Response of *Themeda anathera* (Nees) to Varied Biotic Treatments in Dachigam National Park, Kashmir

G. A. Bhat and M. Y. Qadri

Centre of Research for Development, The University of Kashmir, Srinagar – 190006.

ABSTRACT

The paper reports the effects of a variety of biotic variables on the hypogeal / subterranean rhizomatic biomass of the dominant grass *Themeda anathera* (Nees) of wild stretches of temperate zone grasslands of Dachigam National Park, Kashmir (34° 04′ –34° 11′ N latitude and 74° 54′ – 75° 09′ E longitude). The highest biomass occurred in the post-burnt plots, while the least biomass was recorded for the extremely grazed site expressing the least resistance of the grass to overgrazing ; a clear indication of regenerative trend at the grazed but recently protected site and a very little increase at the clipped site on comparing with that of the least-interfered / protected site. The probable hypothetical reason for the gregariousness and dominance of *T. anathera* in the area could be its subterranean vegetative mode of multiplication in combination with its response to moderate frequency of fires in grasslands.

***Keywords*:** Hypogeal, subterranean, biomass, biotic treatments, post-fire

INTRODUCTION

Most perennial grasses are known to store carbohydrates as reserve material , particularly rhizomatic ones ; it is the amount of this that determines their winter survival (Smith , 1964 ; Mooney and Billings , 1965) and has been found to be required for the regrowth and rejuvenation of their fresh photosynthetic tissues (Jameson , 1964) . Quite a large number of studies have been related to response of plants to defoliation and herbage removal. Both abiotic factors and defoliation by way of such biotic factors as grazing , clipping , and burning at different phonological stages , in different seasons and at different heights affect grasses , their carbohydrate storage and also the life of other forbs variously .

Wolf (1967) reported post-defoliation regrowth in *Phalaria arundinacea* to be related to the carbohydrate reserves of the plant. To clipping, different grasses respond differently. Kinsinger and Hopkins (1961) observed lower carbohydrate storage in unclipped grassland plots than in the moderately clipped plots. Blue gramma and western wheat grass remained unaffected by clipping at 5 .00 cm to 7 . 50 cm heights respectively with regard to carbohydrate storage (Fisher,1966). *Agropyron intermedium* when subject to cutting treatment during summer recovered total water soluble carbohydrates and root growth during Autumn equal to those of uncut plots (Ogden and Loomis, 1972). Owensby *et al.* (1970) recorded decreased amount of storage materials available for winter-dormancy in *Agropyron gerardii* due to late clipping, which resulted in depression in regrowth in ensuing spring. Different grasses have been found to respond to grazing in different seasons differently. Hyder and Sneva (1963) found that crested wheat grass and Siberian wheat grass tolerated spring grazing while bearded wheat grass and blue bunch wheat grass were sensitive to grazing in spring. Too early, too frequent and too heavy defoliation declined the vegetational vigour to a great extent (Hedrick, 1958) and in extreme cases led to death of the plants (Weinmann, 1948).

Grazing reduced photosynthetically active leaf area and also tended to cause increased respiration/ wound respiration (Sing *et al.*, 1980) and as a consequence more storage materials were used up.

Nevertheless, prescribed mowing, clipping, grazing, and burning of grasslands with managemental perspectives are at times regarded as useful practices, most of the least interfered or wild temperate stretches of grasslands of Dachigam National Park, where perennial grass *Themeda anathera* (Nees) forms the dominant cover suffers frequent anthropogenic accidental burning during dry intervals of Autumn and Winter . Besides fires, practices of unprescribed grass cutting and grazing of various intensities are also prevalent in the area. Epigeally *T. anathera* culms are seen to be existing as remnants among the floristic elements of the stretches used as pasturelands of varied grazing intensities . Study on the impact of such practices as grass cutting, grazing, protection and burning on the hypogeal / subterranean biomass of perennial grasses like *T. anathera* could be useful from both range ecology and conservational perspectives and this investigation is a preliminary and an empirical one in this direction.

STUDY AREA

Five clearly differentiable south facing 100 m^2 demarcated grassland pastureland plots located in Dachigam National Park (34^0 04'-34^0 11' N latitude and 74^0 54'-75^0 09' E longitude) in the altitudinal range of 1680 – 1800 m were selected for the study. The diagnostic features of the sites were:

S - 1: This represented an overgrazed grassland site subject to round the year grazing by hill cattle, sheep, goats and horses.

S - 2 : An overgrazed but recently protected and slightly regenerated grassland area.

S - 3: A grassland with a dominant cover of an unpalatable grass *Stipa siberia* and a least dominant *T. anathera* cover. During a dry spell of autumn- winter it suffered an accidental burning. In the ensuing spring it appeared to regenerate *T. anathera* epigeally. Data of S_3a in Fig.1 pertains to an additional *T. anathera* dominated post-fire plot which also suffered accidental burning and was sampled for the last three seasons of the investigating period.

S - 4: The site with a conspicuous cover of *T. anathera* was subject to clipping / cutting in summer and autumn.

S - 5: Comparatively the least interfered/ most protected stretch.

The overall climate of the study area is temperate – nival but all the study sites have a temperate or subnival location experiencing four different reasons a year: spring (March – May), summer (June – August), autumn (September – November) and winter (December – February). The usual termperature range is between –10°C during winter to 37°C during summer, while anpual total rainfall generally varies between 500 mm and 700 mm.

MATERIAL AND METHODS

The samples of fresh, live, subterranean rhizomes of *T. anathera* (Nees) were harvested after cutting five superficial (5 – 7 cm deep) soil blocks of 25cm^2 area at each site in each season in a random manner. The rhizomes were washed, sun dried and then oven-dried at 85°C for 48 hours and weighed and computed as average for 1 m^2 sitewise and seasonwise.

RESULTS

The mean dry weight / biomass mg. /m^2 values of the rhizomes of *T. anathera* under the existing natural edapho-climatic conditions in various plots subject to a variety of biotic treatments through eight successive seasons revealed that the highest biomass was achieved in post-burnt plots. It is noteworthy that the burnt plots were selected from available areas which have suffered accidental burning and as such were not experimentally manipulated plots.

At the site which suffered accidental fire in late autumn (Site S-3) the biomass in the ensuing spring accounted to only 63000 mg /m^2, while in summer it went up to 164000 mg /m^2 and on sampling in ensuing autumn it had risen to 205,000 mg /m^2. At the accidentally burnt site S-3a, whose data were recorded for only last three seasons, the values were also significantly higher, i.e., 252,000 mg /m^2.

The lowest values were recorded for the plot which had a continuously overgrazed history (Site S-1). Here the values, through different seasons of study period, ranged between 2200 mg /m^2 and 5660 mg /m^2.

At the previously continuously grazed but subsequently protected site (S -2) the values appeared to exhibit an increasing regenerating tendency through successive seasons from the lowest of 6450 mg /m^2 in the first spring to the highest of 66060 mg /m^2. in the second autumn. At the site S- 4 which was subject to summer and autumn cutting the values varied between a low of 82200 mg/ m^2 during second winter and a high of 108330 mg/m^2 during the first autumn.

The values at the control / least interfered (protected) site fluctuated between a minimum of 78300 mg / m^2 in the first spring and a maximum of 95220 mg / m^2 in the second autumn. It was sure about this site that it had not suffered any kind of major biotic interference including burning at least for the last two years.

DISCUSSION

From the data obtained and portrayed in Fig.1 and also keeping the vegetative subterranean mode of multiplication of *T. anathera* in view the significant inferences arrived at included:

a) Continuous overgrazing had a negative impact upon the growth, development and spread of the grass.

b) The site which was previously exposed to overgrazing but subsequently protected from grazing appeared to be progressively regenerating and re-establishing the grass species.

c) The plot which has suffered burning during the first autumn / winter of the study period and was dominated by the *S. siberica* began to show a brisk and quick increase in the hypogeal biomass of *T. anathera* rhizomatic network indicating positive rejuvenative stimulus of burning on the grass.

d) The grass appeared to show very little response to the cutting treatment.

e) The control / least-interfered site seemed to have a capacity to support spread and growth of live rhizomes in the mean biomass range of 78300 mg /m^2 and 95220 mg/ m^2.

The gregariousness, and thus the dominance, of *T. anathera*, under the prevailing edapho-climatic conditions, was attributable to the following probable factors:

1. Cryptophytic nature of the grass species.
2. Its predominantly vegetative mode of multiplication, its percent fill and reproductive capacity being sufficiently low (Bhat, 1995).
3. Stimulation of the grass by moderately frequent accidental fires (which have previously always been there but only their frequency on account of anthropogenic agencies has increased recently).

Increased underground biomass on burnt plots in grasslands has been reported by Malana & Misra (1981; c.f. Aggarwal and Gupta, 1988). The latter workers also observed the fire to be responsible for increase in biomass as compared to cutting and control treatment. However, from the overall visual field observations it appeared that in the *T. anathera* dominated areas, which suffered burning annually

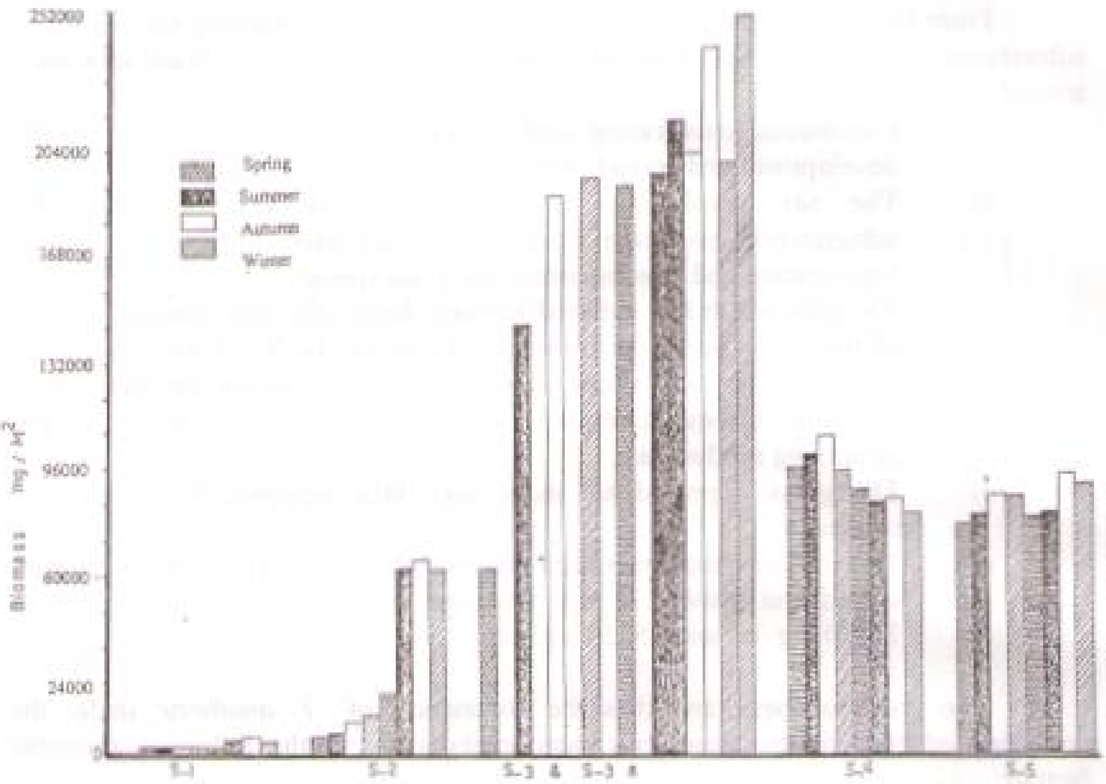

Fig. 1. Subterranean/hypogeal biomass (mg/m^2) of Themeda anathera (Nees) at differently treated sites.

and uninterruptedly, the progression of the grass was inhibited / reduced on account of impact of higher frequency and intense effect of burning. The higher frequency of burning did not allow the accumulation of litter. The rain showers washed away both ash and denuded soil from the slopes, as a result the live rhizomes got exposed and sun-burnt during hot summer months. Presence of accumulated surface litter also formed a sort of insulation and provided humid microclimate and cover both for the surface soil and the superficially but subterraneously straggling rhizomatic network of *T. anathera*.

The evolution of *T. anathera* as a cryptophyte could here be hypothetised as an adaptation in response to fire and adverse / extreme climate and also because of transformation of litter into humus and its mix up with the surface soil. The newly formed soil must have eventually covered or buried the live stems and in course of time the grass might have evolved as a cryptophytic / subterranean species developing aerial shoots only during favourable seasons.

ACKNOWLEDGEMENTS

Permission Granted by the Chief Wildlife Warden, Department of WLP, J&K Government, Srinagar, for sampling and surveying of the study sites is acknowledged.

REFERENCES

Aggarwal, A. K. and Gupta, S. 1988. Effect of fire and clipping on temperate grasslands of western Himalaya (Garhwal), India: Dry matter dynamics. p. 179. Abstract I. Third International Rangeland Congress.

Bhat, G. A. 1995. *Bioecological studies of grasslands of Dachigam N.P., Kashmir*. Unpub. Ph.D. thesis. Univ. of Kashmir, Sringar.

Fisher, A. G. 1966. *Seasonal trends of* root *reserves in blue gramma and western wheat grass*. M. S. Thesis, Colorado State University, Fort Collins, Colorado.

Hedrick, D. W. 1958. Proper utilization – a problem in evaluating the physiological response of plants to grazing use: a review. *Journal of Range Management*. **11**: 34-43

Hyder, D. N. and Sneva, F. A. 1963. Morphological and Physiological factors affecting the grazing management of crested wheat grass. *Crop. Science*. **3**: 267-71.

Jameson, D. A. 1964. Effect of defoliation of forage plant physiology. P. 67-80. In: *Forage Plant Physiology and* Soil *Range Relationships*. American Society of Agronomy, Special. Pub. 5. Modison, Wiscosin.

Kinsinger, F. E. and Hopkins, H. H. 1961. Carbohydrate content of underground parts of grass as affected by clipping. *Journal of Range Management*. **14**: 9-12.

Mooney, H. A. and Billings, W. D. 1965. Effect of altitude on carbohydrate content of mountain plants. *Ecology*. **46**: 750-1

Ogden, P. R. and Loomis, W. E. 1972. Carbohydrate reserves of intermediate wheat grass after clipping and etiolation treatments. *Journal of Range Management*. **25**: 29-32.

Owensby, C. E., Paulsen, G. M. and Mckendrick, J. D. 1970. Effects of burning and clipping on big blue stem reserve carbohydrates. *Journal of Range Management*. **23**: 358-62.

Singh, J. S., Terlca, M. J; Risser, P. G.; Redman, R. E. and Marshal, J. K. 1980. Autotrophic system. p. 59-201 In:A. I. Breymeyer, and G. M. Van Dyne, (eds.) IBP. **19**.

Smith, D. 1964. Winter injury and the survival of forage plants: a review. *Herbage Abstracts*. **34**: 203-9.

Weinmann, H. 1948. Underground development and reserves of grasses: a review. *Journal of the British* Grassland *Society*, **3**: 115-40.

Wolf, D. D. 1967. Characteristics of stored carbohydrates in reed canary grass as related to management and feed value. *Connecticut Agricultural Experiment Station Bulletin*, 402.