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Estimation of Root and Shoot Biomass of *Cenchrus ciliaris* (Dhaman) Under Barani Conditions

M. Umar Farooq, Rashid Saleem and Abdul Razzaq
Rangeland Research Program, National Agricultural Research Centre, Park Road, Islamabad, Pakistan

Abstract: *Cenchrus ciliaris* a palatable and nutritious grass is a warm season grass. Arid and semi-arid rangeland are reseeded with *Cenchrus ciliaris* to enhance productivity, prolong grazing season and increase carrying capacity. A two ha land area was reseeded with *Cenchrus ciliaris*at target area Jamrud in June 1980, under barani conditions. Generally shoot biomass is determined at the end of growing season after seed maturity stage. Root shoot and root biomass of *Cenchrus ciliaris*has not estimated/determined at the end of spring season. The different growing season (spring summer) is lacking. Estimation of shoot and root biomass of *Cenchrus ciliaris* plant in two growing different seasons is essential in grazing management studies. At the beginnings of spring season reserve carbohydrates are used for the production of new shoots. The shoot biomass at the end of spring season is generally less compared to the end of summer season. The shoot and root biomass estimating of *Cenchrus ciliaris* plant at the end of two different growing season is required to devise the grazing management programme. This study is proposed to quantify the shoot and root biomass of *Cenchrus ciliaris* plant at the end of spring and summer growing seasons.

Key words: Cenchrus ciliaris (Dhaman), root and shoot biomass

INTRODUCTION

Cenchrus ciliaris (Dhaman) is a palatable nutritious and warm season grass naturally occurring in the drier parts of the world. This species is used in the reseeding programmes of arid and semi-arid parts of Pakistan. It is a grazing tolerance grass and animals relish it in all the growth stages (Mohammad, 1989; Khan, 1966). About two ha area at Target area Jamrud was seeded with *Cenchrus ciliaris* in 1980 (Khan and Zaraf, 1982).

The health of an individual plant is important because the individual plant tolerate grazing and complete for his existence with other plants. The above ground biomass of range area is generally determined, but the information as shoot and root biomass of individual plant of *Cenchrus ciliaris* is lacking. The root biomass decreases in the spring season, because shoot regrowth occurs and reserved food material in the roots is used for short growth. At the end of growing season, the individual plant has manufactured among food in the leaves through photosynthesis and enhanced food reserves in the roots. The manufactured food is sent to the roots for root growth and storage for use in respiration and regrowth following dormancy. Therefore, the shoot and root biomass is maximum at the end of growing season.

The study is proposed to quantify the root and shoot biomass of *Cenchrus ciliaris* plant at the end of spring and summer growing seasons at target area Jamrud.

Review of literature: *Cenchrus ciliaris* (Dhaman) a nutritious, warm season grass is being used in artificial reseeding prorammes in the arid and semi-arid parts of Pakistan.

Generally above ground biomass of range areas is determined. Individual *Cenchrus ciliaris* plants tolerate the grazing and complete during its life cycle. The root biomass decreases, when regrowth occur in the early growing season (Heady, 1975). The reserved food in the root is used for shoots regrowth and there is decline in the root biomass. After the farmation of 8-10 leaves on stem the reserved food of root is not used for shoot regrowth. As the growing season progresses the leaves manufacture sufficient photosynthates and send extra food material for day to day life requirement to the root of, to enhance the reserve food material (Heady, 1975).

A number of methods have been used to study root biomass of past. Soil bulk method to estimate root biomass of grasses is one of the method used by the different authors.

Wearer (1926) described the soil bulk method to estimate the rest biomass of grasses upto 30 cm of depth. Pavlychenko (1937), NRC (1962), Cook and Stubbendieck, 1986 and Bonham, 1989 have described soil bulk method to study the root biomass of grasses. The authors reported that the grasses may be excavated up to 30 cm depth of soil with ball of earth to study the root biomass.

Ball (1981), conducted the research on biomass of *Cenchrus ciliaris* in North Florida. He further reported the crop was down in the late spring from bed-furrow and flat micro sites under 2,3,5 month old plantation. He founded that the grass grown on furrow gave greater biomass than other two sites under 2 months old plantation.

Felker (1982) conducted the research on the biomass estimation of *Cenchrus ciliaris*. He further reported, that the fresh and dry biomass estimation of five months old crop give key positive result in this regard.

Lang (1982) carried out the research on biomass estimation of *Cenchrus ciliaris*. He further reported, that the grass was clipped on native range and on four reclaimed area sown with *Cenchrus ciliaris*. Dry weight of above and under ground biomass were calculated. The reported that the average biomass of above ground on nation range was greater for than on two of the four reclaimed area.

Andaries (1986) carried out the experiment on biomass estimation of *Cenchrus ciliaris* in south western Pinus ponderosa Forests. He developed logarithmic regression; final regression equation related of biomass of *Cenchrus ciliaris* was highly significant.

Chatterjee, (1988) carried out the trial and *Cenchrus ciliaris*. He further reported that in the subhumid subtropical contribute of west Bengal, L. Leucocephala was sown at a spacing of meter in rows 0.5,1,1.5,2 and 3 meters apart either in pure stands are intercropped with *Cenchrus ciliaris*. The grass was also sown in rows 30 cm apart in pure stands. L. Leococephala gave the highest yearly average DM yield of 17.8 t ha^{-1} in five units, when grown at a spacing of (1×0.5) m in pure stands. *Cenchrus ciliaris* gave the highest average yield of 5.0 t ha^{-1} in pure stands and also in the alley of L. Leucocephala grown at a spacing of 1m in rows.

Description of the study area

Location: Target area Jamrud lies between 71°-51' to 71°-25' East longitude and 34°8-0 and 34°-10′ North latitude. It is a small part of Peshawar Valley in extreme western boundary. The area is bounded by Khyber Mountains in the North West, Peshawar Jamrud Road in the South and high level Warsak Canal in the East and North East.

Geology and soil: In the geological past Peshawar Valley was a big of vast lake bounded by the surrounding hills and fed by lives, which now flow through its formally subsiqueous bed. The plain therefore, consists of a fine alluvial deposit.

According to the soil Survey of Pakistan (1967), the soil is well drained light and porous. The thickness of a horizon various from 5 to 6 inches. It colour varies green light radish brown to brown; texture is loam and occasionally silt loam or sandy loam. The soil is deficit in organic matter. The PH for the entire profiles various from 8 to 8.4.

Table 3.1: Meteorological data recorded at Pakistan Forest Institute, Peshawar (1966-1990)

	Daily temperature (C°)			
Months	Mean maximum	Mean minimum	Relative humidity (%)	Average precipation (mm)
January	19	3	70	25.92
February	20	4	66	40.10
March	22	20	63	85.64
April	28	14	58	33.73
May	34	19	56	25.81
June	38	22	55	10.62
July	37	24	66	43.57
August	34	23	74	58.47
September	33	21	48	18.24
October	30	14	67	13.10
November	26	8	55	13.87
December	21	4	59	25.54

Maximum rain fall occurred in the month of March (85.64 mm). June is the hottest month with the highest mean maximum temperature of 38°C and January is the coldest month with a mean minimum temperature of 3°C

Table 3.2: Climate Data Recorded at metrological station, Pakistan Forest Institute, Peshawar (1992)

	Daily temperature (°C)			
Months	Mean maximum	Mean minimum	Relative humidity (%)	Average Precipation (mm)
January	18	4	73	67.05
February	20	5	69	41.14
March	22	9	62	102.59
April	27	15	75	65.01
May	33	17	70	50.79
June	38	23	64	01.01
July	97	25	72	---
August	34	25	84	
September	33	21	81	83.08
October	30	14	68	26.89
November	25	8	55	11.68
December	18	5	49	22.35

In (Table 3.2), the mean maximum temperature during 1992 was 97°C and mean minimum temperature during January 1992 was 4°C and the maximum rainfall was 102.59 mm during March, 1992

Table 3.3: Climatic data recorded at Meteorological Station, Pakistan Forest Institute, Peshawar (1993)

	Daily Temperature (°C)			
Months	Mean maximum	Mean minimum	Relative humidity (%)	Average precipation (mm)
January	16	3	63	21.23
February	24	8	67	03.55
March	22	8	74	152.89
April	30	15	63	40.13
May	36	21	62	03.54
June	39	23	58	33.52
July	36	25	76	28.43
August	35	25	75	04.06
September	--	--	--	---
October	--	--	--	---
November	--	--	--	---
December	--	--	--	---

The mean maximum Temperature during 1993 was 39°C. But uphills now has been calculated 39°C in June and mean minimum Temperature during January 1993 was 3°C

Climate: The climate is Sub-tropical semi-arid continental. The 25 years (1966-90) average monthly minimum and maximum temperature, rain fall and relative humidity recorded at Pakistan Forest Institute, Peshawar at a distance of about 5 km from the sandy area shown in Table 3.1-3.3.

Growing season starts in February and ends in September. The climatic data fluctuate each year.

Annual growth of herbaceous vegetation is dependent upon the rainfall occurrence during the year.

Cenchrus ciliaris.(Dhaman) is a warm season grass and sprouts in February and becomes dormant at the end of September after seed dispersal.

Vegetation: The annual vegetation consists typically of Sub-tropical Sun-humid ecological Zones.

Tress and shrubs: *Zizyphus nummulalia, Acacia modesta Paganum harmala, Phazya stricta.*

Grasses: *Cympogan Jawarancusa, Aristida adscencionis ,Heteropogan Cantorus, Botheriochloa pertusa, Tetrapogan Villosus, Enneapogan persicus, Cynodon dactylon, Stipa tortilis*, Growing season stats in February and ends in September. The climatic fluctuates each year.

MATERIALS AND METHODS

Five transact lines each 30 m long were randomly laid down in the seeded area of *Cenchrus ciliaris*.(Dhaman) at target area Jamrud. One each transacts line 6(Six) plants were randomly selected for the study. Number of columns or shoots of individual plant were counted.

The maximum roots generally occur in upper 30cm, depth of soil. Therefore, from the base of each plant 20cm, radius which was formed and each plant was excavated upto 30cm, depth with Ball of earth with a Shawal. The individual plant was kept in polythene bag labeled and brought to P.F.I, Peshawar.

The shoot portion was clipped upto ground level and green weight recorded in grams. The clipped material of each plant was air dried (Sun-dried) untill the time, the weight remained constant for these days. The air dried (Sun-dried) weight Shoots/columns of the individual of plant were recorded using in electric balance.

The root portion with Ball of earth of *Cenchrus ciliaris*.was kept in water for a soaking for three days. The root of each plant were washed with sprinkler on wire gauze mesh. A plastic sheet was kept below the mesh to collect the disconnected fine roots. The same procedure was adopted to wash on the roots.

The roots were sun-dried for the time until weight remained content for three days. The air dried weights of root of individual *Cenchrus ciliaris* was recorded in grams. The data were collected in May and October 1992.

Basic statistics are calculated for roots, shoots and number of columns for two growing seasons. The statistical analysis (t-test) of root and shoots biomass; and number of columns between two growing season was performed to find out the significant difference between the two growing season in there parameters.

Equality of variances was calculated, F= (Larger variance/Smaller variance) In case the variances were un equal the effective degrees of freedom for (t-value) comparison were calculated by

$$df= [(S1^2/n1) + (S2^2/n2)]^2 / [(S1^2/n1)^2/ n1-1] + [(S2^2/n2)^2/(n2-1)]$$

Where:

$S1^2$ = Sample variance
n1 = Observation number of plant

Shoot root ratio of individual *Cenchrus ciliaris* planted in May and October 1992 season was calculated by, Shoot root ratio =Average of shoots in grams/Average weight of roots in grams.

Calculation 1: Comparison between root and shoot during may, 1992

$$Sp = 40.00419$$
$$t = 5.588$$

Where calculated value of t

$$t_{(0.025)}(58)=2$$

Hence the calculated value doesn't lies in the acceptance region, So reject our Hypothesis.

Calculation 2: Comparison between root shoot biomass during October, 1992.

$$Sp = 45.1406$$
$$t = 0.5206$$

Tabulated value $(29.29)^2$, Hence the calculated value of 't' is less than the tabulated value, so except our hypothesis.

Calculation 3: Comparison between root biomass during May 1992 and October 1992.

$$Sp = 47.48$$
$$t = 0.2265$$

Tabulated value of t = 2, Hence the value is greater than calculated value So, expect our hypothesis.

Sp = 47.48
t = 0.2265

Tabulated value is greater than calculated value so except our hypothesis

Calculation 4: Comparison between shoot biomass during May, 1992 and October, 1992.

Sp = 40.87
t = 2 Hence the calculated is less tabulated value so except our yhpothesis.

Calculation 5: Comparison of Shoot /columns during May and October, 1992.

Sp = 101.296
t = 12.62

Tabulated value t = 2 Hence the calculated value does not lie in the expectance region so reject our hypothesis.

RESULTS AND DISCUSSION

Data in shoots roots number of columns on individual *Cenchrus ciliaris* plant growing at target area Jamrud, Since 1980 were calculated. Individual plant of *Cenchrus ciliaris* was selected, because it is the individual plant which tolerated grazing in any particular time of grazing. Thirty plants of *Cenchrus ciliaris*.were collected in May and October 1992 by excavate. The individual plant was excavated upto 30 cm depth and 20 cm radius circle around ball of earth using in Shawal. Basic statistics of data were calculated, statistical analysis (t-test) was performed to find out the differences in air dried weight (grams) root, shoot, and number of columns, shoot root ratio in May and October 1992 of an average plant were calculated. Results are summarized in Table 4.1.

Root biomass: The root biomass of *Cenchrus ciliaris* individual plant in May and October 1992 was 96.00 and 86.20 grams, respectively (Table 4.1). The statistical analysis showed non-significant difference in root biomass of *Cenchrus ciliaris* plant in May and October 1992. The non-significant differences may be due to the allocation of more photosynthates to roots by the end of the growing season to enhance reserved food material for respiration during dormancy and for its re-growth during spring season (Fig. 1).

Table 4.1: Results of (t-test) for shoot and roots weight (g) of individual *Cenchrus ciliaris* at target area Jamrud

Parameters	Season	Mean±SD	Calculated t-values
Root weight (g)	May 1992	96.00±53.00	0.2265NS
	Oct 1992	86.20±42.00	0.2265NS
Shoot weight (g)	May 1992	38.30±20.21	0.2537NS
	Oct 1992	80.00±48.53	0.2537NS
No. of shoots	May 1992	244.13±137.14	12.62*
	Oct 1992	86.03±41.49	12.62*
Shoot weight	May 1992	38.30±52.58	5.58*
Root weight	May 1992	96.00±20.21	5.58*
Shoot weight	Oct 1992	80.00±48.53	0.5206NS
Root weight	May 1992	86.20±41.66	0.5206NS

NS= Non-significant *= Significant at P= 0.05

Table 4.2: Calculated Shoot/root ratio from air dried weight of *Cenchrus ciliaris*. plant at target Jamrud

Season	Average weight of the shoot (g)	Average weight of the root (g)
May 1992	38.30	95.70 38/95.7 = 0.400
October 1992	8.00	86.20 80/86.20 =0.928

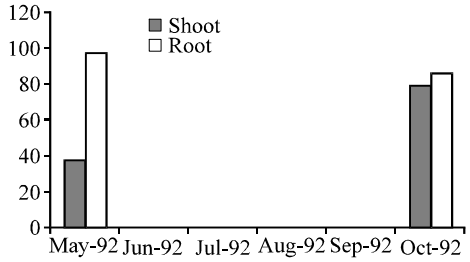

Fig. 1: Shoot and root biomass of individual *Cenchrus ciliaris* plant in May and October, 1992

Shoots/columns biomass: The average shoot weight of individual *Cenchrus ciliaris* plant May and October 1992 was 38.3 grams, respectively (Table 4.1) The shoot biomass was significantly more (P= 0.01) in October 1992 than in May 1992. The higher shoot biomass at the end of growing season may be due to greater hight and fiber content.

No. of Columns/Shoots: The average number of shoot in May and October 1992 were 244 and 137 per plant respectively. The number of shoots of *Cenchrus ciliaris* plant in May was higher than in October 1992 (P = 0.01). The significant difference may due to reduction in light of the top shoots.

Shoot, root biomass: The mean shoot and root biomass of an average *Cenchrus ciliaris* plant was 38.3 and 96.0 g in May 1992 respectively. The average shoot and root weight 80.00 and 86.20 g in October 1992, respectively (Table 4.1).

The shoot biomass was significantly higher (P = 0.05) than the root biomass in May 1992. The root and shoot biomass was non-significantly different in October 1992.

The significant different in shoot, root biomass in May 1992 may be due to the fact that most of the reserve food material in root was used for the initial of new shoots. The shoots gained less height in the beginning of the growing season. Therefore, the shoot biomass was significantly less than the root biomass. The non-significant differences between shoot and root biomass in October 1992 is attributed to the growth of both shoots and roots due to enhanced photosynthetic in shoot and allocation of more of the photosynthetic to the roots for storage and re-growth.

Shoot/root ratio: The shoot root ratio of an individual *Cenchrus ciliaris* plant in May and October 1992 were calculated by, Shoot root ratio =Average weight (g) of the shoot/Average weight (g) of the root.

Shoot/root ratio was 0.4 in May and 0.9 in October 1992, respectively (Table 4.2). The shoot weight increased more than the root of an individual *Cenchrus ciliaris* plant during the growing season and reached to the maximum in October 1992. At the end of growing season the shoot and root biomass were at maximum.

Re-growth of Foliage and continued maintenance of the individual Cenchrus Ciliaris (Dhaman) plant after dormancy depends initially on the reserved food material in the roots. Reserved food material in the roots was used for the re-establishment of Columns/Shoots (photosynthetic surfaces). Therefore a sustainable decrease may occur in shoot biomass. The shoot biomass was also less, because of short growing season in May 1992. At the end of growing season, more photosynthesis were allocated to the shoots and the roots to increase food reserves for future use for daily function i.e. respiration. Apparently the *Cenchrus ciliaris* (Dhaman) plant allocated more photosynthesis to increase the photosynthetic surface (leaf area).

The shoot root ratio of *Cenchrus ciliaris* (Dhaman) plant substantially increased due to prolonged growing season in October 1992. The results are in agreement with Heady (1975), Cook and Stubbendieck (1986).

This study showed that both shoot and root biomass of individual *Cenchrus ciliaris* (Dhaman) are higher at the end of growing season than in the beginning of growing season. The numbers of columns/shoots reduced were less in October compared with that of May 1992. Shoot root ratio increased with the progression of the growing season and on increased in shoot biomass, because the shoot height was maximum.

The health of an individual plant depends upon its ability to synthesis food in leaf area and enhance food reserves in the roots. The food reserves in the roots decrease in beginning of the growing season because it is used for shoot growth. At the end of the growing season both shoots and roots have maximum biomass because of maximum photosynthetic activity due to prolonged growing season. Data on shoot and root biomass and number of columns (dry matter) on thirty plants of *Cenchrus ciliaris* (Dhaman) were collected in May and October 1992.

Statistical analysis (t-test) was performed to find out significant differences among the shoot, root biomass and number of columns in May and October 1992. Shoot root ratio were also calculated using dry matter production in May and October 1992. The result of established analysis revailed that:

- Shoot root biomass was significantly different in May 1992.
- Shoot root biomass was not different in October 1992.
- Numbers of columns/shoots were significantly higher in May 1992, than in October 1992.
- Shoot, root ratio increased at in end of growing season in October 1992.

Evidence exists that at the end of growing season both shoot and root biomass are maximum. Reduction in the number of columns/shoots occurs due to the shading of lower columns by the leading columns.

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