INFLUENCE OF MATURITY ON MORPHOLOGICAL CHARACTERS AND BIOMASS OF BUFFEL GRASS

M. Mushtaque, M. Ishaque[*] and M. Ahmad alias Haji A. Bakhsh[**]

Punjab Forest Department, Lahore
[*]Department of Forestry, University of Agriculture, Faisalabad
[**]Punjab Agriculture Department, Lahore

ABSTRACT: A study was conducted at Forestry Research Institute Faisalabad to determine the influence of maturity on morphological characters and biomass of Buffel grass (*Cenchrus ciliaris* Linn.). The experiment was laid according to Completely Randomized design with four replications. Four clipping stages *i.e.* CS_1, CS_2, CS_3 and CS_4 (clipped after 1, 2, 3 and 4 months, respectively) were studied. Response variables were morphological characters (plant height, number of tillers per plant, basal circumference and leaf to stem ratio) and plant biomass. With increasing clipping stage (plant maturity), plant height, tiller density and basal circumference increased. However, leaf to stem ratio declined with advancing plant maturity. Herbage yield or biomass production of the species increased ($P<0.05$) with advancing plant maturity. Phenology of the species indicated that as the species progressed towards maturity, the proportion of vegetative parts on the plants declined. It is suggested that one month clipping stage should be applied on this grass in order to get sustained grass vigor and enough vegetative growth.

Key words: Buffel grass, clipping stages, morphological characters, biomass

INTRODUCTION

Rangelands in Pakistan are the valuable national resources which cover more than two third area of the country (Mirza, 2007). Most of 91.01 million livestock heads are supported by rangelands either wholly or partially in the country (Quraishi *et al.,* 1993). Mismanagement and over use of these resources have led to the deterioration of range vegetation. Consequently shortage of range forage has adversely affected livestock production in the country. There is an urgent need to overcome this situation by restoring our rangelands through extensive operations which improve the quantity and quality of forage species in rangelands.

Buffel grass (*Cenchrus ciliaris* Linn.) is an aggressive perennial grass invading arid tropical habitats around the globe. The biology of this grass ideally suits for dry communities and colonization of other disturbed sites, especially following fires. Humans have spread this grass for livestock forage in pastures, but its biological characteristics contribute to copious natural dispersal (Tix, 2009). Buffel grass is tufted, tussock-forming perennial grass; 15-120 cm tall and is sometimes rhizomatous. This plant species produces branches from the base. It is native to tropical and sub-tropical Asia, Africa, Latin America, Pakistan, India and Indonesia. It is adapted to tropical and subtropical summer rainfall areas with long dry season. In Pakistan, it is found in Pothowar range, salt range, Thal, Cholistan, D.G. Khan, Kohistan, Baluchistan and Tharparker Desert. The grass grows on wide range of soils, especially on lighter and more sandy soils. It can also grow on harder heavy textured soils. It is a deep rooted plant and about more than 50 % of its roots reach below one meter. Its characteristic of drought resistance is due to its extensive and deep root system (Quraishi *et al.,* 1993).

The species grows well with annual rainfall of 350-800 mm and up to an altitude of 1000 m. Its seed is sown before the onset of monsoon season. After sowing, seeds are covered with 0.5 to 1.0 cm thick layer of soil. If soil moisture is sufficient, seeds germinate within 10 days. Its fresh seeds show very poor germination which can be improved to 70 percent by storing its seeds under dry conditions for two years. Its stand requires one year complete protection after reseeding. The species contains about 10.7 % crude protein and is highly palatable and is relished by sheep, cattle and goats. This grass has a comparable nutritive value to sorghum and millet forages for ruminants (Aganga and Aultwetse, 2000). The species becomes less palatable if allowed to mature. It is one of the most important natural hay grass in Pakistan and is intercropped with legumes to improve the forage quality (Quraishi *et al* 1993).

Buffel grass has been successfully re-seeded over large range areas of Pakistan (Mohammad, 1989) for permanent pastures (Khan and Zarif, 1982). Keeping in view the significance of this grass species for range livestock, a study was conducted to determine the effects of clipping stage of the grass on its morphological characters and biomass production.

MATERIALS AND METHODS

Buffel grass was raised through planting its stubbles at research area of the Punjab Forestry Research Institute Faisalabad in summer season of 2003. The study site had sandy loam to loam soil with pH value of 7.85. In order to maintain the optimum plant density of 5-10 plants/m^2, the grass was established by planting tuft splits in 1x 3 meter plots at 0.3 x 0.3 meter spacing. Completely Randomized Design with four replications was used in this study. For maintaining adequate soil moisture of the site, frequent irrigations (without fertilizers) were given to the grass as and when needed. Biomass of the grass was clipped by hand at the stubble height of 5 cm. Study involved four clipping stages of the grass i.e. clipping after the period of one month (CS_1), clipping after the period of two months (CS_2), clipping after the period of three months (CS_3), and clipping after the period of four months (CS_4).

At each clipping period, plant height (from ground to the end of the tallest leaf) and basal plant circumference (at 5 cm stubble height) were measured in centimeters. Tiller density (number of tillers per plant) was determined from eight randomly selected plants at each clipping period. Percentages of plants at vegetative, flowering, seeding and at seed fall stages were recorded at each clipping.

To determine leaf to stem ratio of the grass at each harvest, a sample (about 500 g) was removed from the innermost two rows of each sub-plot cut at a height of 5 cm. Tillers from this non-weed sample were divided into leaf blades and stem plus sheath fractions immediately after removal from the plot. The leaf and stem fractions were dried separately at 55°C to a constant weight. Leaf to stem ratio was calculated from the dry weights (Baron *et al*. 2000). The data collected for the above-mentioned parameters were statistically analysed using analysis of variance technique and comparison of means was done by Duncan's Multiple Range test (Lawless, 2003)

RESULTS AND DISCUSSION

Plant height: Mean values of plant height of Buffel grass harvested at CS_1, CS_2, CS_3 and CS_4 clipping stages were 29.06, 73.19, 82.01 and 104.3 cm, respectively (Table 1). The plant height in this grass increased with increasing plant maturity due to longer vegetative growth period. Butt *et al.* (1992) reported similar results and reported that Buffel grass cut at the end of growing season produced taller plants (73.8 cm) than those clipped at 3, 6 and 9 weeks of age. Findings of the study are also consistent with those reported by Mislevy *et al.* (1989) who clipped elephant grass at different stages and reported that average plant height increased from 1.2 to 4.9 m with increasing clipping stage.

Plant height increased ($P<0.05$) between CS_1 and CS_2. The difference in plant heights between CS_2 and CS_3 was non-significant which may be because of decline in vegetative growth and initiation of seed formation on the plants at these two clipping stages (Fig. 1). Similarly non-significant difference in plant heights was noted between CS_3 and CS_4.

Number of tillers per plant: Average number of tillers per plant of Buffel grass was 3.64, 12.91, 25.08 and 30.95 when it was defoliated at CS_1, CS_2, CS_3 and CS_4, respectively (Table 1). The results indicated that number of tillers per plant increased with advancing plant maturity. The rate of increase in tiller density was faster during first three months and it declined in the last month of the experimental period. Increased number of tillers per plant with advancing growth resulted in increased basal circumference. The results were in conformity with the findings of previous workers (Madakadze *et al.*, 1999; Butt *et al.*, 1992).

Basal circumference: Average values of basal circumference of Buffel grass defoliated at CS_1, CS_2, CS_3 and CS_4 clipping stages were 7.13, 14.24, 21.08 and 24.04 cm, respectively (Table 1). Basal circumference of the grass increased ($P<0.05$) with advancing plant age. Increasing basal circumference with advancing plant age may be attributed to the increasing number of tillers per plant. These results were consistent with those of Butt *et al* (1992) and Khan (1970). Butt *et al*. (1992) defoliated Buffel grass at 3, 6 and 9 weeks while control plots were cut at the end of growing season. They reported that plant basal circumference was 34.46, 39.86, 37.38 and 45.29 cm (control), respectively at the four clipping stages. Khan (1970) also reported that basal area of Buffel grass increased with increasing clipping stage.

Leaf to stem ratio: Mean values of leaf to stem ratio of Buffel grass defoliated at CS_1, CS_2, CS_3 and CS_4 were 1.72, 0.68, 0.65 and 0.50, respectively (Table 1). Leaf to stem ratio decreased ($P<0.05$) between CS_1 and CS_2 which may be because of decline in the vegetative growth of the plants at CS_2. Ninty-two percent of Buffel grass plants were at vegetative stage at CS_1, which reduced to 69 % at CS_2 (Fig. 1). Results were in line with those of Dabo *et al* (1988) who studied the effect of defoliation in bluestem grass at various stages and reported that leaf to stem ratio was higher at early cut than that at late cut grass. They attributed this reduction to increased fibre components and decreased crude protein with advancing plant age.

Herbage yield: Mean herbage yields (biomass production) of Buffel grass harvested at CS_1, CS_2, CS_3 and CS_4 were 0.92, 14.70, 25.91 and 39.33 tones per hectare (ha), respectively (Table 2). Biomass yield

increased (P<0.05) throughout the experiment period. The herbage yield was less in the first clipping stage because the plants had not fully established and it increased about 16 times during the second month. This might be due to well establishment of Buffel grass during second month. The dry matter was 24.25, 28.42. 34.47 and 37.74 % in samples of CS_1, CS_2, CS_3 and CS_4, respectively. Increase in dry matter and organic matter yield followed pattern similar to fresh biomass during advancing growth stage of Buffel grass. The results are in consistent with the findings of Butt *et al* (1992) who reported that dry matter yields of various cultivars of Buffel grass increased significantly during second year as compared to first year and attributed this increase to better establishment of grass stubbles in second year. Griffin and Jung (1983) reported similar findings and reported increased forage dry matter yield with increasing maturation of *Panicum varigatum*. Frazer *et al.* (2001) reported similar results in forage peas and field beans. They reported that delaying the harvest by 14 weeks gave the highest yields of dry matter. Similarly, Madakadze *et al.* (1999) reported that dry matter yield increased with increasing plant maturity and attributed it to increase in tiller density with advancing plant age.

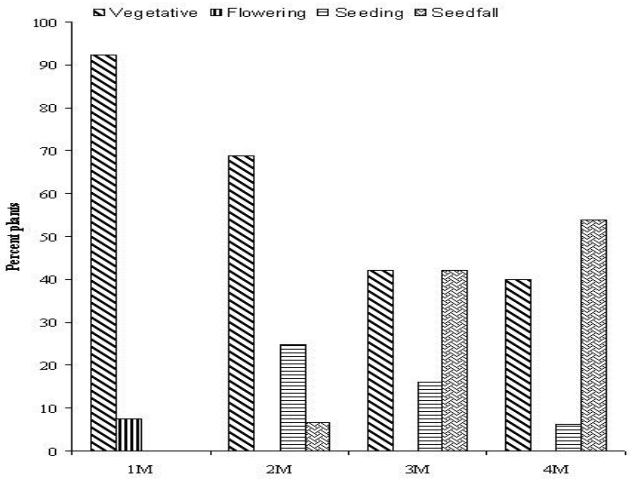

Fig. 1 Phenology of Buffel grass at different clipping stages.

Note: 1. No seeding/ seedfall (zero values/ blanks) at first month clipping stage.
2. No flowering (zero value/ blanks) at clipping stages of 2nd, 3rd and 4th month.

Table 1. Effect of clipping stage[1] on morphological characters of Buffel grass

Parameter	Clipping stage CS_1	CS_2	CS_3	CS_4	S.E
Plant height, cm	29.06^{c}	73.19^{b}	82.01^{ab}	104.30^{a}	8.47
Tillers per plant, No.	3.64^{c}	12.91^{bc}	25.08^{ab}	30.95^{a}	4.26
Basal circumference, cm	7.13^{d}	14.24^{c}	21.08^{b}	24.04^{a}	2.75
Leaf to stem ratio	1.72^{a}	0.68^{b}	0.65^{b}	0.50^{b}	0.09

Means within a row bearing different superscripts differ significantly (P<0.05).
[1]CS_1, CS_2, CS_3 and CS_4 stand for clipping stages harvested at 1, 2, 3 and 4 months, respectively. S.E is the standard error.

Table 2 Effect of clipping stage[1] on biomass production of Buffel grass

Parameter	Clipping stage CS_1	CS_2	CS_3	CS_4	S.E
Fresh biomass yield, Tons/ha	0.92^{d}	14.70^{c}	25.91^{b}	39.33^{a}	2.29
Dry matter, percent	24.25^{d}	28.42^{c}	34.47^{b}	37.74^{a}	0.69
Dry matter yield, Tons/ha	0.23^{d}	4.18^{c}	8.93^{b}	14.85^{a}	0.20
Organic matter yield, Tons/ha	0.20^{d}	3.69^{c}	7.73^{b}	13.23^{a}	0.22

Means within a row bearing different superscripts differ significantly (P<0.05).
[1]CS_1, CS_2, CS_3 and CS_4 stand for clipping stages harvested at 1, 2, 3 and 4 months, respectively. S.E is the standard error.

Conclusion: Morphological characters of Buffel grass (plant height, number of tillers per plant, basal circumference) increased while its leaf to stem ratio declined with advancing plant maturity. Herbage yield of the grass in terms of fresh biomass, dry matter and organic matter yields increased with advancing plant maturity.

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