genotypes.

ADF contents of *Bb* genotypes were 21.20, 20.00, 15.40 % for leaf, and 45.27, 41.50, 43.90 % for stem in 2009 and 2010 years (first and second cut), respectively. It was reported that different researchers determined ADF content of different *Bb* genotypes between 21.9 % and 38.8 % and NDF contents between 25.0 and 50.1 % (FAO 2010). Average NDF contents were 25.85, 27.72 and 21.02 % for leaf and 52.00, 48.53 and 50.68 % for stem during the consecutive years and cuttings (Table 2).

Generally, leaf crude protein ratio was as higher as twice of stem (Table 2, 3). In terms of chemical content, differences between leaf and stem are expected consequences of anatomic and physiological structure of plants, especially due to higher cellulose content of stem cells.

Average Ca content of *Bb* genotypes were determined 1.94, 2.11, 2.61 % for leaf and 0.90, 1.13, 1.35 % for stem, and also Mg contents were 0.57, 0.56, 0.70 % for leaf and 0.19, 0.29, 0.32 % for stem during the consecutive years and cuttings.

According to Principal Component (PC) analyses based on the investigated traits, PC1 corresponds to 51.88 of the total variation and PC2 to 21.80 % (totally 73.68 %) (Table 4). The obtained scatter plot using these first and second principal components is shown in Figure 1. Considering that all collected samples belong to the same species, namely *B. bituminosa*, it can be concluded that the genotypes collected from different locations exhibit remarkable differences regarding their morphological and chemical traits.

Table 2. According to chemical properties of *Bituminaria bituminosa* genotypes (leaf)mean, standard error (Se) and coefficient of variation (CV) in 2009 and 2010.

Quality Traits	LEAF					
	FIRST YEAR		SECOND YEAR			
			FİRST CUTTİNG		SECOND CUTTING	
	Mean±Se	CV	Mean±Se	CV	Mean±Se	CV
DM (%)	87.19±0.40	0.13	87.00±0.10	0.71	86.97±0.05	0.31
CP (%)	24.30±0.44	4.85	24.60±0.02	5.21	19.61±0.31	7.44
ADF (%)	21.20±0.63	8.21	20.00±0.33	5.40	15.40±0.32	9.81
NDF (%)	25.85±0.87	8.93	27.72±0.31	5.59	21.02±0.45	1.53
ADP (%)	0.52±0.04	14.2	0.77±0.02	12.9	0.73±0.02	17.8
ASH (%)	-	-	10.02±0.35	17.2	10.30±0.51	23.1
Ca(%)	1.94±0.04	5.15	2.11±0.18	4.21	2.61±0.06	12.2
Mg (%)	0.57±0.02	10.5	0.56±0.01	11.2	0.70±0.01	8.28
K (%)	1.80±0.04	6.66	1.52±0.06	5.85	0.27±0.04	74.0
P (%)	0.39±0.008	5.89	0.36±0.004	6.38	0.26±0.006	11.1
Fe(ppm)	-	-	322.00±52.00	78.8	122.10±14.55	55.6
Zn (ppm)	-	-	104.00±10.06	47.5	96.00±11.62	56.2
Mn (ppm)	-	-	85.00±4.77	23.1	99.90±5.59	26.0

Table 3. According to chemical properties of *Bituminaria bituminosa* genotypes (Stem) mean, standard error (Se) and coefficient of variation (CV) in 2008 and 2009.

Quality Traits	STEM					
	FIRST YEAR		SECOND YEAR			
			FIRST CUTTING		SECOND CUTTING	
	Mean±Se	CV	Mean±Se	CV	Mean±Se	CV
DM (%)	87.91±0.09	0.28	87.50±0.15	0.84	88.62±0.1	0.56
CP (%)	13.28±0.45	9.03	13.58±0.25	5.21	8.99±0.27	14.34
ADF (%)	45.27±0.80	5.09	41.50±0.46	5.42	43.90±1.62	17.35
NDF (%)	52.00±0.97	4.96	48.53±0.51	5.21	50.68±1.04	9.64
ADP (%)	0.88±0.02	14.2	0.96±0.01	8.33	0.99±0.02	9.89
ASH (%)	-	-	7.30±0.19	13.3	6.60±0.30	22.00
Ca(%)	0.90±0.03	9.22	1.13±0.02	8.31	1.35±0.07	23.70
Mg (%)	0.19±0.01	14.2	0.29±0.007	12.7	0.32±0.02	22.81
K (%)	1.81±0.05	7.18	1.92±0.04	11.2	1.28±0.05	18.75
P (%)	0.33±0.003	2.72	0.32±0.004	7.50	0.25±0.008	15.60
Fe(ppm)	-	-	260.32±60.9	114	156.80±38.82	116.0
Zn (ppm)	-	-	55.60±5.85	51.6	37.30±5.59	48.23
Mn (ppm)	-	-	60.90±4.37	31.5	64.30±3.8	26.45

Table 4. Correlations between two components of *Bituminaria bituminosa* genotypes.

	Traits					
Components	**PH**	**BN**	**LN**	**FN/I**	**TSW**	**% Variation**
Component 1	0.896	0.917	0.970	- 0.091	- 0.018	51.88
Component 2	0.063	0.034	- 0.009	0.720	0.753	21.80

PH: plant height (cm); BN: branch number; LN: leaf number; FN/I: flower number/inflorescence;
TSW: thousand seed weight (g).

Figure 1; plant height, branch number and leaf number features present the first component, and flower number per inflorescence and a thousand seed weight present the second component. According to principal component analyses, *Bb* genotypes influenced geographical regions and the genotypes collected from similar regions were in the same group (Figure 1).

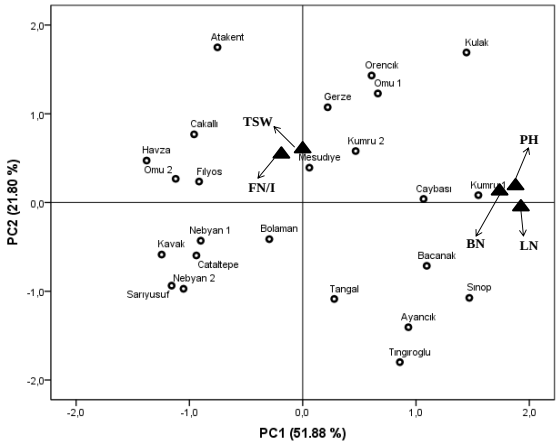

Figure 1. Dispersion of the *Bituminaria bituminosa* genotypes based on the first two principle components

CONCLUSION

Cool season forage crops are cultivated in Turkey. These cool season plants are either thoroughly dry or dormant in summer period. Therefore, the deficiency in substantial forage in high quality occurs from middle of June till end of September. So, the plants can be grown without irrigation or can kept freshness throughout the summer period are important for animal feeding when pasture quality decreased. Present study showed that *Bituminaria bituminosa* (L.) C.H. Stirtion can provide a fresh and high quality feed to animals during summer period.

In addition, *Bb* genotypes can be grown as fodder crops in stony, in clined, poor, eroded and marginal lands, where it is not suitable for other crops. However, further studies are needed test different genotypes under field and range condition. This research is one of the first studies about this area carried out in Turkey, and it will lighten the next studies.

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