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Morphological Description of Some Forage Legumes of Pakistan

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Abstract

Legumes are one of the most important forages in the world. Many Leguminosae members have economic importance, ethnobotanical and medicinal values. The aim of this study was to describe the morphological parameters of twenty five forage legume species. In total, 16 vegetative and reproductive characters have been studied. The morphological features were studied directly from the fresh specimens by using hand lens and dissecting microscope. Quantitative data obtained was analyzed using SPSS software. The most variable characters observed were; type of leaf lamina, shape of leaf apex and base, stem type and texture, flower color and size, fruit type and size, fruit indumentum. This study concluded that morphology of legumes is not just a biological pursuit but can aid in forage managing systems. In addition, more research should take into consideration the ecological forces on these Fabaceae taxa, which deserve care with regard to administration issues and sustainability.

Keywords: forage, legumes, morphology, pastures, reproductive, vegetative.

1. Introduction

Forage legumes belong to family Fabaceae (Leguminosae); Fabaceae is a cosmopolitan family include more than 19,000 taxa, after Asteraceae and Orchidaceae in the world; this family recognized for its ecological and economic potential (Lpwg, 2017). Fabaceae taxa have economic importance and have ecological attention because of adaptations their association with nitrogen fixing bacteria or with ectomycorrhizal (Lewis, 1987). Fabaceae taxa contain plant parts other than separated grain that are employed for ruminant livestock feed (Graham, Vance, 2003). They are usually grazed as fodder or silage and can be developed as monocultures or combination with other species, most frequently grasses. According to Food and Agriculture Organization of the United Nations there are 153 different taxa of legume being used as forage but still worldwide the number of these species used as forage is unknown. This list provides some idea of the variety, together with plants ranging in size from small herbs to large shrubs with temperate, tropical and arctic distributions.

In Pakistan, shortage of green forage is one of the restraining issues to uphold present livestock population. This scarcity is about 40-50 % which attains up to 75 % on May-June and November-December (Sarwar et al., 2002). Pakistan has 21 million hectares of land area that is cultivable but these cultivable lands cannot be shifted permanently to forage crops (Iqbal et al.,

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1998). Under these conditions the evolution of high yielding and first-rate quality forage crops particularly the forage legume crops is dire requirement in bridging the production and demand breach especially during the scarcity periods. Leguminous forages rich in protein, minerals and vitamins B (Hill, Curse, 1992). Forage legumes not only add to fertility, manage soil erosion but also used as covers crops to cut down erosion (Ahmed, Anwar, 1986). Intensive cultivation and higher crop yields are likely to influence the soil nutrients status; Fabaceae taxa maintaining soil fertility particularly due to its nitrogen-fixing bacteria (Khan et al., 1986). Forage performance of a crop be based on plant height, pods, weight, and number of leaves (Ahmed, Anwar, 1986). Various characters used in morphological investigation are of a continuous nature and show considerable variation even between plants of an accession. The accuracy of the data obtained through morphological description will determine the subsequent grouping of the accessions.

The aim of this study was to determine accurate assessment of the morphological variation in forage legume species for their proper identification.

2. Materials and methods

Legume species with vegetative and reproductive parts were collected. For identification and authentication, herbarium specimens as well as flora of Pakistan (Nasir, Ali, 1971) and flora of China (Bentham, Hooker, 1873). Each specimen was labeled and numbered properly with all necessary details; collection date, place of collection, name of the collector and flowering and fruiting period. Voucher specimens were deposited in the Herbarium of Pakistan, Department of Plant Sciences, Quaid-i-Azam University Islamabad.

2.1. Morphological Study

To study the morphological characters of plant specimens, a hand lens or simple binocular light microscope with a magnification of 10X and 20X was used. The vegetative and reproductive parts were described according to terminology adopted by Bentham and Hooker (1873) and Prain (1903). For reliability in terminology and variety of characters examined, a standardized format was employed to enlist the characteristic features. A binocular stereo zoom light microscope with eyepiece WF10 × 10/20 was used to investigate surface hairs and reproductive parts. To explore fresh parts of flower, needle and razor blades were used. Both qualitative and quantitative features plus some diagnostic characters for each species were examined.

3. Results and discussion

In total, 25 legume species belonging to 11 genera are studied for morphological characters (macro and micro). The detailed morphological description of each species is given in Tables 1, 2. Morphological characters exhibit certain inconsistency in studied forage legume species.

Table 1. Morphological Features of Forage Legume Species

No	Plant Species	Period	Leaf	Leaf lamina	Leaf apex	Leaf base	Type of Stem	Stem	Inflorescence	Fruit type	Diagnostic Features
1.	<i>Crotalaria medicaginea</i>	Perennial	Trifoliolate	Ob lanceolate	Obtuse	Subtruncate	Branched	Pubescent	Raceme	Subglobose	Leaf trifoliolate, stipules filiform, bracts subulate, corolla yellow.
2.	<i>Desmodium triflorum</i>	Perennial	Trifoliolate	Obovate	Acuminate	Cuneate	Rough	Glabrous	Fascicle	Curved	Inflorescence axillary fascicle having 1-5 flowers, corolla pink or white, fruit upper suture straight and lower indented.
3.	<i>Lathyrus aphaca</i>	Annual	Alternate	-	-	-	Soft	Glabrous	Raceme	Long	Stipules foliaceous, leaf reduced to a tendrill, peduncle as long as stipule and corolla yellow in color.
4.	<i>Lathyrus pratensis</i>	Perennial	Paripinnately compound	Linear-lanceolate	-	-	Erect	Pubescent	Raceme	Long	Stem scrambling, peduncle longer than leaf, lower calyx tooth longer than tube and fruit 4-8 seeded.
5.	<i>Lens culinaris</i>	Annual	Paripinnately compound	Oblong-linear	Obtuse	Mucronate	Slender/Angular	Pubescent	Raceme	Oblong	Rachis ending in a short bristle or in a tendrill, corolla pale purple and cotyledons orange red.
6.	<i>Lespedeza juncea</i>	Perennial	Trifoliolate	Obovate	Acute	Mucronate	Erect	Pubescent	Raceme	Long	Branches much pubescent, calyx teeth much longer than the cup and corolla pink.
7.	<i>Lotus corniculatus</i>	Perennial	Compound	Oval-linear	Acuminate	Obtuse	Prostate	Glabrous-pilose	Umbel	Cylindrical	Bracts sessile leaf like and corolla yellow.
8.	<i>Medicago falcata</i>	Perennial	Alternate	Obovate-lanceolate	Obtuse	Cuneate	Erect/Procumbent	Glabrous	Raceme	Straight-crescentic	Stipules toothed fruit straight to crescentic.
9.	<i>Medicago laciniata</i>	Annual	Trifoliolate	Obcordate	Acute	Cuneate	Procumbent	Pubescent	Raceme	Globose to ellipsoid	Leaf margins toothed and stem creeping.
10.	<i>Medicago lupulina</i>	Annual	Trifoliolate	Oval	Obtuse	Cuneate	Prostate	Pubescent	Raceme	Curved	Stipules cordate and dentate, corolla yellow, fruit curved.
11.	<i>Medicago minima</i>	Annual	Trifoliolate	Obovate	Acute	Cuneate	Procumbent	Pubescent	Raceme	Curved	Peduncle longer than petiole, fruit having 3-4 coils and spiny.
12.	<i>Medicago monantha</i>	Annual	Trifoliolate	Obovate	Obtuse	Cuneate	Erect	Pubescent	Raceme	Long	Stipules semisagittate, calyx campanulate and fruit reticulately netted.
13.	<i>Medicago polymorpha</i>	Annual	Alternate	Renniform	Obtuse	Cuneate	Herbaceous	Glabrous	Raceme	Spiny, hooked	Stipules lacinate, corolla yellow, fruit spiral and spiny.
14.	<i>Medicago sativa</i>	Perennial	Trifoliolate	Obovate-sublinear	Obtuse	Cuneate	Erect	Pubescent/subglabrous	Raceme	Falcate	Peduncle longer than petiole, corolla violet and fruit falcate.
15.	<i>Melilotus indicus</i>	Annual	Trifoliolate	Oblong-lanceolate	Obtuse	Retuse	Erect	Pubescent	Raceme	Reticulate	Inflorescence 10-16 flowered, corolla yellow, fruit with prominent veins on surface.
16.	<i>Melilotus officinalis</i>	Annual-biennial	Trifoliolate	Ovate	Obtuse	Retuse	Erect/Decumbent	Pubescent	Raceme	Striated	Leaflets of lower leaves obovate to ovate, stipules of lower leaves entire and corolla yellow.
17.	<i>Trifolium alexandrinum</i>	Annual	Alternate	Oblong-lanceolate	Mucronate	Retuse	Erect	Pubescent	Globose head	Subglobose	Inflorescence oblong-conical head, in fruit minute bracts making an involucre.
18.	<i>Trifolium pratense</i>	Perennial	Alternate	Obovate-elliptic	Mucronate	Obtuse	Erect-decumbent	Pubescent	Globose head	Broad	Inflorescence globose head, rarely pedunculate, calyx pubescent, the lowermost tooth longer than all other teeth and calyx tube and corolla purple or pink.
19.	<i>Trifolium repens</i>	Perennial	Alternate	Obovate	Retuse	Cuneate	Prostate	Glabrous	Raceme	Linear	Stipules sheathing, flowers scented, calyx having nerves and corolla white.
20.	<i>Trifolium resupinatum</i>	Annual	Alternate	Oval-oblong	Obovate	Cuneate	Procumbent	Glabrous	Peduncle head	Ovoid	Inflorescence peduncled head and calyx inflated in fruit.
21.	<i>Trigonella gracilis</i>	Perennial	Compound	Obovate	Acute	Cuneate	Trailing	Glabrous	Raceme	Long	Petiole usually shorter than leaflets, flowers 1-5 in the form of raceme and corolla yellow.
22.	<i>Vicia hirsuta</i>	Annual	Paripinnate	Linear	Obtuse	Mucronate	Trailing	Pubescent-glabrescent	Raceme	Broad	Stipules lanceolate, tendrill mostly branched, flowers 2-7 having peduncled raceme.
23.	<i>Vicia sativa</i>	Annual	Pinnately compound	Obovate	Acute	Obtuse	Erect	Pubescent-subglabrous	Raceme	Oblong	Tendrill branched, flowers 1-2, corolla pale pink.
24.	<i>Vicia tetrasperma</i>	Annual	Paripinnate	Linear-ob lanceolate	Acute	Obtuse	Decumbent	Pilose-glabrous	Raceme	Linear-oblong	Stipules hastate, flowers 1-3 in the form of peduncled raceme.
25.	<i>Vicia tenuifolia</i>	Perennial	Pinnately compound	Oblong-linear	Obtuse	Mucronate	Erect	Subglabrous	Raceme	Oblong-lanceolate	Flowers 20-40 in the form of axillary raceme.

Table 2. Quantitative Morphological Features of Forage Legume Species

S. No	Plant species	Length of Leaf [cm]	Width of Leaf [cm]	Length of Petiole [cm]	Size of Flower [cm]	Length of Pedicel [cm]	Size of Fruit [cm]
1.	<i>Crotalaria medicaginea</i>	0.6-1.4	0.3-0.5	0.2-0.5	1-2.8	0.1-0.4	2-4
2.	<i>Desmodium triflorum</i>	0.5-1.5	0.4-0.7	0.3-0.7	1.5-3	0.5-1.0	3-6.5
3.	<i>Lathyrus aphaca</i>	0.8-4.5	0.2-0.9		2.5-6.5	0.2-0.8	1.8-4
4.	<i>Lathyrus pratensis</i>	1-4.5	0.5-1.5	0.3-0.6	2-6.5	0.3-1.2	2-4.5.2
5.	<i>Lens culinaris</i>	0.5-1.5	0.2-0.5	0.1-0.4	2.5-5	0.4-1.6	0.8-1.4
6.	<i>Lespedeza juncea</i>	0.8-2.6	0.3-0.9	0.2-0.5	2-4.5	0.4-1	0.3-0.8
7.	<i>Lotus corniculatus</i>	2-4.5	1-2	0.3-0.6	1.5-2.9	0.3-0.9	2-4
8.	<i>Medicago falcata</i>	0.5-2.5	0.2-0.8	0.2-0.4	1.5-4	0.2-0.5	1-2.7
9.	<i>Medicago laciniata</i>	0.2-1.2	0.1-0.3	0.1	0.4-1.2	0.1-0.2	1-2-3.5
10.	<i>Medicago lupulina</i>	0.5-2.5	0.3-1	0.1-0.3	0.5-2.7	0.2-0.4	1.2-5.4
11.	<i>Medicago minima</i>	0.5-1.4	0.3-0.9	0.1-0.3	0.6-1.2	0.1	1-3.4
12.	<i>Medicago monantha</i>	1-2.5	0.8-1.8	0.2-0.6	2-4.5	0.1-0.5	1-2.8
13.	<i>Medicago polymorpha</i>	0.8-2.5	0.3-1.2	0.1-0.2	0.4-1.8	0.1-0.2	0.2-1.6
14.	<i>Medicago sativa</i>	1.2-2.4	0.7-1.3	0.1-0.3	0.5-2.1	0.1-0.3	0.3-2
15.	<i>Melilotus indica</i>	1-2.8	0.7-1.6	0.2-1	4-10.6	1-3.5	0.2-0.5
16.	<i>Melilotus officinalis</i>	1.2-8.6	0.5-1.7	0.2-1	3.8-12.4	1.3-4.8	0.3-0.6
17.	<i>Trifolium alexandrianum</i>	1.5-4	0.5-1	0.2-0.5	3-7.5	0.5-2.5	1-2
18.	<i>Trifolium pratense</i>	1-3	0.4-0.8	0.2-0.7	1.5-3	0.2-0.9	0.7-1.1
19.	<i>Trifolium repens</i>	1.2-4.5	0.3-0.6	0.2-1	1.8-3.6	0.2-1.7	0.3-1.8
20.	<i>Trifolium resupinatum</i>	0.7-3	0.2-0.8	0.1-0.6	1-2.4	0.2-0.8	0.4-1
21.	<i>Trigonella gracilis</i>	0.5-1.2	0.3-0.7	0.2-0.6	0.4-1.9	0.2-0.4	1.5-6.5
22.	<i>Vicia hirsuta</i>	0.4-2.5	0.2-1.5	0.2-0.4	1.2-3.6	0.2-0.4	5-12.6
23.	<i>Vicia sativa</i>	0.8-4	0.1-1	0.5-1	1-3.5	0.2-0.4	2-6
24.	<i>Vicia tetrasperma</i>	0.6-2.2	0.3-1.2	0.1-0.4	0.5-1	0.1-0.3	0.6-1.3
25.	<i>Vicia tenuifolia</i>	1.2-4.5	0.7-1	0.9-1.5	0.8-1.8	0.2-0.3	2-5

In total, 16 vegetative and reproductive features have been examined. The morphology of forage species show variability in; shape of leaf lamina, leaf apex and base, type of stem and texture, flower size, type of fruit & size. Morphological characters have been studied as a significant taxonomic tool in earlier studies (Adedeji, 2006). The forage species of legumes are widespread in distribution, with greater range in subtropical regions (Singh, 2016). This study showed that most of plant species possess pinnately or imparipinnately compound and trifoliate leaves. The genus *Lathyrus* (*Lathyrus aphaca*) is distinguished from other forage species by possessing sessile leaves. Consequently, Mohammed (2014) revealed that *Lathyrus aphaca* has reduced tendril that supports the present results. Similarly, *Medicago laciniata*, *Medicago minima* and *Trifolium resupinatum* have been observed with procumbent type of stem, therefore separating these from rest of the species. Quantitatively, the highest leaf size (length and width) is recorded for *Lotus corniculatus* (2-4.5 cm × 1-2 cm) whereas lowest is recorded for *Medicago laciniata* (0.2-1.2 cm × 0.1-0.3 cm). The forage species of genus *Trifolium* are differentiated on the basis of trifoliate leaves, dentate margins and pubescent or glabrous leaf surfaces. These results are in agreement

with earlier study conducted on leaf characters of *Trifolieae* by Taia (2004). The results provided in this study are generally in accordance with the morphological description of leguminous plant species in Flora of Pakistan and Flora of China, but some sort of variations exist regarding the morphological description and some morphological characters are complemented in the light of this study.

4. Conclusion

This study concluded that the morphological description of forage legumes is of significant importance particularly in forage managing systems. Furthermore, attention should be paid on the ecological pressures and management issues of these fodder species, as they deserve greater attention with regard to these aspects for their sustainability.

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