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Performance of Grasses to Provide Soil Cover and Produce Biomass (Fodder) Under Rainfed Conditions

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Abstract. The grasses are suitable to provide cover to the soil and they can be used as fodder. A study was conducted to screen out the best species of native and exotic grasses which can flourish under rainfed conditions of Pothwar for biomass (fodder) production, grass hedge suitability and soil cover due to spreading character. Initially twelve grasses were planted for evaluation of their performance under rainfed conditions *viz*. Khavi, Madhana, Palwan, Lemon, Mott, khabbal, Kai, Suryala, Vetiver, Chingen, Babbar and Kangroo. Four grasses which could not survive under stress were Khabbal, Palwan, Chingen and Kangroo compared to other eight grasses. These remaining eight grass species were tested for biomass yield, spread ability and growth during 2008-2013 and data for plant height, periphery (hedge suitability) and biomass yield were collected at each year in three months intervals. The mean data of six years from 2008-2013 indicated that Mott grass (*Pennisetum perpureum*) attained the highest spreading (1.49 m) as well as biomass yield (47.48 t/ha) followed by Kai grass (*Typha latifolia*) with periphery (0.93 m) and biomass yield (13.7 t/ha). Khavi (*Cymbopogen schoenanthus*) produced least periphery and biomass yield as compared to other grasses. The order of suitability regarding biomass among eight grasses was Mott grass> Kai grass > Lemon grass > Shryala grass> Vetiver grass> Madana grass> Babbar grass> and Khavi grass. The results revealed that these grasses are suitable as soil cover for strengthening bunds structures to arrest erosion as well as fodder production for livestock in this area.

Keywords: grasses, soil cover, hedge suitability, high rainfall area, soil conservation.

Introduction

Pothwar Plateau mainly consists of Rawalpindi, Chakwal, Attock and Jhelum districts of Punjab, which covered an area more than one million hectare. It contributes significantly to agricultural and livestock production of Pakistan (Arshadullah *et al*., 2012). A good vegetative cover on the soil may help to control soil erosion as well as water conservation. Groundcover vegetation management has proven to be an effective means to limit soil erosion (Ruiz-Colmenero *et al*., 2013). The grasses are suitable to provide cover to the soil and they can be used as fodder (Akram *et al*., 2018). Grasses are fed to live stock, during summer season, various times in arid areas (Desrial *et al*., 2020; Khan *et al*., 2004). Animal's performance depends on the character and accessibility of fodder during the year (Hatam *et al*., 2001). The biomass of the grasses is correlative to the vegetative growth period and efficiency of biomass producer. Rainfed area can brought under cultivation considering the grass species for fodder production. Even under hot and hardy climatic conditions marginal lands can be used for testing new species for green fodder production (Anwar *et al*., 2012).

This study was undertaken at soil and Water Conservation Research Station, Sohawa, District Jhelum, to screen out the best species of native and exotic grasses which can flourish under drought conditions for: (i) Biomass (fodder) production under moisture stress conditions, (ii) Grass hedge suitability, (iii) Soil cover due to spreading character.

At Sohawa, various grass species i.e., Khavi, Madhana, Palwan, Lemon, Mott, Khabbal, Kai, Suryala, Vetiver, Chingen, Babbar and Kangroo grasses were grown. Theses grasses have been taken from Soil and Water Conservation Research Institute, Chakwal during 2006-07 and planted at, Sohawa, district Jhelum under high rainfall conditions.

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The major problems in the country for food security are poor living, deficit of fodder and fodder resources, reduction of vegetation cover and overgrazing of rangelands (Afzal *et al*., 2007). Many attempts regarding adaptability, spreading ability and habitat to control soil erosion have been made of the grasses of rain fed area. There has not adequate research been done about the grasses of the rain fed area that show great adaptability and exclusive spreading ability under very adverse ecological conditions. Therefore, this study was conducted for screening of diverse grasses versus moisture stress and assessing adaptability of grasses and erosion control under high rainfall conditions of Sohawa, district Jhelum.

Materials and Methods

The experiment was carried out at Soil and Water Conservation Research Station Sohawa (longitude: 73.42308°; latitude: 33.12775°) during 2008 to 2013. The climate of the planting site is sub-humid, sub-tropical continental type with an annual rainfall of about 1000 mm, occurring in bi-model pattern mostly in late summer and winter spring periods. About 60-70% of total rainfall is generally received during monsoon (mid June to mid September), the monsoon rains are usually in heavy down pours and are accompanied bythe thunder storms. The remainder rain fall is received in winter mostly during in December to March. June and July are the hottest months of the year with mean maximum temperature ranging from 36 °C to 42 °C with extremes some times as high as 48 °C contrarily. December and January are the coldest months with mean temperature of about 3 °C to 3.5 °C. Occasionally, the lowest minimum temperature may drop to –3.3 °C (Nizami *et al*., 2004) generally frost occurs from mid December to February during the days of favourable conditions i.e. clear sky, calm wind and temperature close to below the freezing point. Agro-metrological data of the study period is given in Fig. 1A, 1B and 1C. The tufts plantation of the grasses was done during 2006-07 with three replications in a randomized complete block design row to row and plant to plant distance was 50 cm and plot size was 3 x 4 m^2. The grass plots were maintained without irrigation and fertilizer application. Weeding and hoeing was done manually whenever needed. Data on fresh and dry

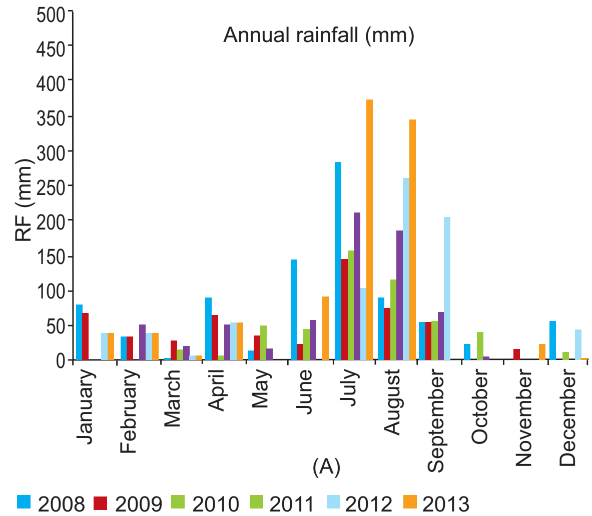

Fig. (1a). Rainfall pattern in Sohawa district Jhelum during 2008-2013.

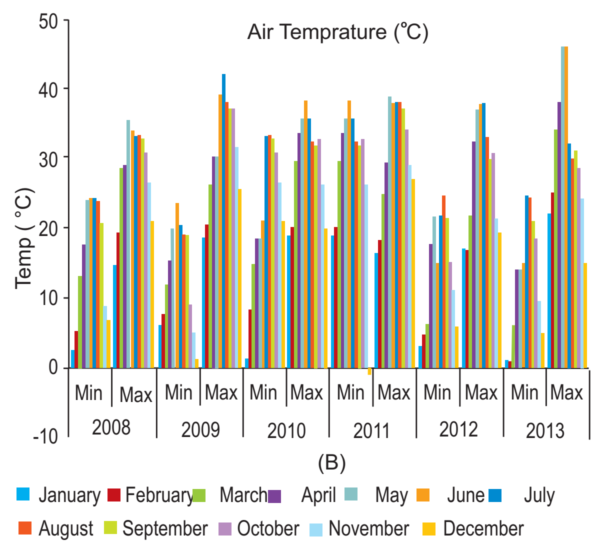

Fig. (1b). Air temperature pattern in Sohawa, district Jhelum during 2008-2013.

matter yield were collected from the same plots during 2008 to 2013. Data were collected at 50% flowering stage. Three quadrates were harvested randomly for fresh and dry matter determination (Khan, 2004). The fresh biomass was weighed with this formula:

Fresh biomass (t/ha) = fresh biomass weight/area in m^2 x 10.

All plots in one square meter (1m^2) were clipped close to ground level and fresh biomass was weighed and

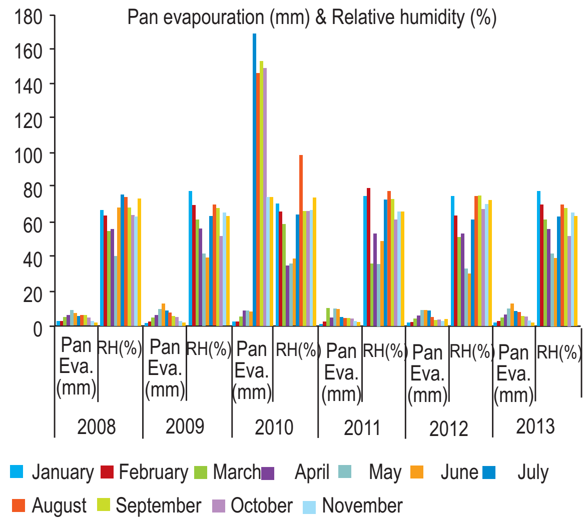

Fig. (1c). Pan evapouration and Relative humidity in Sohawa, district Jhelum during 2008-2013.

samples were oven dried to a constant temperature at 65 °C for 48 h. Dry samples were weighed and determined dry matter yield. Moisture contents percentage was calculated with the help of formula:

Moisture contents percentage (%) = fresh weight of soil-dry weight of soil / fresh Weight of soil x 100 Statistics.

The data were subjected to analysis of variance (ANOVA) and means were separated using least significant differences (Steel and Torrie, 1997).

Results and Discussion

The characteristics and botanical names of diferent grasses are given in Table 1. After about six to nine months, grasses like khabbal, Palwan, Chingen and Kangroo were disposed because of poor performance and less adaptability in the area of Sohawa. So, eliminated from the statistical analysis and was not presented verious parameters studied and discussed are as follows:

(A) Plant height (cm) and plant periphery (m). The basic production units of grasses are height and number of tillers per plant. The statistic analysis showed that

Table 1. Local, technical names of grasses and their characteristics

Local name	English name	Botanical/ technical name	Salient features
Lemon grass	Fever grass	*Cymobopogon citrates*	frost-tender clumping perennial grass that is popularly used as a lemony flavouring in Thai, Vietnamese, Laotian and Cambodian cooking and is widely cultivated in southeast Asia for that purpose.
Mott grass	Napier grass	*Pennisetum perpureum*	Tall, erect, stem upto 6.5 m high, planted like sugarcane, culms having three nodes are cut into pieces and buried in the soil up totwo nodes with 3rd above the ground.
Kai grass		*Typha latifolia*	Personnial herbaceous plant in the genus Typha . It is found as a native plant species in north and south America, Europe, and Africa.
Khas grass	Vetiver grass	*Chrysopogon zizanioides*,	Profusely branches stem upto 60cm, Panicle dense, suitable for mix seeding with legumes.
Babbar grass	Sabai grass	*Eulaliopsis binata R*	The Babbar grass is very effective to reduce soil erosion. Its plantation in the catchment of small dams checks silt movement and it also reduce the velocity of runoff water in the rainy season.
Khavi (Camel) grass	Camel grass	*Cymbopogon schoenanthus*	Camel's hay, fever grass, geranium grass or west Indian lemon grass is a herbal plant of and with fragrant foliage. It is often made into a common herbal tea.
Madhana (Crowfoot) grass		*Dactyloctenum ageyptium*	Egyptian crowfoot grass is a member of the family native in Africa. The plant mostly grows in heavy soils at damp sites.
Suryala grass	Spear grass	*Cynodon dactylon*	A rhizomatous perennial, growing from 200 to 1000 mm high. The greenish grey leaves are usually glabrous. Ligules are membranous.

there are significant differences in plant height and periphery of all the grasses during the experiment at the site. The cumulative data of six years presented in Table 2 revealed that maximum plant height and periphery were observed in Mott grass as 1.68 m and 1.49 m respectively. After Mott grass the Madhana grass showed better results in respect of plant height (1.27 m). The results also depict that height of grasses like Kai, Vetiver and Madhana are statistically at par. Overall, Suryala grass achieved minimal plant height during all the six years may be due to its less spreading ability and downwardly growth pattern. It is also observed that these grass species resisted the severe weather conditions ranging from drought to very humid and rainy conditions as there was more than 300 mm of rainfall in number of occasions and no rainfall many times (Fig 1A).

The data revealed that lowest plant height and periphery was observed in Suryala grass during the study period compared to other seven grass species.

(B) Biomass yield (t/ha) and moisture contents (%). The grass data showing average biomass (t/ha) and moisture contents is depicted in Table 3. The analysis of the data showed that highest biomass yield (47.48 t/ha) achieved by Mott grass followed by Kai grass which was 13.7 tons per hectare. The data also showed that minimum biomass yield observed in Khavi grass i.e., 0.84 t/ ha. Similar results was observed by Akram *et al*. (2018) as they concluded that the Lemon grass showed better results which were at par with Mott grass under low rainfall conditions of Fateh Jung. Arshadullah *et al*. (2012) also recorded 229 t/ha biomass yield in Mott grass under rainfed conditions. Highest moisture content was observed in lemon grass, which was at par with all other grasses, statistically (Table 3). The correlation analysis between rainfall and temperature showed non-significant effect of rainfall on temperature as elaborated in Fig 2.

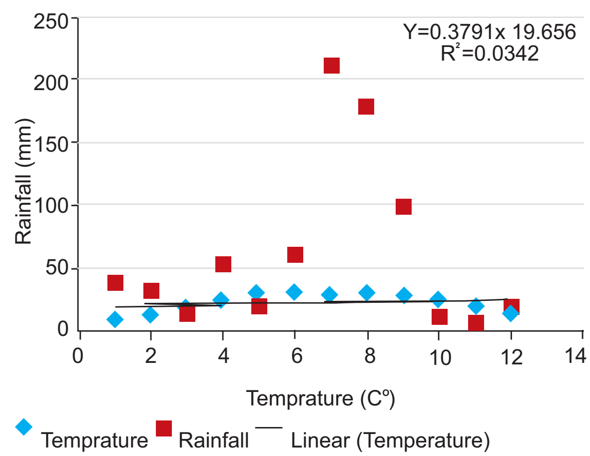

Fig. 2. Correlation between temperature and rainfall during 2008-2013.

Table 2. Plant height and periphery of different grass species under rain fed conditions (average of five years 2008-2013)

Common name	Grass species	Av. height / Plant (m)	Av. periphery (m)
Lemon grass	*Cymobopogon citrates*	0.60 c	0.73 b
Mott grass	*Pennisetum perpureum*	1.68 a	1.49 a
Suryala grass	*Cynodon dactylon*	0.36 d	0.34 cd
Kai grass	*Typha latifolia*	1.11 ab	0.93 b
Vetiver grass	*Chrysopogon zizanioides*,	0.88 bc	0.52 c
Babbar grass	*Eulaliopsis binata R*	0.65 c	0.40 cd
Khavi grass	*Cymbopogon schoenanthus*	0.86 bc	0.25 d
Madhana grass	*Dactyloctenum ageyptium*	1.27 ab	0.29 d

Values followed by same letter (s) are statistically similar at P=0.05 level of significance

Table 3. Biomass yield and moisture content percentage of different grass species under rain fed conditions (average of five years 2008-2013)

Common name	Grass species	Biomass yield (t/ha)	Moisture %
Lemon grass	*Cymobopogon citrates*	11.73 bc	77.88 a
Mott grass	*Pennisetum perpureum*	47.48 a	70.06 ab
Suryala grass	*Cynodon dactylon*	7.13 bcd	71.67 ab
Kai grass	*Typha latifolia*	13.7 b	60.09 b
Vetiver grass	*Chrysopogon zizanioides*,	3.74 cd	73.60 ab
Babbar grass	*Eulaliopsis binata R*	1.38 d	63.20 b
Khavi grass	*Cymbopogon schoenanthus*	0.84 d	54.00 bc
Madhana grass	*Dactyloctenum ageyptium*	2.09 d	68.57 ab

Values followed by same letter (s) are statistically similar at P=0.05 level of significance

Conclusion

In summary, Mott grass produces maximum biomass, and performed better as compared to all other grasses irrespective of its low palatability and can withstand even under adverse climatic conditions. After Mott grass at the second place Kai and Lemon grasses performed better as compared to all other grasses. Theses grasses are recommended for rainfall area of Sohawa, district Jhelum under similar climatic condition, for soil cover and fodder purposes.

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Conflict of Interest. The authors declare no conflict of interest.

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