*Pak. J. Bot.*, 41(5): 2379-2386, 2009.

# STUDIES OF VEGETATIVE BEHAVIOR AND CLIMATIC EFFECTS ON SOME PASTURE GRASSES GROWING WILD IN PAKISTAN

**TARIQ HUSAIN[1], ASRAR HUSSAIN[2] AND MOINUDDIN AHMED[3]**

[1]*Hamdard University, Muhamamd Bin Qasim Avenue, Karachi-74600, Pakistan*
[2]*Department of Botany, Govt. D.J. Science College Karachi, 74200 Pakistan*
[3]*Department of Botany, Federal Urdu University of Arts, Science & Technology, Gulshan-e-Iqbal Campus Karachi-75300, Pakistan*.

**Abstract**

Eight genera and 12 species of plants *viz*., *Apluda mutica* L., *Bothriochloa ischaemum* (L.) Keng, *Chrysopogon aucheri* (Boiss.) Stapf., *C. serrulatus* Trin., *Cymbopogon caesius* (Nees ex Hook. & Arn.) Stapf., *C. jwarancusa* (Jones,) Schult, *C. martinii* (Roxb.) Wat., *C. commutatus (Steud.)* Stapf., *Dichanthium annulatum* (Forssk.) Stapf., *Hyparrhenia hirta* (L.) Stapf., *Themeda anathera* (Nees) Hack and *Sorghum halepense* (L.) Pers, were collected from different climatic regions of Pakistan. They were replanted in a nursery at Karachi to investigate their vegetative and climatic behaviours. Although growing m different habitats and conditions, these pasture grasses are quite able to grow in monoclimate condition successfully. *Hyparrhenia* and *Themeda* showed slight deviation. Once they established by proper irrigation it helped them to survive in adverse conditions also. The vegetative growth occurs through runners, root-stocks and small rhizomes. The erect and dropping new clones / branches also shoots arise from vegetative buds in the rainy season which is most suitable.

## Introduction

The increase in human population is biological living process and world population is tremendously increasing with the passage of time. Pakistan having population of 65.3 millions in 1980 and 166 millions now, in 2009. Due to rapid increase in population, so many problems have developed like, food, housing, health, fuel and drinking water etc. Pakistan is an agricultural country and cultivated land becoming insufficient with the passage of time also yield from different crops provide minimum share towards population. We are importing various items and putting burden on our economy. By introducing pasture lands we can have more live-stocks etc., which will make self sufficient.

In Pakistan only little research was under taken on these grasses (Ahmed *et al*., 1978. Hussain *et al*., 1980; Husain *et al*., 1983; Ahmed, 1994; Ayaz, 1992, Bano *et al*., 2009; Hussain, & Ihsan Ilahi 1997). However, multiplication of these investigations on study of pasture grasses can improve live-stock and poultry etc. Some species of *Cymbopogon* provide essential oil. Species of *Chrysopogon* and *Cymbopogon* check soil erosion by wind and water (Rafi, 1958) also help in maintenance of area and reclamation of saline land.

The advanced countries viz., Australia, Switzerland and Denmark spending millions of dollars for development, management and protection of pasture lands. These flourished industrial formations are exporting meat, leather, milk, wool, fertilizer and poultry feeds through which earning billions of dollars from the world. Hence their economy is mostly based on these pasture grasses. The America, France and Germany have well planned grasslands as per their requirements.

In Pakistan no artificial/natural grasslands are present. Only in patches these grasses are reported in Sindh, Punjab, NWFP & Azad Kashmir. In NWFP, Punjab & Azad Kashmir moisture is available for their growth while most have wide amplitude (Fig. 1). The cattle were with chance to graze on pockets/patches of seasonal grasses, which after rain fall appeared on the banks of canals, nallahs and barren areas etc.

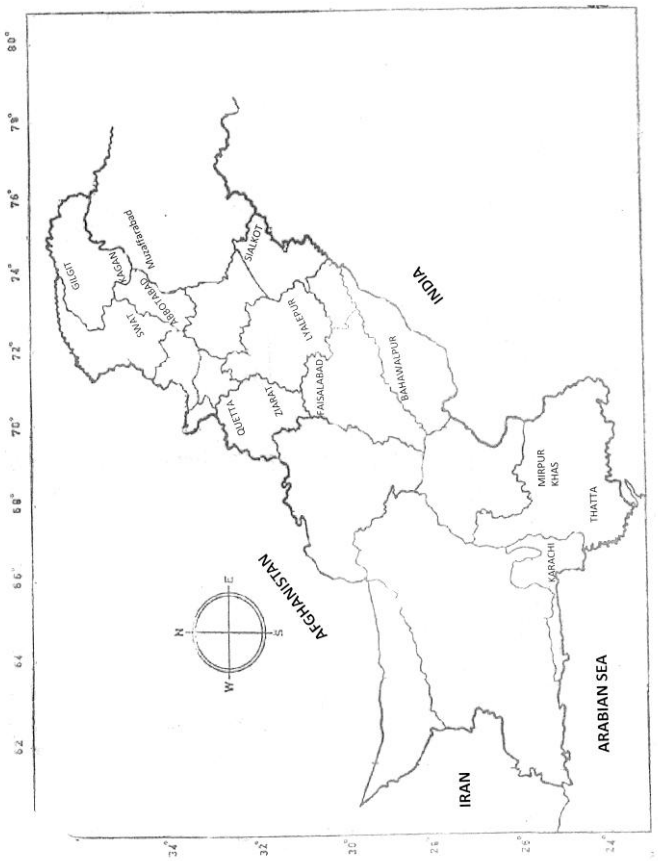


Fig. 1. Collection area.

These pasture grasses are also exhibiting same behaviours as reported from India, Iran, Turkey & Afghanistan. They also form important vegetation of tropical and sub tropical regions of the world.

In western countries the sufficient work has been done and finally developed improved varieties of these grasses for drought, frost, and shade and temperature resistance (Tompsett, 1976). Looking towards the need of Pakistan research was conducted related ecological aspects and vegetative behaviour of these grasses to improve their vegetative and reproductive responses for the development of pasture lands. Since some of these grasses are collected from cooler areas and their behaviors in warm areas will increase our knowledge, toward the impact of climate change scenario.

Present studies are coordinated to above aspects and hope that it will increase our scientific knowledge which could be beneficial to improve their better qualities, varieties and resistance for adverse prevailing conditions.

## Materials and Methods

**Development and maintenance of grass nursery at Karachi:** Prior to collection of these grasses 10 plots of 2.15 sq meter size were prepared for grass nursery. It was also

fenced with barbed iron wire upto 1.5m high to protect from grazing animals. In each plot monospecific condition was restricted may be species collected from different places of Pakistan (Table 1). There were required about six month continuous to look after with concentration on proper irrigation especially during dry season. The trimming of dropping branches and other cares fully provided. Finally a grass nursery was developed having 266 plants.

**Observations of growth and development of plants:** The adventitious buds develop in the axil of branches / clones, rhizomes and rootstock, which further grow into branches/shoots of long erect and dropping types depending upon species. On maturation of plants floral primordia initiated which further grow and develop into inflorescences.

**Propagation of grasses:** The formation of new plants of same species from any part of mother plant other than seeds known as vegetative propagation. In these grasses it takes place through runners, root-stocks and rhizomes.

**Climate of Karachi region:** The area had an arid tropical maritime climate, characterized by hot summer and mild winter. According to the lower Indus, report (1996) the area falls in the coastal climatic zone with the following average data.

| | |
|---|---|
| Mean annual rainfall | 175-200mm |
| M. annual evaporation | 1500-2000mm |
| M. Max. summer temperature | 35°C |
| M. Min. winter temperature | 10°C |
| M. relative humidity, summer | 80% |
| M. relative humidity, winter | 50% |

Rainfall is highly variable and erratic, falling mostly during the monsoon season. Tropical storms originating over the Arabian Sea cause torrential rain in some years (Fig. 2).

**Short Taxonomic account of the Grasses (Cope, 1982)**

**1. *Apluda mutica* L.:** Rambling perennial; culms up to about3 m long rooting from the lower nodes. Leaf-blades flat, 5-25cm long, 2-10 mm wide, attenuate at the tip.

Flase panicle linear, interrupted, 3-40 cm long. Spatheole narrowly ovate in side view. 3.5-10 mm long, acuminate. Sessile spikelet 2-6 mm long; lower glume narrowly elliptic-lanceolate; upper lemma deeply bified with" an awn 4-12 mm long or entire to emarginate and awnless. Pedicelled spikelets broadly lanceolate, the larger 2-5 mm long; pedicels narrowly oblong. 2-4 mm long.

**Distribution in Pakistan:** Punjab, Sindh, Baluchistan.

**2. *Bothriochloa ischaemum* (L.) Keng:** Tuft perennial with mostly based leaves; culms erect or geniculately ascending, up to 80 cm high. Leaf-blades 3-15 cm long, 2-4 wide. Inflorescence composed of 5-15 subdigitate racemes; racemes 4-6 cm long, shortly pedunculate, the peduncles glabrous. Sessile spikelet oblong-lanceolate. 3.5-5 mm long; lower glume chartaceous, hairy below the middle, not glossy, without a pit. acute; awn 12-15mm long Pedicelled spikelet glabrous on the back, without a pit.

**Table 1. Collection areas of study grasses in Pakistan.**

| Species | Place of Collection |
|---|---|
| *Apluda mutica* L. (AM01) | Kallar Kahar hills |
| *Bothriochloa ischaemum* (L.) Keng (BI01) | Mirpur Khas |
| *Chrysopogon aucheri* (Bioss.) Stapf (CA01) | Muzaffarabad, S. Waziristan |
| *C. serrulatus Trin* (CA102) | Thatta |
| *Cymbopogon caesius* (Nees ex Hook & Arn.) Stapf (CC01) | Faisalabad |
| *C. caesius* (Nees ex Hook. & Arn). Stapf (CC02) | Chowkandi Tombs |
| *C. commutatus* (Steud.) Stapf (CC03) | Karachi University Campus |
| *C. commutatus* (Steud). Stapf (CC04) | Ziarat |
| *C. jwarancusa* (Jones) Schult. (CJ05) | Urak, Quetta |
| *C. jwarancusa* (Jones) Schult. (CJ06) | Ayub Park, Islamabad |
| *C. jwarancusa* (Jones) Schult. (CJ07) | Karachi |
| *C. jwarancusa* (Jones) Schult. (CJ08) | Bahawalpur |
| *C. jwarancusa* (Jones) Schult. (CJ09) | Chowkandi Tombs |
| *C. jwarancusa* (Jones) Schult. (CJ010) | Khoushab |
| *C. martinii* (Roxb.) Wats. (CM011) | Karachi |
| *Dichanthium annulatum* (Forssk.) Stapf (DA01) | Sialkot |
| *Hyparrhenia hirta* (L.) Stapf (HH01) | Swat |
| *H. hirta* (L.) Stapf (HH02) | Mingora |
| *Sorghum halepense* (L.) Pers. (SH01) | Faisalabad |
| *Themeda anathera* (Nees) Hack. (TA01) | Kaghan |
| *T. anathera* (Nees) Hack. (TA02) | Nathiagully |

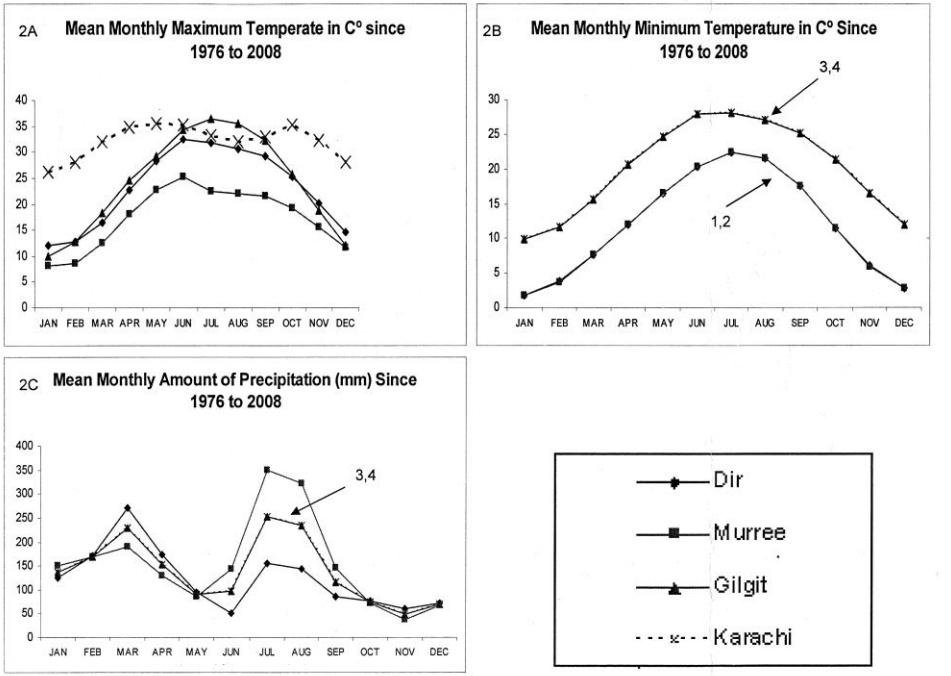


Fig. 2. Mean monthly climatic variables four different locations (Dir, Murree, Gilgit and Karachi) of representative sampling sites. In fig. 2B and 2C data of two climatic stations are overlapping.

**Distribution in Pakistan:** Punjab, Sindh, Baluchistan.

**3. *Chrysopogon aucheri* (Boiss.) Stapf:** Tufted glaucus perennial; culms up to 60 cm high. erect or ascending, slender. Leaf-blades up to 25 cm long. 2-4 mm wide, acute to acuminate, puberulous and with tubercle-based cilia on the rnargins especially near the base. Panicle ovate, 5-10 cm long. Sessile spikelet narrowly elliptic to narrowly oblong; lower glume 5-8 mm long, laterally compressed to a rounded keel, shortly ciliate at the tip; upper glume cliliate at the tip, with an awn 1.5-10 mm long; upper lemma minutely bidentate, with a shortly pubescent awn 25- 40 mm long. Pedicelled spikelets 4-7-10mm long, the lower glume bearings an awn 4-7 mm long; pedicels fulvously villous.

**Distribution in Pakistan:** South Waziristan & Azad Kashmir.

**4. *Chrysopogon serrulatus* Trin:** Perennial, culms 30 - 100 cm high, erect, robust. Leaf-blades mostly cauline, up to 30 cm long and 5 mm wide, but sometimes basal and much shorter, bluntly acute to acuminate, glabrous or sometimes with a few tubercle-based hairs. Panicle ovate, 3-12 cm long, with delicate capillary branches fulvously bearded at the tip. Sessile spikelet narrowly oblong; glume 4-7 mm long, laterally compressed to a rounded keel, hispidulous at the tip; upper glume glabrous or with a few white hairs on the keel, bearing an awn 6-10 mm long; upper lemma mainutely bidentate, with a glabrous or pubescent awn 2-3 (-3.5) cm lone. Pedicelled spikelets (3-) 4.5 -8 mm long, lower glume bearing an awn 3.5 - 6.5 mm long; pedicels fulvously villous.

**Distribution in Pakistan:** Sindh, Punjab, Baluchistan.

**5. *Cymbopogon caesius* (Nees ex Hook. & Arn.) Stapf:** Tufted perennial arising rhizome; culms 30-120 cm high, win1 straggling, leaf-blades linear. 5-30 cm long. 1.5-8 (-10) mm wide light green to glacous, broadest at the rounded base and tapering to a filiform tip. False- panicle narrowly oblong, 5-20 (-30)cm long, erect; spatheoles narrowly lanceolate. 1-2 cm long, becoming yellowish. Racemes 10-15 mm long. The lowermost internode and pedicel connate and swollen: internodes and pedicels densely ciliate along the margins, puberulous on the back. Sessile spikelet oblong elliptic. 3-4.5 mm long: lower glume flat in the upper half and with a deep V-shaped.

**Distribution in Pakistan:** Punjab, NWFP & Azad Kashmir.

**6. *Cymbopogon jwarancusa* (Jones) Schult.:** Perennial; culms erect or geniculately ascending, up to 150 cm high. Leaf blades up to 30 cm long and 5 mm wide, whitish, narrowed at the base, attenuate ora filiform, tip; basal sheaths glabrous, flat or coiled, ligule 0.5-4mm long. False panicle 15-40cm long, erect, spatheoles lanceolate to narrowly elliptic, becoming reddish. 1.5-2.5 cm long. Racemes 13-22 mm long, lowest pedicel not swollen: internodes and pedicels densely ciliate along the margins and on the back. Sessile spikelet laceolate. 4.55-5.5 mm long: lower glume shallowly concave on the back; upper lemma-deeply billed, with an awn 7-10 mm long.

**Distribution in Pakistan:** Sindh, Punjab, Baluchistan, NWFP Gilgit & Azad Kashmir.

**7. *Cymbopogon martinii* (Roxb.) Wats.:** Tufted perennial arising rootstoek; culms up to 3 m high, the lower nodes otter, swollen. Leaf-blades linear lanceolate or lanceolate, up to 50 cm long. 10-30 mm wide, glaucus or pruinose below, usually dark green above,

cordate at the base and often amplexicaul. tapering to a filiform tip. False panicle liner-oblong, up to 30 cm long, erect: spatheoles narrowly elliptic to narrowly lanceolate. 2-4 cm long: green, becoming orange or reddish at maturity. Racemes 15-20 mm long, the lowermost pedicel swollen and barrel shaped; internodes 7 and pedicel densely ciliate along the margins, sparsely pilose on the back. Sessile spike let elliptic oblong or oblong. 4-4.5 mm long; lower glume flat on the back in the upper half and with a deep V-shaped groove in the lower, the keels winged above; upper lemma deeply bifid, with an awn 12-18 mm long.

**Distribution in Pakistan:** Sindh, Punjab, Baluchistan, NWFP & Azad Kashmir.

**8. *Cymbopogon commutatus* (Steud.) Stapf:** Perennial: culms erect or ± geniculately ascending, 15-150 chi high. Leaf blades flat, 10-50 cm long. 1- 4 mm wide, dull green to reddish, narrowed at the base, attenuate to a filiform tip; basal sheaths persistent, thinly to densely pubescent, sometimes almost glabrous. False panicle 5-35cm long, erect: spatheoles narrowly lanceolate to narrowly elliptic, 2-2.6 (-4.3) cm long. Racemes 15-40 mm long, lowermost pedicel swollen and barrel shaped, free from the adjacent pedicel which is also sometimes swollen; inter modes and pedicels densely ciliate along the margin glabrous to minutely puberulous on the back. Sessile spikelet narrowly lanceolate, 4-7 mm long; lower glume flattish to deeply concave on the back; upper lemma deeply bifid, with an awn 10-20 mm long.

**Distribution in Pakistan:** Sindh,Punjab, Baluchistan, NWFP & Gilgit.

**9. *Dichanthium annulatum* (Forssk.) Stapf:** Perennial; culms 25-100 cm high, geniculately ascending. Leaf-blades 3-30 cm long. 2-7 mm wide. Inflorescence composed of (1-) 2-15 subdigitate shortly peduncled racemes, the peduncles glabrous; racemes 3-7cm long, the spikelets subimpricate with 0-6 smaller homogamous pairs at the base: internodes and pedicels solid. Sessile spike let narrowly oblong. 2-6mm long: lower glume firmly cartilaginous, slightly concave, pubesent to villous below the middle with long bulbous based hairs on the margins above, obtuse to subacute; awn 8-25 mm long.

**Distribution in Pakistan:** Sindh, Punjab, Baluchistan, NWFP & Azad Kashmir.

**10. *Hyparrhenia hirta* (L.) Stapf:** Caespitose perennial arising from short underground rhizomes, the basal leaf-sheaths glabrous or very rarely obscurely puberulous: flowering culms wiry typically 30-60 cm high standing over a dense leafy tussock 10-20 cm high. Leaf-blades narrowly linear to conduplicate and filiform, 2-15 (-30) cm long, 1-2 (-4) mm wide, flexuous, glaucous, harshly scaberulous. False panicle typically scanty, up to 30 cm long, bearing 2 -10 raceme-pairs or sometimes more; spatheoles hnear-laceolate. 3-8 cm long: at length reddish, the peduncles about as long. Racemes 2-4 cm long 8-13 (-16) awned per pair, white villous, never deflexed; raceme-bases unequal, the upper 2.5-5 mm long, filiform, glabrous or more often pubescent to hirsute. Homogamous pairs 1 at the base of the lower or both racemes. Sessile spikelet 4-6.5 mm long, white villous (occasionally the hairs rather sparse); callus 0.5-1.5 mm long, subacute to acute; awn 10-35 mm long, puberulous. Pedicelled spike let white villous. muticous.

**Distribution in Pakistan:** NWFP & Gilgit.

**11. *Sorghum halepense* (L.) Pers.:** Rhizomatous perennial; culms simple or branched, 0.5-3m high or more, slender to rather stout. Leaf-blades 20-90 cm long, 0.5-4 cm wide. Panicle loose when in flower, sometimes somewhat contracted after flowering, laceolate to pyramidal, mostly 10-55 cm long. 3-25 cm wide, primary branches compound, bare at the base, ultimately bearing racemes of 1-5 spikelet pairs. Sessile spikelet elliptic to subelliptic, 4.5-5 (5.5) mm long, at first = hairy and cream to buff-yellow or tawny, at the length often tawny, mahogany red. purplish to blackish brown or black and sometimes almost glabrous; lower glume keeled above, the wings of the keels widening upwards to end in minute teeth, forming with the short apex a distinctly 3-toothed tip; upper lemma acute and minutely mucronate or 2-lobed with an awn 10-16 mm long pedicelled spikelet at length deciduous, often purplish, male, 4.5-6.5 mm long.

**Distribution in Pakistan:** Sindh, Punjab, Baluchistan, NWFP, Gilgit, Azad Kashmir.

**12. *Themeda anathera* (Nees) Hack:** Densely tufted perennial with creeping rhizome; culms 30-120 cm high, exact geniculately ascending. Leaf-Blades flate, up to 30 cm long and 4 mm wide, panicle 20-30 cm long, compound, loose, the racemes solitary or paired; spatheole 1.5-2 cm long, usually tinged with grey, red or purple, glabrous, raceme containing 2-4 fertile spikelets. Homogenous pairs separated by a short intern ode 0.3-1 mm long: lower glume laceolate, 5-8 mm long, glabrous to sparsely or densely tuberculate-ciliate. Sessile spikelct 5-7 mm long, dorsally compressed, with a blunt bearded callus. 1 mm long; lower glume puberulous or subglabrous to tuberculate ciliate especially on the keels: upper lemma leceolate, hyaline, awnless. Pedicelled spikelet 6-8 mm long includes the callus, puberulous to tuberculate-ciliate on the keels.

**Distribution in Pakistan:** Sindh, Punjab, Balochistan. NWFP, Gilgit. Azad Kashmir.

**Result and Discussion**

These species belong to the tribe Andropogoneae of the family Poaceae. In this tribe some species are exodus and originally reported from India. Afghanistan. Egypt, Nepal. Syria. Mauritania. Italy and South Europe. Genera like *Cymbopogon, Chrysopogon* and *Bothriochloa* grow in dry areas, and *Dichanthium, Sorghum* in moist climate while *Hyparrhenia* and *Themeda* prefer cool climatic regions. In nursery at Karachi in monoclimatic conditions most species showing normal growth and development, though more vigorous growth (Mirza, 2002) is in rainy season. *Hyparrhenia* and *Themeda* exhibit some variation from original places (slow growth etc.).

*Apluda, Bothriochloa, Dichanthium, Cymbopogon caesius, C. jwarancusa* and *C. commutatus*, propagate through runners. From mother plants lower axillary buds grow into branches become prostrate and spread on the surface of soil in all directions. From the nodes adventitious roots arise and penetrate into the soil. From upper side branches clones arise and after some time become independent. Generally most species required 25 to 30 days for the completion of young clones, shoots.

In *Cymbopogon martinii* the propagation occurs through rootstoek in *Hyparrhenia, Themeda* and *Sorghum* by small rhizomes. The rhizome stored food is irregular in shape and covered with brown skin scale leaves having nodes, axillary and apical bud size 1-2

cm present 5-6 cm deep in the soil. They exhibit the perennation in which the aerial part, wither in extreme cold and dry seasons but young shoots appeared in monsoon season.

As said earlier these pasture grasses are widely distributed in Pakistan and growing in different climatic and adverse situation, hence showing deviation in behavior from their native places. In those parts of country where water was not a limiting factor they could be established by means of seeds (Gulzar & Khan. 2001, Khan & Gulzar 2002). However, in the areas of drought they survive by rhizomes, rootstocks. This indicates their survival behavior is not dependant on particular ecological conditions, but of varied condition. Therefore, pasture land could be developed of mono or "multi-specific type.

So that, concluded from studies that in less time and investment grass lands could be developed which ultimately enhance the economy of the country. It is also elucidated from the experiments that grasslands can be established in different regions of Pakistan except of *Hyparrhenia* and *Themeda*. It is also suggested that these species can be easily developed by farmers as per their requirements while on large areas by government level.

**Acknowledgement**

We are thankful to Mr. Tajammul Hussain Khan, Govt. Degree College Liaquatabad, Karachi, Pakistan for his help during these investigations.

**References**

Ahmed, M. 1994. *A study of the germination profiles of some perennial grasses of Cholistan*. M.Sc. Thesis Dept. Chem. Islamia Univ. Bahawalpur. Pakistan.

Ahmed, M., T. Husain and A. Husain. 1978. Studies of some range grasses of Pakistan. *J. Forestry*, 28(1): 7-12.

Ayaz, S. 1992. Germination strategy of *Cymbopogon jwarancusa* (Jones) Schult. *Journal Sci. & Technology*, 16: 59-64.

Bano, Gul, M, Aslam, S, Ahmed, S. Aslam, and S. Koukab 2009. Seasonal variation nutritive value of *Chrysopogon aucheri* (Boiss.) Stapf and *Cympogon jwarancusa* (Jones) Schult in high land Balochistan, Pakistan.

Cope, A.T., 1982. Poaceae. In: *Flora of Pakistan*. (Eds.): E. Nasir and S.I. Ali. 143: l-678. University of Karachi. Karachi Pakistan.

Gulzar, S. and M.A Khan. 2002. Alleviation of salinicity induced dormancy perennial grasses. *Biologia Planterum*, 45(4): 617-619.

Husain, T., A. Husain and M.Ahmed 1983. Behavior of some pasture grasses of Pakistan. *Pak J Sci. Res*., 35: 1949-154.

Hussain, A., M. Ahmed and T. Husain. 1980. Sex distribution and male sterility in some range Grasses of Pakistan. *Pak. J. Agri. Res*., 1(2): 77-80.

Hussain, F. and Ihsan Ilahi 1997. Germination enhancement of *Chrysopogon serrulatus*. *Pak. J. Pt. Sc*., 3(1): 25-31.

Khan, M.A and S. Gulzar. 2001. Seed germination in halophytic grass *Aeluropus lagopoides*. *Anals Bot*., 87: 319-324.

Mirza, S.N. 2002. Effect of growth stages on the yield and quality of forage grasses. *Pak. J. Agri. Res*., 17(2): 145-147.

Rafi, M., 1958. Erosion control and soil conservation in Northern up land of West Pakistan. *Pak. J. Forestry*, 8(2): 192-203.

Tompsett, P.B. 1976. Factor effecting the flowering of *Andropogon gayanus* Kunth, responses to photoperiod temperature and growth regulators. *Annals of Botany*. 40: 695-705.

(Received for publication 27 February 2009)