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GROWTH AND HERBAGE YIELD OF *SETARIA SPHACELATA* GRASS IN RESPONSE TO VARYING CLIPPING STAGES

M. Mushtaque, M. Ishaque* and M. Ahmad alias Haji A. Bukhsh**

Punjab Forest Department, Lahore
*Department of Forestry, University of Agriculture, Faisalabad
**Agriculture Adaptive Research Complex, Dera Ghazi Khan
Corresponding author: mahmada2003@yahoo.co.uk

ABSTRACT

Setaria sphacelata is an aggressive perennial grass of arid tropical habitats around the globe. It prefers very warm climate and is restricted to these tropical environments. It was studied for its growth and herbage yield during early summer in 2003. Grass nursery of this plant was raised through its stubbles on a site having sandy loam to loam soil with a pH of 7.85 in plot size 1m x 3m. The experiment was carried out in complete 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. Data on morphological characters and herbage yield were recorded with delayed clipping stages (plant maturity), plant height, tiller density and basal circumference of the grass increased ($P<0.05$) while its leaf to stem ratio showed a decline. Herbage yield (fresh biomass, dry matter yield and organic matter yield) of the grass increased ($P<0.05$) as grass reached maturity. At later stage of plant maturity, the grass had lower vegetative parts than at the early stages of plant maturity. This study concluded that in order to get optimum biomass and sustained grass vigor; three months clipping stage should be recommended on this grass species.

Keywords: *Setaria sphacelata*, clipping stage, herbage yield, vegetative growth

INTRODUCTION

Rangelands are very important natural renewable resources of Pakistan. These are a big chunk of land those support country's livestock and wildlife populations. About two third area of the country is under rangelands (Quraishi *et al*., 1993). Mismanagement and over-exploitation of these rangeland resources have severely deteriorated potential for forage production. The need of the time is to restore their forage potential by establishing high diversity of most productive forage species in these natural resources of the country (Butt and Ahmad, 1994).

In order to have a continuous supply of good quality forage for a long grazing season on regular basis, natural reseeding of range vegetation and artificial reseeding resorted in small patches as and when needed are desirable practices. Most of Pakistan's existing rangelands are marginal (very low potential) and are producing 10-50 % of their potential productivity). As a result of severe deterioration, majority of these rangelands are at present more suitable for supporting a thin population of wildlife rather than range livestock. In spite of low productivity due to severe overgrazing, erosion and depletion, the existing rangelands are unable to provide over half of the forage requirements for our livestock. This gives an indication of the importance of these lands in the national economy (Quraishi *et al*., 1993).

Setaria sphacelata Stapf. cv. Kasungula is native to Northern Rhodesia (Zambia) and has been developed for grazing and hay production (Anonymous, 1972). It is an aggressive perennial grass of arid tropical habitats around the globe. It prefers very warm climate and is restricted to these tropical environments (Duke, 1983). It is a valuable forage grass because of nutritional quality and its ability to recover from grazing (Morisawa, 2000).Plants of this grass species attain a height of one meter at flowering. It is highly palatable, drought-resistant grass species and is better suited to the more shallow soils and lower rainfall situations. On the other hand, it has considerable tolerance to prolonged water-logging and areas frequently inundated with flood water and the cattle accept its stubble grazing (Redrup, 1967).

For harvesting heavy herbage and dry biomass production clipping stage plays a vital importance in the life cycle of a grass. There is no bigotry among the scientists that fresh biomass yield is significantly influenced by difference in plant maturity or age (Shehu *et al*., 2001; Fraser *et al*., 2001). It was observed that dry matter production was increased due to more number of tillers plant^{-1} (Griffin and Jung, 1983), increased plant height (Gracia and Rodriguez, 1980) and basal circumference (Khan, 1970). However, the leaf to stem ratio was decreased (Dabo *et al*., 1988) at later stages. The possible reason might be the duration available for the production of organic matter yield (Mushtaque *et al*., 2009).

Inadequate information is available on variation in morphological characters and herbage yield of this grass against different clipping stages. The objectives of this study were to determine the effects of clipping stages on *S. sphacelata* grass regarding its growth behavior and herbage yield.

MATERIALS AND METHODS

In this study, the stubbles of *S. sphacelata* grass were grown on a site at Punjab Forestry Research Institute, Faisalabad during early summer 2003. Soil of the site was sandy-loam to loam soil. Soil pH recorded up to the depth of 30.5 cm was 7.85. Mean daily minimum temperature ranged from 15 to 31^{o}C (as shown in Fig. 2), while correspondingly maximum temperature was 32 to 48^{o}C. Total precipitation recorded at the site was 300 mm. More than 75 % (about 260 mm) of the precipitation was received during the first two months (July-August).

Grass nursery of *S. sphacelata* plants was raised on site through planting tuft splits in 1x3 meter plots at 0.3x0.3 meter spacing to maintain optimum plant density of 5 to 10 plants m^{-2} (Butt and Ahmad, 1994). No fertilizer was applied. Four irrigations of 2 acre inch were done with one month interval to ensure adequate soil moisture. Four clipping stages *i.e*. clipping at 1-month (CS_1), 2-month (CS_2), 3-month (CS_3) and 4-month (CS_4) were studied where CS_1, CS_2, CS_3 and CS_4 represented vegetative, flowering, seeding and seed fall growth stages, respectively. The experiment was laid out in completely randomized design with four replications. The grass biomass was manually clipped with sickle at 5 cm stubble height. The morphological data regarding plant height, number of tillers per plant, basal circumference and leaf to stem ratio were recorded on each clipping date. Plant height (cm) was measured from ground to the end of the tallest leaf. Number of tillers per plant was determined by counting eight randomly selected and permanently tagged plants from each replicate for each clipping stage. Basal plant circumference was measured by taking the plant circumference (cm) with measuring tape at 5 cm stubble height (Butt *et al.,* 1992).

Phenology of the grass was also recorded at each sampling date in which percent of plants in vegetative, flowering, seeding and seed fall stages were calculated. To determine leaf to stem ratio 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 different parameters (like plant height, number of tillers, basal circumference, leaf to stem ratio and herbage yield) were statistically analyzed using analysis of variance and comparison of means was done by Duncan's Multiple Range test (Dowdy and Wearden, 1991).

RESULTS AND DISCUSSION

Plant height: Mean plant heights of *S. sphacelata* defoliated at CS_1, CS_2, CS_3 and CS_4 stages were 37.05, 72.75, 127.10 and 136.8 cm, respectively (Table. 1). Plant height progressively increased throughout the experimental period, the rate of increase was the maximum between CS_2 and CS_3 defoliation stage. Plant height of this grass increased ($P<0.05$) with advancing grass maturity.

Increase in height with advancing clipping stage may be attributed to longer vegetative growth period of this grass. Similar findings were reported by Butt *et al*. (1992) and Mushtaque *et al*., (2009) who stated that *Cenchrus ciliaris* and Blue panic grass (*Panicum antidotale*) cut at the end of growing season produced taller plants (73.8 cm) than those clipped at 3, 6 and 9 weeks, respectively. They attributed these taller plants to longer vegetative growth period. Findings of Garcia and Rodriguez (1980) supported these results. They also concluded that plant height of *Cenchrus ciliaris* increased with advancing clipping stage. In their study, *Cenchrus ciliaris* showed the highest mean height (96.7 cm) when it was cut at 84 days after sowing, while the lowest mean height (51.3 cm) was recorded when it was harvested at 42 days of age. Similar results were presented 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 advancing clipping stage.

Number of tillers per plant: Average number of tillers per plant of *S. sphacelata* defoliated at CS_1, CS_2, CS_3 and CS_4 stages was 2.89, 5.56, 7.38 and 7.53, respectively (Table 1). The data revealed that tiller number increased with advancing plant maturity. The rate of increase in number of tillers was faster during the first three months which slowed down during the last month of the experimental period. Higher tiller density at the early clipping stages may be due to more vegetative growth of grass at CS_1, CS_2 and CS_3 (Fig. 1). The results of Butt *et al.* (1992) and Mushtaque *et al*. (2009) supported the findings of this study. They defoliated *Cenchrus ciliaris* and *Panicum antidotale* at intervals of 3, 6 and 9 weeks and compared them with plots clipped at the end of growing season *i.e.* after 4 months (control), respectively. They reported that control plots produced maximum number of tillers. They further reported that number of tillers per plant was influenced ($P<0.05$) by the main effect of clipping interval and attributed it to longer vegetative growth period. These results are also consistent with those of Madakadze *et al.* (1999) who evaluated changes in biomass of switch grass at different

growth stages and observed that tiller density increased with advancing plant age.

Basal circumference: Mean values of basal circumference of *S. sphacelata* were 10.14, 12.67 at CS_1 and CS_2 which significantly differed with 16.85, 17.21 cm at CS_3 and CS_4 with no significant difference between themselves (Table 1). Basal circumference progressively increased with advancing plant maturity. Initial basal circumference was 10.14 cm, which significantly increased at CS_3 defoliation stage. Rate of increase in basal circumference was higher at between CS_1 to CS_3 than that at CS_4 clipping stage.

Increase in basal circumference with advancing maturity was because of increased number of tillers per plant (Table 1). Results of present study are consistent with those of Butt *et al*., (1992) and Khan (1970). Butt *et al*. (1992) and Mushtaque *et al*. (2009) recorded basal circumference of *Cenchrus ciliaris* and *Panicum antidotale* at 3, 6 and 9 weeks of age, respectively and compared it with the control plots, which were clipped after 4 months. They reported that basal circumference increased with rising of clipping stage and the control plots had the maximum basal circumference (45.29 cm). They attributed it to longer vegetative growth period with advancing plant maturity.

Leaf to stem ratio: Mean values of leaf to stem ratio *of S. sphacelata* defoliated at CS_1, CS_2, CS_3 and CS_4 clipping stages were 1.72, 0.80, 0.29 and 0.18, respectively (Table 1). The results revealed that leaf to stem ratio decreased ($P<0.05$) with advancing plant maturity of the grass. The rate of decline in leaf to stem ratio was more at CS_1 and CS_2 clipping stages than that at CS_3 and CS_4 stages.

Decreased leaf to stem ratio with advancing plant age may be attributed to synthesis of more cell wall contents with advancing maturity. Similar results were also reported by Crowder and Chheda (1982), Dabo *et al.* (1987), Dabo *et al.* (1988) and O'Reagain *et al*. (1996) that a short vegetative period resulted in decreased leaf to stem ratio with advancing age.

Herbage yield: Mean values of fresh herbage yield of *S. sphacelata* defoliated at CS_1, CS_2, CS_3 and CS_4 clipping stage were 2.07, 14.22, 38.64 and 42.12 tons per hectare (t ha^{-1}), respectively (Table 2). Fresh herbage yield increased ($P<0.05$) throughout the experimental period with advancing plant maturity. The yield was low in the first clipping stage because the plants had not established fully and it increased to about 7 times during the second month.

The increased yield at CS_2 might be due to well establishment of *Setaria sphacelata* plants. The dry matter contents of the grass were 15.94, 17.54, 22.36 and 26.91% in the samples of CS_1, CS_2, CS_3 and CS_4 clipping stages, respectively. Increase in dry matter and organic matter yields followed a pattern similar to fresh biomass during advancing growth stage of this grass (Table 2). These results are in consistent with the findings of Vogel *et al.* (2002), Shehu *et al*. (2001), Fraser *et al.* (2001) and Beaty and Powell (1976) that delaying in harvest gave the highest dry matter.

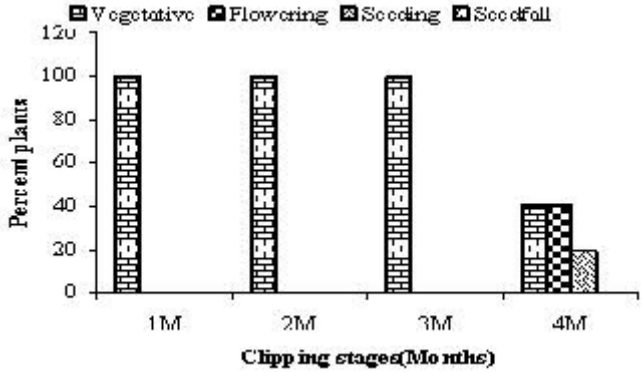

Fig. 1 Phenology of S. sphacelata at different clipping stages.

Table 1 Effect of clipping stage[1] on morphological characters of *S. sphacelata*

Parameters	Clipping stages				S.E
	CS_1	CS_2	CS_3	CS_4	
Plant height (cm)	37.05^d	72.75^c	127.10^b	135.80^a	2.05
Tillers per plant (No.)	2.89^b	5.56^a	7.38^a	7.53^a	0.84
Basal circumference (cm)	10.14^b	12.67^b	16.85^a	17.21^a	1.87
Leaf to stem ratio	1.72^a	0.80^b	0.29^c	0.18^c	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 herbage yield of *S. sphacelata*

Parameters	Clipping stages				S.E
	CS_1	CS_2	CS_3	CS_4	
Plant height (cm)	2.07^d	14.22^c	38.64^b	42.12^a	0.24
Tillers per plant (No.)	15.94^d	17.54^c	22.36^b	26.91^a	0.64
Basal circumference (cm)	0.33^d	2.49^c	8.65^b	11.33^a	0.22
Leaf to stem ratio	0.27^d	2.25^c	7.62^b	10.19^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.

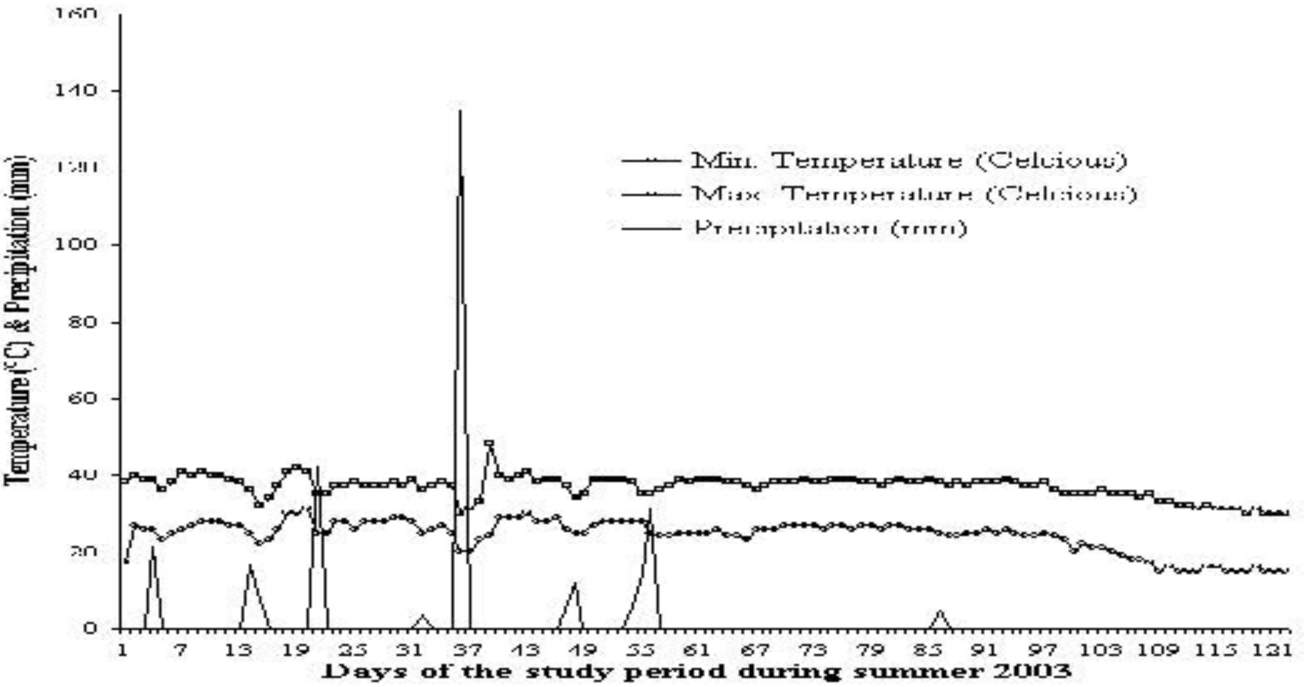

Fig. 2 Climate data of the study site at Punjab Forestry Research Institute, Faisalabad

Conclusion: From the above discussion it can be concluded that morphological characters of *S. sphacelata* grass like its plant height, tiller density, basal circumference and herbage yield (fresh biomass yield, dry matter yield, and organic matter yield) increased with advancing plant maturity. However, leaf to stem ratio declined as the species advanced towards maturity. At the last clipping stage of the species, the proportion of plants with vegetative parts declined which suggested that for getting more vegetative forage for livestock, this grass should be harvested up to three months.

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