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# EVALUATION OF EXOTIC GRASSES IN THE MESIC CLIMATE OF POTHWAR PLATEAU, PAKISTAN

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## ABSTRACT

Continuous heavy grazing has reduced drastically the biomass productivity of rangelands in Pakistan. Therefore, to improve grazing potential of the rangelands, 10 promising exotic grass species along with an indigenous benchmark, Blue Panic Grass (*Panicum antidotale*) were tested in the Rainfed conditions of National Agricultural Research Center (NARC), Islamabad for biomass production comparison. Data on plant height, number of tillers, aboveground fresh and dry matter (DM) production were collected. Hybrid Bajra/Mott grass (*Pennisetum purpureum* var. Mott.), Green Panic (*Panicum maximum* var. Gatton), and Elephant/Napier grass (*Pennisetum purpureum* var. elephant) gave significantly greater aboveground dry matter than that of indigenous benchmark (P<0.0l). Among these grasses, only Green Panic could be grown through seeding, whereas the other two grass species are grown through cutting or slip planting. Since cutting or slip planting is highly labor intensive, Green Panic is recommended for range seeding in the mesic areas of Pothowar plateau. However, establishment of on-farm forage reserves of Mott and Elephant grass through cutting/slip planting on the marginal lands of high rainfall areas of Pothwar could provide not only additional forage to the livestock for emergency use but will also help reduce grazing pressure on the overstocked rangelands of the Plateau.

**Keywords:** Biomass production; Forage grasses; sub-humid area; Islamabad

## INTRODUCTION

Pothwar Plateau is located in the sub-tropical, semi-arid to sub-humid ecological zone of Pakistan. Natural vegetation consists of scrub forest having mostly thorny trees, shrubs, and grasses. Total area of the Plateau is approximately 30,362 $km^2$ out of which 15,340 $km^2$ is severely eroded and is currently used as rangelands or woodlands (Nizami et. al., 2004). In general, rangelands of the plateau are in degraded ecological status due to continuous heavy grazing, cutting, and uprooting of palatable plants. Consequently, rangelands, at present, are producing far less than their expected production potential. Hence, it seems necessary to introduce comparatively more productive, palatable, nutritious, and fast growing forage plants to improve grazing potential of the degraded rangelands of Pothwar Plateau.

Germplasm of promising grass species was obtained from different regions of the world through international organizations for evaluating their growth potential under the rainfed conditions. The germplasm was tested and scrutinized at NARC, Islamabad for six years. Out of these, ten perennial grass species, namely, Buffel Grass (*Cenchrus ciliaris*), Elephant grass (*Pennisetum purpureum* var. Elephant), Green Panic Grass (*Panicum maximum* var. Gatton), Green Panic Grass (*Panicum maximum* var. Tanzania), Hybrid Bajra/Mott Grass (*Pennisetum purpureum* var. Mott.), Pangola Grass (*Digitaria decumbense*), Rhodes Grass (*Chloris gayana*), *Setaria anceps*, Swaziland Finger Grass (*Digitaria swazilandensis*), and Vetiver Grass (*Vetiveria zizynoides*) were selected for further study. This preliminary selection was based on germination response, vigour, establishment, and fresh and dry matter yield of the grass species. These grass species along with a local benchmark, Blue Panic Grass (*Panicum antidotale*) were grown to compare different plant production traits and to recommend promising grass species for further multiplication and propagation in the rangeland area.

### Location and General Description of Planting Site

The experiment was conducted at NARC, Islamabad. The site was located 518 masl at $33^o$ $42^/$ N and $73^o$ $8^/$ E. Climate was sub-humid subtropical continental type with an annual rainfall of above 1,000 mm (Table 1) occurred in bi-model pattern mostly in late summer and winter-spring periods. About 60 to 70 percent of total rainfall was received during monsoon (mid June to mid September). The monsoon rains were usually in heavy downpours and were accompanied by the thunderstorms. The remainder rainfall was received in winter, mostly during December to March (WRRI, 2006). The four years annual rainfall data collected during the study period are given in Table 1 below:

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Table 1. Annual rainfall for the study period (2002-2005).

| Year | Rainfall (mm) |
|---|---|
| 2002 | 901 |
| 2003 | 1,341 |
| 2004 | 961 |
| 2005 | 1,033 |
| **Avg. Annual Rainfall:** | **1,059** |

Source: Agricultural Meteorological Data Record, Water Resources Research Institute (WRRI), NARC, Islamabad

Agricultural Meteorological Data Record, Water Resources Research Institute (WRRI), NARC, Islamabad depicts further that June and July were the hottest months of the year with mean maximum temperature ranging from 36° to 42°C with extremes sometimes as high as 48°C. Contrarily, December and January were the coldest months; with mean minimum temperatures of about 3° to 5.5°C. Occasionally, the lowest minimum temperature dropped to -1°C. Usually, frost occurred from November to February during the days of favorable conditions, i.e., clear sky, calm wind, and temperature close to or below freezing point. The soil of the experimental area was clay loam, deep, and slightly alkaline with pH 8.0, low in organic matter (0.5 percent) and deficient in N (0.042 percent) and P (5.4 ppm) except for available K (78.5 ppm) (Qamar, 1997).

## MATERIALS AND METHODS

Grasses were grown by slips (root and shoot material) in 3 x 4 $m^2$ plots at 50 x 50 cm plant interspacing during the spring 2002. Plots were maintained under rainfed conditions without fertilizer application. Weeding and hoeing were carried out manually whenever needed. Plots were harvested regularly in summer and fall to enable the plants give maximum growth in the next growing season. After three years of planting, data on plant height, number of tillers, aboveground fresh and dry matter production, and moisture content were taken by random drawing of three one-meter squared quadrat in each of the grass plot during early summer 2005. First, plant height and number of tillers within the quadrat area were recorded. For height measurements, five plants per quadrat were selected randomly and their height was measured and averaged. After that the plant material lying in the quadrat area was harvested flush to the ground level for fresh and dry matter production and moisture content determination. Plant samples were air dried until the weight of DM became constant. Data were analyzed using one-way analysis of variance with the help of MSTAT-C software program (Bricker 1991). A least significant difference (*LSD*) was applied for mean multiple comparisons. Percent water content was calculated by using the following formula:

$\%\ \text{Water} = (W_1-W_2)100/W_1$

Where

$W_1$ = Fresh weight of forage (g $m^{-2}$)

$W_2$ = Air dry weight of forage (g $m^{-2}$)

Dry matter production (metric ton $ha^{-1}$) was calculated by the following formula:

DM production (t $ha^{-1}$) = DM yield (g $m^{-2}$) x $10^{-2}$

## RESULTS AND DISCUSSION

Plant DM, height, and number of tillers were found significantly different from one another ($p< 0.01$) (Table 2). The average DM yield of Mott, Green Panic (var. Gatton), and Elephant Grass was significantly higher than that of the indigenous benchmark (Blue Panic). Although, DM means of Mott and Green Panic (var. Gatton) were not significantly different from each other but the former gave the higher DM yield. Mott grass is also an excellent grass used for silage making and its digestibility has been reported to be higher than that of corn silage (Rushland et. al., 1993). However, a wood-like hardy structure was gradually developed on the base of Mott Grass that may impair its palatability through hurting the mouthparts of the grazing animals. Therefore, stall-feeding of Mott Grass is suggested when wood-like structure is developed on the base of the grass.

Mengel and Kirkby (1987) reported that old leaves of plant tissues might contain water from 75 to 85 percent of the fresh weight, whereas only 59 to 72 percent water level in the harvested biomass of different grasses was recorded in this study. This depicts that the harvested material in addition to green leaves also contained previous years' old growth that reduced moisture level in the plant tissue.

Table 2. Means of production traits of grasses in the Rainfed conditions of NARC, Islamabad

| S. # | Grass Species | Fr. Bio.* (g $m^{-2}$) | DM (g $m^{-2}$) | Moisture % | DM (t $ha^{-1}$) | Plant ht. (cm) | No. of Tiller $m^{-2}$ |
|---|---|---|---|---|---|---|---|
| 1. | Hybrid Bajra/Mott Grass (*Pennisetum purpureum* var. Mott.) | 1581 | 596$^{a}$ | 62 | 5.96 | 169$^{a}$ | 81$^{f}$ |
| 2. | Green Panic (*Pennisetum purpureum* var. Gatton) | 1412 | 506$^{a}$ | 64 | 5.06 | 109$^{cd}$ | 200$^{e}$ |
| 3. | Elephant Grass (*Pennisetum purpureum* var. Elephant) | 1262 | 377$^{b}$ | 70 | 3.77 | 155$^{ab}$ | 231$^{de}$ |
| 4. | *Setaria anceps* | 813 | 284$^{c}$ | 65 | 2.84 | 164$^{a}$ | 192$^{e}$ |
| 5. | Pangola Grass (*Digitaria decumbens*) | 743 | 270$^{c}$ | 64 | 2.70 | 59$^{f}$ | 705$^{a}$ |
| 6. | Vetiver Grass (*Vetiveria zizynoides*) | 782 | 264$^{c}$ | 66 | 2.64 | 179$^{a}$ | 267$^{d}$ |
| 7. | Green Panic (*Panicum maximum* var. Tanzania) | 732 | 261$^{c}$ | 64 | 2.61 | 130$^{bc}$ | 197$^{e}$ |
| 8. | Blue Panic (*Panicum antidotale*) | 581 | 240$^{cd}$ | 59 | 2.40 | 123$^{c}$ | 239$^{de}$ |
| 9. | Finger Grass (*Digitaria swazilandensis*) | 820 | 229$^{cd}$ | 72 | 2.29 | 62$^{ef}$ | 738$^{a}$ |
| 10. | Rhodes Grass (*Chloris gayana* var. Kenya) | 595 | 196$^{cd}$ | 67 | 1.96 | 126$^{c}$ | 445$^{c}$ |
| 11. | Buffel Grass (*Cenchrus ciliaris*) | 473 | 164$^{d}$ | 65 | 1.64 | 88$^{de}$ | 541$^{b}$ |
| Standard Error of the mean | | -- | 30.95 | -- | -- | 9.06 | 20.63 |
| *LSD* | | | 90.78 | -- | -- | 26.57 | 60.50 |

*Fresh Biomass ; Values followed by the same letter (s) are not statistically different at P<0.01.

**Analysis of Variance in CRD for Grass Introduction Trial**

**i) DM Production (g $m^{-2}$)**

| Source of Variation | Df | Mean Square | F Value | P Value |
|---|---|---|---|---|
| Treatment | 10 | 53538.121 | 18.627 | 0.0000* |
| Error | 22 | 2874.212 | | |
| CV% | 17.46% | | | |

*=Significant at 1 % level

**ii) Plant Height (cm)**

| Source of Variation | Df | Mean Square | F Value | P Value |
|---|---|---|---|---|
| Treatment | 10 | 5152.521 | 20.919 | 0.0000* |
| Error | 22 | 246.303 | | |
| CV% | 12.66% | | | |

*=Significant at 1 % level

**iii) Number of Tillers per $m^2$ Area**

| Source of Variation | Df | Mean Square | F Value | P Value |
|---|---|---|---|---|
| Treatment | 10 | 149765.600 | 117.307 | 0.0000* |
| Error | 22 | 1276.697 | | |
| CV% | 10.25% | | | |

*=Significant at 1 % level

Three grass species, Vetiver, Mott, and *Setaria* gave significant (P<0.01) height response in the experiment. It is important to note that the height of inflorescence was also included while measuring the plant height of the Vetiver Grass. The Number of tillers was significantly greater (P<0.01) in both *Digitaria* spp. Being trailing rooting runners, both the species spread by rooting at nodes and gave off tillers profusely.

It was also observed during the study that an orange-coloured exudate was accumulated on the harvested/cut tillers of Green Panic var. Gatton in early spring that caused mortality in the grass. Samples of the exudate were collected for identification from Crop Disease Research Program (CDRP), NARC, Islamabad. CDRP reported that

*Fusarium* spp. was observed in the trace slide along with *Cladosporium* and *Alternaria* spp., which are secondary invaders. It looked as if an insect had cut the tiller and all these fungi grew on the gummy exudate from the wound.

## TECHNICAL IMPLICATIONS

Out of three grasses, i.e., Mott, Green Panic (var. Gatton), and Elephant Grass that gave significantly higher DM yield than that of the indigenous benchmark (Blue Panic), only Green Panic can be grown through seeding. It is, therefore, recommended for range seeding in the mesic climate of the Plateau. The other two grasses, i.e., Mott and Elephant are grown only through cutting/slip planting, which require a lot of inputs, so planting of these two grasses over the extensive rangeland areas is not recommended. However, establishing on-farm forage reserves of these two species on the marginal lands of sub-humid climate of Pothwar Plateau could be quite useful to counterbalance the shortage of forage for the livestock. The attack of pathogenic fungi on the small population of Green Panic var. Gatton was quite evident. So it becomes advisable to develop cost effective medical treatment for the pathogenic fungi before recommending the grass species for artificial dissemination of seed on the rangeland area.

## REFERENCES

Bricker. B. (1991). *User's Guide to MSTAT-C.* Michigan State University, USA.

Mengel, K. and E.A. Kirkby (1987). *Principles of Plant Nutrition* 4$^{th}$ed. International Potash institute, Bern, Switzerland.

Nizami, M.M.I, M. Shafiq, A. Rashid, and M. Aslam (2004). *The soils and Their Agricultural Development Potential in Pothowar.* Water Resources Research Institute and Land Resources Research Programme, National Agricultural Research Centre, Islamabad.

Qamar, I.A. (1997). *The effect of defoliation of vetch, barley, and their mixtures on forage yield and their residual effects on the succeeding crops in rainfed areas of Pakistan*. Ph.D. Thesis, Dept. of Agric., Univ. of Reading, Uk.

Rushland, G.A., L.E. Scollenberger, and C.S. Jr. Jones (1993). Nitrogen fertilization effects on planting stock and characteristics and establishment performance of elephant grass. *Agron. J*., 85: 857-61.

WRRI. (2006). *Agricultural meteorological data record*. Water Resources Research Institute, NARC, Islamabad.

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