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MORPHOLOGICAL VARIATION IN WILD CYMBOPOGON MARTINI (ROXB.) WATS OF SIX DIFFERENT ECOTYPES

Morphology

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ABSTRACT

The Genus Cymbopogon is a major aromatic grass belonging to the family Poaceae. It produces essential oil of commerce and utilized in aromatic and pharmaceutical industries. It consist of more than 180 species, sub species, varieties and sub varieties worldwide. During the present investigation morphological investigation in Cymbopogon martinii (Roxb.) Wats were carried out. Different ecotypes shown the variation in their morphological features Size, shape and structure of leaf, inflorescence with the ecological variations. Most of the species of Cymbopogon have shown difference in ploidy levels ranging from diploid (2n=20 Chromosomes) to hexaploidy (2n=60 Chromosomes) types.

KEYWORDS

Wild, Ecotypes, Morphology and Cytology

INTRODUCTION:

Grasslands are the largest and most important natural ecosystems of the world, in which grasses, sedges and other herbaceous legumes are dominant. The grass family is one of the largest and most diverse families in the plant kingdom, covering 70% land surface of the globe and showing high adaptability with respect to their environments and their ability to coexist with grazing animals and man. Grasses comes from Old High German word "grass" – generally used to describe any suitable for livestock grazing and they evolved in late cretaceous era (Stromberg, 2011; Prasad *et al*., 2011). They are one of the largest groups of the plants. Grasses are uniformly distributed on all continents and in all climatic zones. They are cosmopolitan in distribution with important centres of diversity in Brazil, Central North America, Southern east Africa, and Australia and occupy an enormous. It is surprise, but fact is that the grass species (Gramineae members) are more in Arctic regions than the other family. Even they grow in range of habitats (Clayton and Renvoize, 1986; Osborne *et al*., 2011), for example, grow in marshy area, Desert, water, water logged area, etc. Grass species are ubiquitous on earth, occurring in ecosystems on every continent and when they form grasslands, they have a major influence on climate through the cycling of carbon and water between soils and the atmosphere. Grasses are very important group of plants not only to human beings but also to animals. Grass species are most of the world's major food crops, including wheat, barley, oats, rice, maize, millets, sugarcane and pasture species. Grasses are very difficult to identify and generally they are identified on the basis of their inflorescences type, for example, on the basis of their reproductive parts. The other feature was the falling of lemma and palea after maturity. Rather than this identification of them are difficult and no more literatures available. Grasses have unique features so they can differentiate easily form the other families. They are cosmopolitan in distribution. The culm is either erect or prostrate. It consists of nodes and internodes. Few grasses have stolons or rhizomes. Leaves have mainly two parts: leaf blade and leaf sheath. At the junction of these two parts there is a ligule present, which is either membranous or hairy or sometime absent(Handbook on the Morphology of Common Grasses).

The study of the physical features (external structure) of plants is referred to as morphology. Morphology of grass plants is not just a biological pursuit but can aid in many everyday decisions for the forage manager. Grasses, whether annual or perennial, are mostly herbaceous (not woody), monocotyledon plants with jointed stems and sheathed leaves. They are usually upright, cylindrical, with alternating leaves, anchored to the soil by roots. Grasses have leaves (blades that narrow into a sheath), a stem (culm), a collar region (where leaves attach to the stem), roots, tillers, and during the reproductive stage an inflorescence or seed head develops. Grasses may have rhizomes or stolons and the collar regions have differing variations of ligules, auricles, and blades (laminas). Inflorescences of grasses also vary widely so during vegetative stages, the collar and leaves help in proper identification and during reproductive stages the inflorescence is very helpful.

Inflorescences are an arrangement of many spikelets composed of individual florets. Grasses have three main inflorescence (seed head) types: panicle, spike, and raceme.

From a seed, primary (seminal) roots develop to nourish and anchor the seedling. Eventually fibrous or adventitious roots develop from lower stem nodes. Some grasses have underground stems called rhizomes which grow horizontally before pushing above ground to a new shoot. Stems or culms are really a series of sections called internodes which are separated by nodes. This is why grasses are referred to as jointed or as "joints" (during the proliferation of marijuana). The internodes or sections are very close together near the stem and but lengthen or stretch out as the plant matures. The internodes are most often hollow but a few grasses have internodes of white pith, such as sorghum. The branching of leaves always occurs at the nodes and develops from a bud that is between the leaf-sheath and the stem. When branching results from nodes at the base of the plant it is called tillering (suckering, stooling).

All grasses have a distinctive collar region. Proper identification requires a look at this area where the leaf blade wraps around the stem. If the leaf blade is pulled back, the collar region reveals a unique combination of ligule, auricle, and meristematic tissue. Barnyard grass has no ligule or auricles. But other grasses will have a ligule (hairy or membranous growth at the blade-sheath junction). Ligules vary in size, shape, and type. Many grasses will also have distinctive auricles (appendages that wrap the blade around the stem). The meristematic tissue will appear whitish and is the area of leaf blade growth and expansion.

MATERIALS AND METHODS:

Wild *C. martinii* were collected from hilly regions of South India i.e. Devarayana Durga hills from Karnataka, Sidderabetta hills Tumkur Karnataka, Bangalore University (short leaf) Bangalore, Bangalore University (Big leaf) Bangalore, Shira(short leaf) Tumkur, Shira (Big leaf) Tumkur. The plant collections were cons idered as six different populations and were maintained in the departmental garden of Microbiology and Biotechnology, Bangalore University, Bangalore under uniform conditions for further studies. 1. Morphological studies: The selection of the plant for study was based on the habit of the plant (morphology) and its aroma value. The morphological characters of the plant such as plant appearance, plant height, leaf size, leaf colour,

stem colour and inflorescence were recorded.

RESULTS:

Inflorescence

Inflorescence is a portion of a flowering culm upward from the node at the base of the uppermost leaf (Abercrombie et al., 1960; Benson, 1979; Gould, 1968; Smith, 1977). In grasses, true flower parts are inconsequential in identification. The grass inflorescence is a highly modified and complex structure with a different ontogeny. Based on the spikelet arrangement will be used for description of the inflorescence type. Basically three type of inflorescence are there: the panicle, the raceme and the spike.

Panicle

The spikelets are born on branches from the central axis of the inflorescence. Panicles are the most common grass inflorescence. It has two different forms: (i) spreading panicles having varying branch lengths; and (ii) compact panicles have short panicle branches.

Raceme

The spikelets are attached directly to the rachis by a single stalk. There are two forms: (i) digitate raceme, and (ii) multiple racemes.

Spikelet

The sessile spikelets are attached directly to the central axis of the inflorescence. It may in three forms: (i) solitary spikes have one rachis of spikelets; (ii) digitate spikes have more than one rachis of spikelets; and (iii) multiple spikes have more than one rachis and they form from various points

The different populations of *C. martinii* were studied for its appearance, height, leaf colour and size and for colour of the stem and inflorescence. The plant or E-1 was tall, bushy with broad leaves of bluish green colour. The culm of the plant was dark red in colour possessing marron inflorescence. *C. martinii* of E2 and E3 showed dispersed appearance, the culm was red in colour with narrow leaves and brownish inflorescence. The plant E4 was medium height with pale bluish green color leaves. The plant of E5 and E6 were dwarf and medium with dark green leaves.

It has long been noted that in *C. martinii*, the lower glume of the sessile spikelet has a deep median groove in its lower half. It is noted that the florets are narrow, long with a deep median groove on the lower half of the glume. Thus morphologically it is intermediate in character. Anatomically it is quite evident that in *C. martinii*, the prickles are absent from the epidermis except on the leaf margin. In *C. martinii* the lamina is quite flat both abaxially and adaxially. The present studies on the six ecotype of *C. martinii* species reveal that there is no drastic variation with regard to the structure and morphology of the spikelets, both within and between the species, indicating the floral homogeneity of the members and the series as a whole.

The species of Cymbopogon are either densely or loosely tufted. Ranging in the height from 20 cm, they are perennial, except some of them which are annual. It is not always possible to distinguish annuals from perennials. Annuals, however, usually have solitary culms or 2-3 culms in loose tuft, the cataphyll or the basal scale is absent, the rhizomes are usually absent, and the base of the culm is without the old basal sheaths. Perennials on the other hand, usually have several culms in loose or dense tufts, coated by old basal sheaths, the cataphylls, rhizomes and perennating buds are present.

Based on the consistent and distinct morpho-anatomical characters, six types are being erected newly in one species of *Cymbopogon martinii*.

In *C. martinii* it comprises the wild species **E1 and E2** resemble each other in their morphological characters, with little variations in their growth characteristics. These wild types are unique and differs from other types morphologically by its gigantic size. Type 3 has a characteristic leaf blade which is coarsely scab rid along the margin and possesses hooks and micro-hairs and narrow keel. **E4, E5** and E6 differ from the rest in possessing lamina that forms a characteristic acute angle with the culms.

E3 and E4 Recemble each other in habit, in the short stature of plants, and in possessing a lamina of narrow keels, but differ in their leaf angles and trichomes. The leaves of E3 forms obtuse angle with E2, in many respects but differs from it in leaf character forming an obtuse angle with the culm. E1 differs from rest of the types in having he aerial parts of the plant body suffused with purple colour; the leaf margin being smooth. E1 of C. martini notably has the largest distribution. These grasses are medium statured and very common in South India, possessing cordate leaves with narrow keel.

Ecotype1:

Strongly aromatic grasses, culms erect, 35-40 cm hight and unbranched.

Leaves 27-35 x 1.6-1.9 cm., linear lanceolate, coarsely scabrid along the margin; cordate as base, amplexicaul, making an obtuse angel with the culms; ligule membrano chartaceous, 3-5 mm long; leaf sheaths shorter than the internodes, smooth all nodes exposed. Inflorescence false decompound panicle, up to 35 cm long, moderately dense, spatheole 18-20 mm long, orange to bright red at maturity elliptic acute; racemes 15-18 mm long, one subsessile, other pedicelled. Lowest pair of spikelets in the subsessile raceme homogamous male. Pedicel of the lowermost pedicelled spikelet in the sessile raceme swollen and adnate to rachis. Sessile spikelet 3-3.5nm long, elliptic oblong excluding the wings; lower glume with a deep median groove, 2-nerved, broadly winged, awn 16-18 mm long, pedicellate spiklets 4.4-5mm long elliptic-acute, lower glume With 7-9 nerves.

Ecotype 2:

Loosely tufted perennial aromatic grass, culms procumbent to erect; 25-30 cm tall, 8-10 mm in diameter, rarely branched at the base, radical leaves few; culms often bent at nodes, nodes swollen, often waxy. Leaves 24 X 2-3cm, pale green, linear lanceolate, coarsely scabrid along the margin, base cordate, nearly amplexicaul, angle on the culm obtuse; ligules 2-5 mm long, membrano-chartaceous. Leaf sheath upper 2-3 shorter than internodes rest longer, over-lapping smooth glabrous, spathate panicle erect, compound up to 60 cm, spatheole 15-22 mm long, orange to bright red at maturity. Racemes 15-17 mm long, lowermost pedicel of pedicelled spikelet in sessile raceme swollen and adnate to pedicel; sessile spikelet 3.5-4 long elliptic-oblong, broadly winged, lower glume 0.8-1 mm wide, with a deep median groove 2-nerved and broadly winged; awn 12-16 mm long. Pedicellate spikelet elliptic acute, 2.5-5 mm long, lower glume 1.2 mm wide, glabrous 7-9 nerved.

Ecotype 3:

Perennial aromatic grasses: culms erect, 22-29 cm long, smooth, glabrous, terete; lower nodes often swollen, radical leaves few, often branched at the base; lamina 23-28 X1.4cm, dark green linear lanceolate, scabrid along the margin, rounded to cordate at base, forming right angle to obtuse angle with the culm; ligule membrano chartaceious, 3-4 mm long.

Leaf sheath-upper few shorter, lower ones longer and overlapping, smooth glabrous. Spathate panicle sparsley branched, 15-30 long, spatheole 15-22 mm long, bright -red at maturity. Racemes 18-20mm long, the pedicel of the lowermost pedicelled spikelet in the sessile-raceme swollen and glossy; rachis internodes and pedicel pilose along the margin; sessile spikelet up to 3mm long, glabrous, lower glume chartaceous, 1mm wide, elliptic ovate with a deep median groove, broadly winged, 2-nerved; awn 12-18 mm long; pedicellate spikelet 4mm long, glabrous, lower glume elliptic-acute, 8-nerved

Ecotype 4:

Perennial aromatic grasses; culms erect, 15-22 cm tall, smooth, glabrous, terete, tillers many , unbranched, radical leaves few, lower nodes often swollen. Leaf blades 16-20 x 1.0-1.2 cm, linear lanceolate, pale green, scabrid along the margin, cordate to amplexicaul at base, leaf blade forms acute angle with the culm. Leaf sheath smooth and glabrous, upper 2-3 shorter, lower ones longer and over lapping. Panicle 20-30 cm long, erect, sparely branched; spatheole8-10 mm long bright red at maturity. Racemes 18-20 mm long; the pedicel of the lowermost pedicelled spikelet in the sessile ace swollen and adnate to rachis. Internodes of the rachis and pedicel pilose along the margin. Sessile spikelet 3.5 mm long, glabrous, lower glume chartaceous, 1mm wide, ovate with a deep median groove, broadly winged, 2-nerved; awn 12-18 mm long, pedicellate spikelet 4 mm long, glabrous, lower glume lanceolate, 8-nerved.

Ecotype-5:

Perennial aromatic grasses with thick and erect sometimes procumbent. Culms, 13-20cm tall, 4-7 mm in diameter, smooth, glabrous, lower nodes swollen culms unbranched, often waxy, tillers

20-30, radical leaves few. Leaf blades 14-28 x 2-2.5 cm, pale yellow, leaf blades thick, lanceolate, the tapering into a long narrow structure, margin smooth, seldom scabrid, amplexicaul at the base, making acute angle with the culms; ligule membrano-chartaceous, 4-7 mm long. Leaf sheath glabrous, smooth the upper few shorter and the lower ones longer and overlapping, spathate panicle 30-60 mm long, branched, dense, spatheoles 20-30 mm long, bright red at maturity; racemes 18-20 mm long, the pedicels of the lower-most pedicelled spikelet in the sessile raceme swollen and glossy; sessile spikelets 3.5-4.5 mm long, lower glume lanceolate acute, wings broad, sometimes with 2 nerves, 1mm wide with a deep median groove; awn 12-18 mm long; pedicellate spikelet 4-4.5 mm long, glabrous, lower glume lanceolate with 8-10 nerves.

Ecotype:6

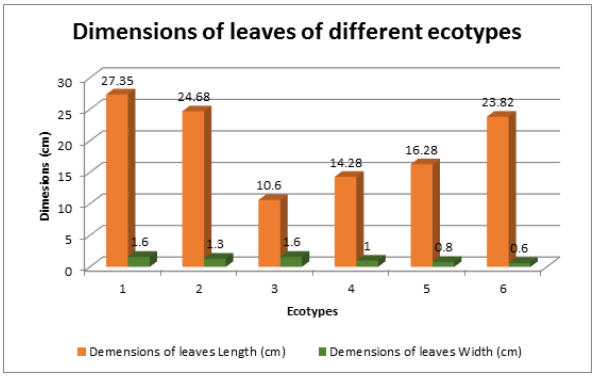
Perennial aromatic grasses; culms erect, terets, 8-20 cm tall, unbranched, lower nodes swollen, tillers 20-30. Leaf blade 10-15 x 2.0-2.0 cm, linear lanceolate, yellow-green, cordate to rounded at base, forms obtuse angle with the culm ligule 3-5 mm long membrano chartaceous; leaf sheaths glabrous smooth, the upper are shorter and the rest longer and overlapping. Spathate inflorescence compound, 45-65 cm long, dense; spatheoles 20-25 mm long, bright red at maturity. Racemes 18-20 mm long, lowermost pedicel of the pedicelled spikelet in sessile raceme swollen and glossy. Rachis internodes and pedicel pilose along the margin, sparsely pilose on the back. Sessile spikelet 3.5-4mm long, glabrous, lower glume elliptic acute with a broader tip, wings broad; glume with a deep median groove, 2-nerved, awn 12-18 mm long nerved. Herbarium specimen is shown in Fig. a (plate IV).

Table:1morphological Characters In Different Population Of *C. Martinii*

Parameter	Ecotype-1	Ecotype-2	Ecotype-3	Ecotype-4	Ecotype-5	Eco-6
Plant appearance	Bushy	Spread	Spread	Spread	Bushy	Spread
Plant height	Tall	Medium	Tall	Dwarf	Dwarf	Medium
Leaf colour	Bluish green	Pale bluish green	Deep green	Pale bluish green colour leaves	Dark green leaves	Dark green leaves
Leaf size	Broad	Narrow	Narrow	Broad	narrow	Narrow
Stem colour	Dark Red	Red	Red	Yellowish	Brownish	Brownish
Inflorescence colour	Maroon	Brownish	Brownish	Maroon	Maroon	Brownish

Table:2 Ecotypes Showing Different Dimensions Of Leaf (cm)

Ecotype	Leaf Dimension	
	Length (cm)	Width (cm)
1	27.35	1.6
2	24.68	1.3
3	10.6	1.6
4	14.28	1.0
5	16.28	0.8
6	23.82	0.6



The E1 is short – statured, narrow leaves, both surfaces of the leaves are smooth, including the leaf margin. On the other hand E2 of C. martinii are medium statured grasses with long leaves, each coarsely scabrid along the margin with prickles. Plants of the E2 are not as common as the E1.

The different ecotypes differs morphologically from the other ecotypes in having variegated florets, persistent spatheoles, and larger spikelet; the pedicel of the lowermost pedicelled spikelet in the sessile raceme is not swollen and free.

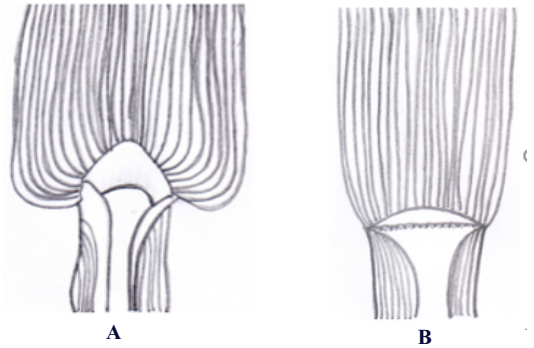


Fig:leaf Bases And Ligule In Cymbopogon Martini In Different Ecotypes.
A(E4 and E5), B(E1, E3, E6), C(E2)

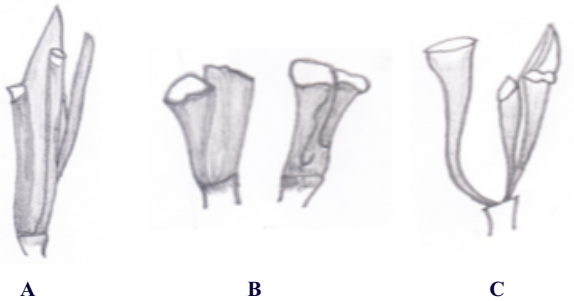
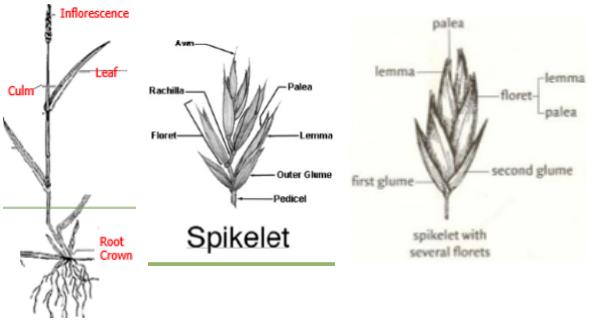


Fig: Different Types Of Raceme Bases In Ecotypes Of Cymbopogon Martini
A(E1and E3), B(E4), C(E5 and E6).

Fig: Glumes Cymbopogon Martini Of Different Ecotypes (a And B In E1,e2, E4, And E6, C And D In E3 And E5

Fig: Diagram Of Spathate Panicle In Cymbopogon Martinii; Lateral Branch,
Prophyllum, Raceme, Tier, Spathe, Spatheole



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