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Some Morphological and Nutritional Properties of Legumes under Natural Conditions

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Abstract: The legume species in the flowering time were harvested on 6500 da in campus area for every three days interval from beginning of March to end of July, 1999. Forty six legume species, subspecies or varieties were determined and sampled as different number for each species. Some morphological properties such as; growing form of species, color of flower, flowering period, number of stem on root, length of main stem and some chemical properties such as; crude protein ratio, crude ash ratio, Ca, Mg, K, Mn, Fe, Cu, Zn contents and K/(Ca+Mg) ratio were determined for all species. Samsun province is an important gene origin for the most legume species. Therefore, many differences in morphological properties were determined among the species. According to results of chemical properties, nutritional quality values of legume species were higher than the recommended standard values.

Key words: Legume, morphology, nutrition, natural conditions.

Introduction

Five subgene origins have been determined in Turkey which lies on intersection of near east and Mediterranean gene origins (Demir, 1990). Turkey is a very rich country for species, ecotype, genetic diversity and gene sources (Özgen *et al.*, 1995; Kislalioğlu and Berkes, 1992; Dokuzoğuz, 1990). Migrations to Anatolia or having different civilizations for years increased genetic differences in Anatolia which is like a bridge between Asia and Europe. Samsun – Amasya – Tokat province is a subgene origin for many legume species which show much variance and distribution. Species, ecotypes and genetic diversities in heavy grazing pasture areas of Turkey decrease for years. According to Davi's square system, the research area in this study is in A_6 square (Davis, 1970), and has been protected since early 1970's. The research area in irregular topography is about 500 meter elevation and has sand, sandy clay and silty clay near coast, greybrown podzolic and brown soil on hillside and upland positions (Pamir and Erentöz, 1974). Morphological structure and nutritional qualities among legume species grown in the research area show much variety due to different vegetations, soil types and protection of campus area for years.

There is a strong relationship between morphological structure and nutritional qualities of forage crops (Açikgöz, 1991; Korkmaz *et al.*, 1993). Soil has an important effect on mineral content of plants grown on it (Korkmaz *et al.*, 1993).

This study may be useful for determining nutritional qualities and some genetic properties for selection studies of legumes grown on areas having much biological diversity.

Materials and Methods

Legume species in the flowering time were picked up from 6500 da of campus area for each three days interval between March and June, 1999. Some properties for each legume sample such as; sampling area, main stem length, growing form, number of stem on root, colour of flower and flowering period were reported. Classification of the plants were done according to Davis (1970) and the herbariums in the Laboratory of Biological Science Department in O.M.U. Growing forms of plants were evaluated according to angle between main stem and soil surface as follows (Anonymous, 2001):

0 - 30° is spreading
30 - 45° is semi – spreading
45 – 60° is semi – erect
> 60° is erect

After the samples were dried at 78 °C in an oven until achieving constant weight, the legume samples were ground and mixed for crude protein, crude ash and mineral content analyses. Crude protein ratio was done according to Kjeldahl method (Kacar, 1972); mineral contents of samples were determined using Atomic Absorption Spectrophotometer after digesting the samples with $HClO_4$:HNO_3 (1:4) according to Kacar (1972).

Results and Discussion

Morphological Properties: Some morphological properties such as; number of legume species, number of samples for each species, growing form of stem, colour of flower, flowering period, number of stem on root and length of main stem are given in Table 1.

Forty six legume species, subspecies or varieties from legume family were determined and more than 10 samples were collected for each species. This number sometimes achieved to 26. Growing forms for some species showing differences from lateral to vertical while some species had the same growing form. Especially *Medicago, Trifolium, Vicia* and *Lathyrus* species showed more differences in stem growing form.

While flowering period was 15 days for some species, this time extended to 45 for other species. Also, differences in the number of stems on root were obtained among the species. Most number of stems on root achieved until 60 for *Lotus, Medicago* and *Trifolium,* while less number of stems on root were obtained for *Vicia* and *Lathyrus* species. These species sometimes did not have stem other than main stem.

More differences among the species were determined for length of main stem due to the effects of soil structure, soil moisture content and other ecological conditions. The plants grown on moist and alluvial deeply soil profile around the creek were taller than the plants grown on dry shallow soil profile around upper land positions. But, length of the plants within the same species showed differences even they had

Table 1: Some morphological properties of the legume species.

Plant species	Sample	Growing form number	Colour of flower	Flowering periods	Number of stems on root	Length of main stem (cm)
Coronilla cretica L.	13	Spreading	White–purple	01.05–25.05	7-13	50-80
Coronilla orientalis Miller var. orientalis	14	Semi spreading	Yellow	15.05 – 15.06	1-5	70-80
Coronilla varia L. ssp. *Varia*	17	Semi erect	White–purple	20.05. –18.06	3-8	60-100
Galega officinalis L.	12	Erect	White	15.04 – 10.05	3-8	70-100
Hymenocarpus circinnatus (L.) Savi.	15	Semi spreading	Yellow	20.04 –15.05	4-11	40-55
Lathyrus annuus L.	16	Erect - indeterminate	Yellow	16.05 – 07.06	1-6	100-160
Lathyrus aphaca L. Var. Affinis (Guss.) Arc.	15	Semi erect –indeterminate	Cream	15.05 –10.06	3-5	80-110
Lathyrus hirsutus L.	18	Indeterminate	Pink – purple	20.05 – 13.06	5-11	75-110
Lathyrus laxiflorus (Desf.) O.Kuntze, Supsp laxiflorus	12	Semi erect	Purple	10.04 – 8.05	3-8	25-50
Lathyrus nissolia L.	20	Semi erect	Dark red	25.04 –15.05	5-9	20-35
Lathyrus ochrus (L.) Dc.	17	Semi erect	White	18.04 – 12.05	1-4	90-120
Lotus angustissimus L.	22	Erect	Yellow	15.05 –10.06	10-18	30-45
Lotus corniculatus L.	23	Semi spreading –erect	Yellow	10.05 –05.06	50-60	30-50
Medicago arabica (L.) Huds	25	Spreading – erect	Yellow	05.04 – 15.05	7-10	50-65
Medicago disciformis DC.	14	Semi erect	Yellow	15.05 – 10.06	5-7	20-40
Medicago falcata L.	18	Semi erect – erect	Yellow	12.05 –10.06	20-30	100-170
Medicago hispida Gaertn.	26	Spreading – erect	Yellow	02.04 – 05.05	3-12	50-70
Medicago lupulina L.	25	Spreading	Yellow	05.04 – 08.05	8-20	60-100
Medicago minima (L.) Bart. Var. Minima	16	Spreading – erect	Yellow	15.05 – 20.06	3-9	10-35
Medicago polymorpha L. Var. Polymorpha	12	Full spreading	Yellow	10.04 – 05.05	4-9	10-25
Melilotus alba Desr.	15	Erect	White	15.05 – 30.06	3-7	150-180
Melilotus officinalis (L.) Desr.	17	Erect	Yellow	10.05 – 25.06	5-8	100-120
Onobrychis oxyodonta Boiss.	22	Full spreading	Purple	10.05 – 30.05	10-25	50-70
Ononis pussila L.	18	Erect	Yellow	10.05 – 25.05	1-3	40-50
Psoralea bituminosa L.	20	Erect	Purple	15.05 – 10.06	3-7	100-150
Scorpiurus muricatus L. Var. Subvillosus (L.) Fiori	21	Spreading	Yellow	12.04 – 20.05	15-25	40-60
Trifolium arvense L. Var. arvense	23	Erect	Light pink	15.05 – 08.06	2-5	30-45
Trifolium dubium Sibth.	18	Spreading – erect	Yellow	20.04 – 25.05	3-15	10-50
Trifolium fragiferum L. Var. pulchellum Lange	25	Spreading	Pink – white	20.05 – 25.06	7-13	30-55
Trifolium hybridum L. Var. anatolicum Boiss.	25	Semi erect	Light red	10.04 – 15.05	30-45	35-60
Trifolium meneghinianum Clem.	28	Spreading–erect	White	20.04 – 25.05	7-16	40-110
Trifolium pallidum Waldst. & Kit	13	Semi spreading–erect	Pink–white pink	10.05 – 30.05	1-15	15-50
Trifolium pratense L. Var. pratense	17	Erect	Red	15.04 – 10.05	20-45	70-85
Trifolium repens L. Var. repens	21	Spreading	White–light pink	10.04 – 25.05	20-35	25-40
Trifolium resupinatum L. Var. majus Boiss.	24	Spreading – erect	Pink – purple	10.04 – 20.05	10-28	20-60
Trifolium scabrum L.	12	Erect	White – cream	12.05 – 10.06	3-9	15-35
Trifolium subterranum L.	20	Spreading–semi erect	White	01.05 – 25.05	3-8	30-55
Trifolium trichocephalum Bieb.	22	Erect	Cream	12.04 – 15.05	8-16	60-95
Vicia lutea L. Var hirta (Balbis) Lois.	15	Semi spreading	Cream	10.04 – 10.05	6-13	40-70
Vicia lutea L. Var. Lutea	18	Indeterminate	White–cream	25.04 – 20.05	3-9	60-110
Vicia narbonensis L.	14	Semi erect – erect	Violet	10.04 – 05.05	1-5	70-100
Vicia sativa L. ssp. *Nigra* (L.) Ehrh.	16	Semi spreading	Cream	01.04 – 30.04	1-4	50-85
Vicia sativa L. ssp. *Sativa*	23	Indeterminate	Violet	07.04 – 20.05	2-5	65-120
Vicia sativa L. Var. segetalis (Thuill.)Ser. ExDc	11	Semi erect	Violet	05.04 – 12.05	2-6	50-75
Vicia villosa Roth. ssp. *Eriocarpa* (Hausskn.) P.W. Ball	18	Indeterminate	Violet – purple	12.05 – 30.05	1-5	70-105
Vicia villosa Roth. ssp. *Villosa*	20	Indeterminate	Purple – violet	01.05 – 25.05	3-7	100-165

grown under the same ecological conditions. Excess of these differences increases potential of this area to be of genetic origin for most legume forage crops (Özgen *et al.*, 1995; Acar *et al.*, 1995; Kislalioğlu and Berkes, 1992).

Chemical Properties: Some chemical properties of the legume species such as; crude protein ratio, crude ash ratio, Ca, Mg, K, Fe, Cu, Mn, contents and K/(Ca+Mg) ratio are given in Table 2.

Crude protein ratio for the samples varied between 12.15 and 20.66 %. While crude protein ratio in *Galega officinalis* L. is 12.15 %, this ratio in annnual *Lathyrus nissolia* L. increased to 26.66 %. *Medicago, Trifolium* and *Vicia* species mostly preferred by animals had more variability and their crude protein ratio were between 16 and 18 %. The highest crude ash ratio was 14.94 % in *Trifolium meneghinianum* Clem., the lowest crude ash ratio was 8.79 % in *Lathyrus annuus* L. Crude protein ratios and nutritional qualities in legume species grown under natural conditions without any cultivation were higher. But, *Galega officinalis* L., *Ononis pusilla* L., *Psorelea bituminosa* L. and *Melilotus* species are not preferred to feed the animals.

Ca contents of the species varied between 3.76 and 1.17 %. Tajeda *et al.* (1989) reported that forage crops should contain at least 0.3 % of Ca for ruminants. The American National Research Council (NRC, 1984) recommended that forage crops should contain 3.1 g/kg of Ca concentration for beef cattle. Obtained results for Ca concentration in this study were higher than these recommended values.

Mg concentrations in the legume species were between 0.562 and 0.090 %. Mg concentrations for forage crops are recommended as 0.2 % for ruminants by Tajeda *et al.* (1985) and 1 g/kg for beef cattle by the NRC (1984). Except *Lathyrus annuus* L. and *Psoralea bituminosa* L., all the species had rich Mg concentration in nutritional quality for animals. But, Loreda *et al.* (1986) reported that 0.18 – 0.20 % of Mg concentration in forage crops would not be adequate for ruminants if the plants have 1.36–1.69 % of K concentration. All species had higher K concentration. K concentration varied between 3.96 and 1.23 %. These results were higher than suggested values of 0.8 % by Tajeda *et al.* (1985) and 6.5 g/kg by the NRC (1984). But, high K concentration may cause Mg deficiency (Loreda *et al.*, 1986).

K/(Ca+Mg) ratio in forage crops consumed by ruminants was recommended as less than 2.2 (Mayland *et al.*, 1979; Kidambi *et al.*, 1989; Korkmaz *et al.*, 1993). More than 2.2 of K/(Ca+Mg) ratio indicates potential tetany of risk (Ward, 1966). All species had lower K/(Ca+Mg) ratio than 2.2 in this study because of legume species. Mg content in legumes is generally higher than that in cereals (Gençkan, 1985).

Table 2: Average crude protein, crude ash, Ca, Mg, K, Fe, Zn, Cu, Mn contents of the legume species and K/ (Ca +Mg) ratios.

Plant species	Crude Protein (%)	Crude ash (%)	Ca (%)	Mg (%)	K (%)	K/(ca +mg)	Fe (ppm)	Zn (ppm)	Cu (ppm)	Mn (ppm)
Coronilla cretica L.	15.10	10.05	3.01	0.199	1.82	0.569	369.3	30.55	9.64	38.94
Coronilla orientalis Miller var. orientalis	14.71	10.21	1.93	0.205	3.96	1.855	96.0	28.46	19.29	64.09
Coronilla varia L. Supsp. Varia	14.86	9.99	2.08	0.188	2.24	0.988	482.6	57.35	14.46	40.37
Galega officinalis L.	12.15	9.51	2.22	0.347	2.60	1.013	729.3	27.77	15.61	59.35
Hymenocarpus circinnatus (L.) Savi.	15.07	13.44	2.81	0.183	1.76	0.588	159.8	46.78	8.26	20.43
Lathyrus annuus L.	15.84	8.79	2.36	0.392	1.62	0.589	133.1	27.07	13.77	36.57
Lathyrus aphaca L. Var. Affinis (Guss.) Arc.	19.30	9.50	1.67	0.090	2.34	1.330	702.6	44.70	7.80	47.96
Lathyrus hirsutus L.	18.79	8.13	2.28	0.344	2.30	0.877	345.5	44.93	10.56	37.07
Lathyrus laxiflorus (Desf.) O.Kuntze, Supsp laxiflorus	19.82	9.31	2.83	0.398	2.60	0.805	702.6	26.14	26.65	48.91
Lathyrus nissolia L.	20.66	9.01	3.60	0.324	2.14	0.545	902.6	47.02	15.15	117.73
Lathyrus ochrus (L.) Dc.	15.03	9.11	2.14	0.382	2.34	0.928	381.7	127.00	28.02	79.28
Lotus angustissimus L.	16.41	10.70	2.39	0.176	1.23	0.479	675.9	41.10	15.15	44.16
Lotus corniculatus L.	17.87	11.00	2.07	0.144	2.21	0.998	588.3	50.38	11.01	53.18
Medicago arabica (L.) Huds	17.63	10.34	2.01	0.311	2.67	1.150	764.5	20.81	18.15	52.94
Medicago disciformis DC.	16.15	14.24	1.83	0.350	2.34	1.073	196.0	25.56	6.88	48.43
Medicago falcata L.	14.58	9.89	2.67	0.353	3.77	1.247	272.2	29.04	7.80	56.50
Medicago hispida Gaertn.	16.66	9.75	1.17	0.347	3.25	2.142	788.3	26.38	30.33	52.23
Medicago lupulina L.	17.01	10.68	1.84	0.317	3.09	1.433	638.8	30.32	10.56	49.86
Medicago minima (L.) Bart. Var. Minima	17.50	13.70	2.29	0.385	2.60	0.972	320.7	36.46	6.88	38.46
Medicago polymorpha L. Var. Polymorpha	19.93	12.32	1.41	0.305	2.34	1.364	274.1	34.15	15.61	38.94
Melilotus alba Desr.	17.50	12.74	2.42	0.257	2.79	1.042	357.9	29.74	13.31	71.21
Melilotus officinalis (L.) Desr.	15.81	13.20	2.44	0.266	2.60	0.961	623.6	51.43	9.18	43.68
Onobrychis oxyodonta Boiss.	17.33	14.22	1.93	0.196	1.95	0.917	312.2	47.95	11.01	31.82
Ononis pussila L.	14.50	9.47	1.84	0.434	2.21	0.972	300.7	28.46	12.39	46.53
Psoralea bituminosa L.	15.00	9.50	2.67	0.090	1.82	0.659	222.7	25.91	5.50	30.87
Scorpiurus muricatus L. Var. Subvillosus (L.) Fiori	13.36	10.30	1.84	0.297	2.89	1.352	729.3	27.94	8.03	65.99
Trifolium arvense L. Var. arvese	17.03	11.11	3.29	0.254	2.21	0.624	642.6	43.54	8.72	58.87
Trifolium dubium Sibth.	14.79	11.89	1.61	0.199	2.46	1.360	229.0	33.45	19.60	59.50
Trifolium fragiferum L. Var. pulchellum Lange	15.89	12.60	1.56	0.337	2.27	1.197	407.4	22.66	7.80	56.50
Trifolium hybridum L. Var. anatolicum Boiss.	18.92	12.08	1.34	0.327	2.99	1.794	181.7	22.20	8.72	48.91
Trifolium meneghinianum Clem.	16.23	14.97	2.72	0.334	2.08	0.681	889.3	31.95	34.46	103.00
Trifolium pallidum Waldst. & Kit	14.96	13.83	1.71	0.320	2.86	1.409	331.7	27.48	5.04	84.03
Trifolium paratense L. Var. pratense	17.74	13.70	1.91	0.353	2.73	1.206	169.3	33.10	15.15	44.16
Trifolium repens L. Var. repens	18.93	13.64	1.39	0.366	2.53	1.441	83.6	26.14	22.05	21.85
Trifolium resupinatum L. Var. mayus Boiss.	14.87	12.82	1.97	0.271	2.40	1.071	487.9	36.00	22.74	39.65
Trifolium scabrum L.	14.10	11.30	1.73	0.408	2.53	1.183	761.7	36.93	12.85	108.71
Trifolium subterranum L.	14.23	12.90	1.63	0.215	3.12	1.691	245.5	40.64	18.83	19.48
Trifolium trichocephalum Bieb.	18.30	11.95	3.76	0.562	2.92	0.676	693.1	31.48	27.57	71.21
Vicia lutea L. Var hirta (Balbis) Lois.	17.63	11.00	2.05	0.344	3.51	1.466	816.9	51.66	16.53	96.37
Vicia Lutea l. Var. Lutea	18.29	11.15	1.64	0.225	2.47	1.324	564.6	59.61	15.15	61.72
Vicia narbonensis L.	17.33	14.37	1.24	0.270	2.30	1.523	172.2	42.15	31.70	48.91
Vicia sativa L. Subsp. Nigra (L.) Ehrh.	18.75	13.80	1.80	0.337	3.51	1.642	493.1	30.32	19.29	50.33
Vicia sativa L. Subsp. Sativa	18.23	14.27	2.10	0.302	2.12	0.883	226.1	31.24	12.70	36.72
Vicia sativa L. Var. segetalis (Thuill.)Ser. ExDc	18.41	12.80	2.40	0.341	2.73	0.996	616.9	35.42	23.89	72.15
Vicia villosa Roth. Subsp. Eriocarpa (Hausskn.) P.W. Ball	18.21	11.71	2.23	0.257	2.73	1.098	594.0	51.31	7.34	50.80
Vicia villosa Roth. Subsp. Villosa	18.33	11.62	3.06	0.186	1.23	0.379	893.1	37.05	20.67	112.98

Therefore, increasing Mg content in legumes most probably caused a lower K/(Ca + Mg) ratio.

Fe content in forage crops for ruminants is recommended at least around 50 ppm (Periguad, 1970; Lamand, 1975). Fe concentration in all species were higher than this suggested value. The results for Fe content in this study were similar to the results of previous study about legume forage crops done in this area by Korkmaz *et al.* (1993). Application of high amount of N fertilizer causes a decrease in Fe contents of legumes (Rybah, 1977; Acar *et al.*, 1993). Higher iron concentrations in all species were obtained in this study because of collecting legume species from uncultivated natural flora. In addition to unfertilized conditions, Fe content of legume species in other studies has been found higher than that of cereals (Loue, 1986; Boila *et al.*, 1985).

Zn content in the samples varied between 127.00 and 20.81 ppm. Recommended Zn contents for forage crops consumed by ruminants are around 10 ppm by Danbara *et al.* (1985), 50 ppm by Periguad (1970) and Lamand (1975), and 30 mg/kg by NRC (1984).

Zn deficiency in forage crops may cause infertility, anemia or suppressed immune response in animals (Hidiroğlu and Knipfell, 1984). Furthermore, Zn contents have complex and scarcely understandable effect on the male reproductive systems (Kidambi *et al.*, 1989).

Cu contents in the samples varied between 34.46 and 5.04 ppm. Recommended Cu content in fresh forage crops are 10 ppm by Periguad (1970), and Lamand (1975), 8 ppm by Rybak (1977); 5 ppm by Kozlowsky (1977), and 8 mg/kg by NRC (1984). All the species had higher Cu content than the suggested value by Kozlowska (1977). Also, Cu deficiency may cause infertility, anemia or suppressed immune response in animals like Zn (McMurray, 1980).

Mn concentration in forage crops is recommended around 50 ppm for excess consumption conditions (Periguad, 1970; Lamand, 1975). Mn concentration of the species varied between 117.73 and 19.48 ppm and most samples had lower Mn concentration than 50 ppm of critical value. Excess Mn concentration may cause to decrease the appetite in animals (Danbara *et al.*, 1983).

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