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# GROUND BIOMASS ASSESSMENT OF SHRUB SPECIES IN TEHSIL TAKHT-E-NASRATI, PAKISTAN

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**Abstract**

The shrub biomass of different species of Tehsil Takht-e-Nasrati was different at different altitude. In the present study it was found that the average shrub biomass was decreasing with increasing altitude. Result confirms that the biomass of *Saccharum bengalense* was high 5020.38 Kg.hec$^{-1}$ in phase 1 and phase 2 (4331.58 Kg.hec$^{-1}$). The highest ground biomass 1125.1 Kg.hec$^{-1}$ of *Zizyphus nummularia* was found in Phase 3. Furthermore in Phase 4 the biomass of *Capparis deciduas* was high 437.79 Kg.hec$^{-1}$. Along with shrubs average biomass of *Saccharum bengalense* was high 2665.12 Kg.hec$^{-1}$ and low 13.47 Kg.hec$^{-1}$ of *Cassia angustifolia*. With seasons the biomass of *Saccharum bengalense* (13800 Kg.hec$^{-1}$) was greater during winter at Phase 1 and *Periploc aaphylla* (12.35 Kg.hec$^{-1}$) biomass was lowers during spring at Phase 4. In comparison in season the biomass was high in winter due to the dormant stage of shrubs in phase 1 while it was low in summer in phase 4. In winter the grazing process was stop due to agriculture point of view while in hilly area the grazing was high and the low percentage of rain fall consequently the biomass was high in plain area as contrast to hilly area. The biomass of shrubs is high in winter while it was low in summer as the grazing and palatability rate was high in summer as well as low in winter. The assessment of shrub biomass in research area is a requirement for successful management at the same time as it gives a complete documentation for the area in complexity and work out unpredictable resources to help imagine shrubs potency and behavior.

## Introduction

Shrub biomass is the total mass of the shrub within a given unit of ecological region. Biomass estimates are frequently exercised informating the prime productivity of ecosystems, quantifying energy pathways, nutrient cycles and produce accepts from yield activities, estimating nature habitats and assessing region potential. On different viewpoint the estimation of shrubs biomass for various region and alternative place is important. Thus, biomass information and judgment methods have been often discussed by Sah *et al*., 2004. The evaluation of wild land manners prospective necessitates quantitative estimation of accessible weights by condition and by size category (Rothermel, 1972). A lot of biomass finds out have been performed on shrub (Richard & Rugg, 1989; Buech & Rugg, 1995). Shrub is one of the mass vital fuel types in the region and has no longer been associated with frequent forest. Therefore, numerous studies on fire prone communities have been carried out to set up the relationships between precise vegetation composition and structure (Papio & Trabaud, 1991; Pereira *et al*., 1995; Beaza *et al*., 1998). Fire behavior-vegetation height, shrub height, horizontal, straight down fuel continuity, shrub behavior, total biomass, shrub concentration and harshness were studied by Fernandes, (2001) and De Luis *et al*., (2004). In specific area cover up types and narrates to the possible threat reflected in different magnitudes in excess of the stages of stand progress (Lamberty *et al*., 2002). Shrub land plant communities and open forest with a continuous shrub understory are not widespread in Takht-e-Nasrati due to dry condition of the area. Thus, estimation of shrub biomass is of essential power in combustion, forest, grazing and land management in the region. Different studies were conducted on shrubs biomass in world and in different area of Pakistan such as; Brown, (1976), Ohmann *et al*., (1976), Grigal, (1977), Martin *et al*., (1981), Smith & Gray, (1983), Hussain & Durrani, (2007), Zhou *et al*., 2007), Ahmad *et al*., (2009), Saleem *et al*., (2009). Shrub is one of the mass vital fuel types in the present region and has no longer been linked with normal forest. Therefore, numerous studies on different community's level are required to workout to plan the relationships between diverse vegetation composition and structure. No effort is available especially on the biomass of shrubs from the present area. The key point of this study was to determine the fresh ground biomass of shrubs species in Takht-e-Nasrati. The results of this study will also show useful in many forestry disciplines, such as ecology, protection, and management.

## Methods and Materials

**Research area:** The Tehsil Takht-E-Nasrati is situated at 32.47$^{o}$ to 33.28$^{o}$ North and 70.30 $^{o}$ to 71.30$^{o}$ East. The Tehsil is bounded by Tehsil Banda Daud Shah on the North West, Tehsil Karak on the North East, District Mianwali and District Lakki Marwat on the South East, and Tribal area Adjoining District Bannu on the South West. The total area of Tehsil is about 613.66 Sq. kilometer. Majority of the area consists of rigged dry hills and rough fields areas *i.e*., 323.97 Sq. kilometers and agriculture land is about 289.7 Sq. kilometer. The major income source of the people is Agriculture, which is rain depended. The area is situated at 340 m above the sea level. The major problem of the area is shortage of drinking water because the rainfall is scanty in the area. In the year 2010, 62.5 mm. y$^{-1}$ of rainfall recorded. The area is very hot in summer and very cold in winter. June and July are the hottest months, whereas December and January are the coldest months. In the year 2010 the mean maximum temperature was 39.5$^{o}$C, in the month of the

May, whereas the mean minimum temperature was as low as 4°C, in the month of January. The wind speed was different in different years. In the year 2009 the wind speed was high 6 Km per hour (h) in the month of July whereas in the year 2010 it was high in the month of April 7.2 Km. $h^{-1}$ (Table 1).

**Site selection:** The Tehsil Takht-e-Nasrati was divided into four phases i.e., Phase 1 (340-399m), Phase 2 (400–499m), Phase 3 (500–599m) and Phase 4 (600–700m) for biomass samplings on the basis of altitude and preferred designed for diversity of situation. Samples were taken in period of three expected seasons *i.e.*, spring, summer and winter for two years in order to test whether the season's arrangement inclined estimate biomass of plant. The relationship of growing season to latitude was developed from available global positioning system (GPS) data. Time and length of the growing season was then estimated for each study site.

**Species selection:** Relative abundance of each vegetation species as estimated on a broad. All species present in the area were selected for fresh ground biomass study on the source of reference unit, relative abundance of each vegetation species, range of stand, age-classes, geographic locations and edaphic conditions.

**Sampling procedure:** The area was divided into four phases during 2009-2010. Each phase again divided into more than four sites on the basis of shrubs availability in the area. In each site 10 quadrats (5x5 m) were chosen during spring, summer and winter for estimation of above ground biomass. A small representative part of a plant like shoot was designated as reference unit. The size of the reference unit was 10-20% of the foliage weight of average plant. The number of reference unit of plants were counted and multiplied by average weight of clipped reference unit to estimate shrub biomass production. The results were expressed in gram per unit area and after that changed it into kilogram per hectare (hec) (Khan, 2013).

$$Biomass = \frac{\sum_{i=1}^{n} Qi}{P} X \; R$$

Q = Weight of total plant species in Quadrat in gram

n = Number of plant species in Quadrat

P = Area of Quadrat in square meter

R = Constant value

Constant value = 10

**Table 1. Climatic data of Tehsil Takht-e-Nasrati, District Karak for the year 2010.**

| Months | Temperature (°C) | | Humidity (%) | | Rainfall (mm) | Soil temperature (°C) average | Wind speed (Km $h^{-1}$) |
|---|---|---|---|---|---|---|---|
| | Max | Min | Max | Min | | | |
| January | 20 | 4 | - | - | 19.0 | 2.1 | 2.1 |
| February | 21 | 7 | - | - | 19.2 | 3.5 | 3.3 |
| March | 30 | 15 | 82 | 39 | 11.5 | 5.9 | 2.5 |
| April | 35 | 20 | 68 | 32 | 20.2 | 10.4 | 7.2 |
| May | 38 | 23 | 62 | 26 | 1.8 | 10.6 | 5.7 |
| June | 34 | 27 | 64 | 40 | 80.5 | 13.4 | 5.1 |
| July | 34 | 24 | 86 | 44 | 345.2 | 88 | 5.2 |
| August | 33.7 | 25.6 | 84.7 | 52.6 | 167 | 86 | 3.4 |
| September | 34 | 20 | 73 | 36 | 82.8 | 83 | 1.95 |
| October | 32 | 19 | 85 | 48 | - | 77 | 2.23 |
| November | 26 | 10 | 77 | 36 | - | 69 | 2.32 |
| December | 21 | 4 | 84 | 38 | 2.8 | 57.82 | 2.61 |

## Results

The shrub biomass of different species of Tehsil Takht-e-Nasrati was different at different altitude. In the present study it was found that the average shrub biomass was decreasing with increasing altitude. The occurrence of shrub was diverse in different area i.e. hilly as well as plain area. In Phase 1 the biomass of *Saccharum bengalense* (5020.38 Kg $hec^{-1}$) was high followed by *Periploca aphylla* (1638.85 Kg $hec^{-1}$) and *Calotropis procera* (1500.91 Kg $hec^{-1}$). The biomass of *Saccharum bengalense* was high 4331.58 Kg $hec^{-1}$ followed by *Calligonum polygonoides* (2025.18 Kg $hec^{-1}$) and *Periploca aphylla* (389.01 Kg $hec^{-1}$) in Phase 2. The biomass high 1125.1 Kg.$hec^{-1}$ in Phase 3, was present by *Zizyphus nummularia* followed by *Saccharum bengalense* (925.87Kg.$hec^{-1}$) and *Rhazya stricta* (699.46 Kg $hec^{-1}$). In Phase 4 the biomass of *Capparis decidua* was high 437.79 Kg $hec^{-1}$ followed by *Rhazya stricta* (332.7 Kg $hec^{-1}$) and *Astragalus psilocentros* (329.14 Kg $hec^{-1}$) (Table 2). Among shrubs average biomass of *Saccharum bengalense* (2665.12 Kg.$hec^{-1}$) was greater followed by *Calotropis procera*(677.73 Kg.$hec^{-1}$), *Periploca aphylla* (533.67Kg.$hec^{-1}$), *Calligonum polygonoides* (506.29 Kg.$hec^{-1}$), *Zizyphus nummularia* (355.83 Kg.$hec^{-1}$), *Rhazya stricta* (258.04 Kg.$hec^{-1}$), *Datura metel* (242.37 Kg.$hec^{-1}$), *Capparis decidua* (213.25 Kg.$hec^{-1}$), *Astragalus psilocentros* Fisch. (201.81 Kg.$hec^{-1}$), *Withania coagulans* (175.13 Kg.$hec^{-1}$), *Ricinus communis* (160.62 Kg.$hec^{-1}$), *Saccharum spontaneum* (144.14Kg.$hec^{-1}$), *Punica granatum* (62.18 Kg $hec^{-1}$), *Capparis spinosa* (38.67 Kg.$hec^{-1}$) and *Cassia angustifolia* (13.47 Kg.$hec^{-1}$) (Table 2). Among seasons variation the biomass of *Saccharum bengalense* (13800 Kg.$hec^{-1}$) was greater during winter at Phase 1 and *Periploca aphylla* (12.35 Kg.$hec^{-1}$) biomass was lowers during spring at Phase 4 (Table 3).

**Table 2.The altitudinal variation in the average biomass (Kg.hec$^{-1}$) of shrubs of Takht-e-Nasrati during the year 2009-2010.**

| S. No. | Species name | Regions | Phase 1 | Phase 2 | Phase 3 | Phase 4 | Mean |
|---|---|---|---|---|---|---|---|
| | | Altitude | 340 – 399m | 400 – 499m | 500 – 599m | 600 – 700m | |
| 1. | *Astragalus psilocentros* Fisch | | - | - | 478.1 | 329.14 | 201.81 |
| 2. | *Calligonum polygonoides* L. | | - | 2025.18 | - | - | 506.29 |
| 3. | *Calotropis procera* (Wild.) R.Br. | | 1500.91 | 921.33 | 138.63 | 150.04 | 677.73 |
| 4. | *Capparis decidua* (Forssk.). Edgeworth | | - | - | 415.21 | 437.79 | 213.25 |
| 5. | *Capparus spinosa* L. | | - | - | 116.72 | 37.97 | 38.67 |
| 6. | *Cassia angustifolia* Vahl | | - | - | 53.88 | - | 13.47 |
| 7. | *Datura metel* L. | | 721.45 | 248.04 | - | - | 242.37 |
| 8. | *Periploca aphylla* Decne. | | 1638.85 | 389.01 | 21.3 | 85.51 | 533.67 |
| 9. | *Punica granatum* L. | | - | - | 116.22 | 132.52 | 62.18 |
| 10. | *Rhazya stricta* Decne. | | - | - | 699.46 | 332.7 | 258.04 |
| 11. | *Ricinus communis* L. | | 549.77 | 92.72 | - | - | 160.62 |
| 12. | *Saccharum bengalense* Retz. | | 5020.38 | 4331.58 | 925.87 | 382.64 | 2665.12 |
| 13. | *Saccharum spontaneum* L. | | 416.55 | - | 24.08 | 135.95 | 144.14 |
| 14. | *Withania coagulans* (Stocks) Dunal | | - | - | 510.29 | 190.24 | 175.13 |
| 15. | *Zizyphus nummularia* (Burm.f) W.&A. | | - | - | 1125.1 | 298.23 | 355.83 |
| | **Average** | | **656.52** | **533.86** | **308.32** | **167.51** | **416.56** |

## Discussion

The people of the area use shrubs for fuel purposes because most of the shrubs are non palatable or less palatable. The tree position in the area is very trouncing so the people go towards the shrubs for fuel. The shrubs biomass determines the probable quantity of heat but the type and nature of shrub change their combustibility. In good vigor shrubs are wipe out by fire more readily than ordinary ones. The moisture contents of fuel influence the completeness of combustion. Living tissues have higher moisture content than dead stuff and as a result burn less readily. Our result is similar with that of Bilgili & Saglam, (2003) and Gambiza *et al*., (2005). It was noticed that in the plain area people put off those shrubs which are nonfunctional for the burning purposes. The high quantity of moisture in the young plants is due to the dominance of fuels from species and plant fractions with greater moisture content. A decrease in water content with age, has also been found in the shrubs. Similar decreases, have also been reported for plant by Pook & Gill, (1993). The shrubs biomass was increased with the age of species and seasons. In spring the biomass is high due to the large amount of shrubs and high quantity of moisture then summer because in summer most of shrubs are exterminated in the area by reason of low rain and high temperature. At the end of winter the people cut shrubs for the fuel purposes because at that time the biomass was high as compare to other seasons. According to people the plants have short time in burning when it is cut in spring and summer while in winter the duration is more due the dormant condition of plants. Fine fuels react faster to weather changes, particularly if these fuels are dead, and they play a major role in the initial stages of all fires (Baeza *et al*., 2002). It was also detected that in plain area the biomass was high while in hilly area it was low because in plain the soil is soft so the shrubs easily penetrate their root as compare to the hilly area. The some shrubs biomass was high in plain area than hilly area due to its life cycle completed earlier than other shrubs and this capability might be due to its establishment and growth early in the every season in plain area and at any temperature of the year. Our result is similar with that of Saleem *et al*., (2009). In comparison in season the amount was high in winter due to the dormant stage of shrubs in phase 1 while it was low in summer in phase 4. In winter the grazing process was stop due to agriculture point of view while in hilly area the grazing was high and the low percentage of rain fall. Available shrubs are very important for burning causes and fire intensity.

In this study, average total shrub biomass was 741.58 Kg.hec$^{-1}$. The total biomass in different area was diverse from 13.47 Kg.hec$^{-1}$ to 2665.12 Kg.hec$^{-1}$ (Table 3). In whole the biomass was high in winter while low in summer. Our outcome was originated comparable with next to De Luis *et al*., (2004) and Dimitrakopoulos, (2002). Association analyses were undertaken to investigate the relationships between shrub properties, altitude and biomass. In phase 1and 2, total 6 species were recorded with biomass of 656.52 Kg.hec$^{-1}$ and 533.86 Kg.hec$^{-1}$, respectively. In phase 3, total 12 species were recorded with biomass of 308.82 Kg.hec$^{-1}$ and in phase 4, total 11 species were found with ground biomass of 167.51 Kg.hec$^{-1}$. It confirmed that the species number were increased while the biomass were decreased with the increase in altitude. According to Khan & Hussain, (2012), the herbaceous biomass change with change of altitude. Numerous studies have established the relation between vegetation structure and shrubs biomass. The present investigation showed that all biomass were related with area composition and are highly significant for all components of shrubs (Table 2), our result have the same opinion with the end of Peek, (1970). The main professions of the hilly area people are animal selling so the people use the hills as grass land. Estimates of ground shrub biomass are required for much purpose in the fields of area organization, bionetwork, bio energy and biomass exploration. However, the use of destructive sampling to provide these estimates is time consuming and expensive, and so collection of the number of samples required to give an accurate estimate is difficult to achieve. This study describes the development of relationships of shrubs biomass with area condition such as altitude and environmental effect.

**Table 3.The seasonal and altitudinal variation in the biomass (Kg. hec$^{-1}$) of shrubs species in Tehsil Takht-e-Nasrati during 2009-2010.**

| SN | Species name | Altitude | Phase 1 | | | Phase 2 | | | Phase 3 | | | Phase 4 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Seasons | Mean | Min | Max | Mean | Min | Max | Mean | Min | Max | Mean | Min | Max |
| 1 | *A. psilocentros* Fisch. | Summer | - | - | - | - | - | - | 80.94 | 116.24 | 194.24 | 77.74 | 109.6 | 201.36 |
| | | Winter | - | - | - | - | - | - | 369.23 | 203.2 | 1266.72 | 61.02 | 111.84 | 132.24 |
| | | Spring | - | - | - | - | - | - | 984.13 | 206.4 | 5333.36 | 848.66 | 1601.5 | 1793.1 |
| | | Average | - | - | - | - | - | - | 478.1 | 175.28 | 2264.77 | 329.14 | 607.65 | 708.91 |
| 2 | *C. polygonoides* L. | Summer | - | - | - | 955.94 | 636.8 | 2220 | - | - | - | - | - | - |
| | | Winter | - | - | - | 3097.51 | 1430.32 | 7556.72 | - | - | - | - | - | - |
| | | Spring | - | - | - | 2022.1 | 447.36 | 5805.44 | - | - | - | - | - | - |
| | | Average | - | - | - | 2025.18 | 838.16 | 5194.05 | - | - | - | - | - | - |
| 3 | *C. procera* (Wild) R.Br. | Summer | 901.02 | 342.88 | 3604.08 | 880.84 | 624.4 | 1642.8 | 54.01 | 62.72 | 160.96 | 113.7 | 104.6 | 205.52 |
| | | Winter | 743.06 | 284.8 | 1244.24 | 963.95 | 353.44 | 1973.12 | 147.33 | 126.48 | 474.32 | 118.66 | 96.16 | 239.52 |
| | | Spring | 2858.64 | 586.16 | 7826.16 | 919.2 | 424.16 | 1449.6 | 214.55 | 78.96 | 1256.32 | 217.76 | 212.64 | 366.08 |
| | | Average | 1500.91 | 404.61 | 4224.82 | 921.33 | 467.33 | 1688.51 | 138.63 | 89.38 | 630.53 | 150.04 | 137.8 | 270.37 |
| 4 | *C. deciduas* (Forssk). Edge worth. | Summer | - | - | - | - | - | - | 155.84 | 103.76 | 537.2 | 210.7 | 113 | 346.48 |
| | | Winter | - | - | - | - | - | - | 702.9 | 881.12 | 1566 | 563.68 | 209.28 | 1183 |
| | | Spring | - | - | - | - | - | - | 386.89 | 216.32 | 1814.64 | 539 | 158.4 | 1007.2 |
| | | Average | - | - | - | - | - | - | 415.21 | 400.4 | 1305.95 | 437.79 | 160.23 | 845.55 |
| 5 | *C. spinosa* L. | Summer | - | - | - | - | - | - | 92.68 | 152.8 | 496 | 29.58 | 118.3 | 118.3 |
| | | Winter | - | - | - | - | - | - | 112.17 | 159.28 | 625.92 | 43.84 | 175.36 | 175.36 |
| | | Spring | - | - | - | - | - | - | 145.33 | 437.04 | 580.24 | 40.5 | 162 | 162 |
| | | Average | - | - | - | - | - | - | 116.72 | 249.71 | 567.38 | 37.97 | 151.89 | 151.89 |
| 6 | *C. angustifolia*Vahl. | Summer | - | - | - | - | - | - | 34.72 | 243.04 | 243.04 | - | - | - |
| | | Winter | - | - | - | - | - | - | 78.36 | 548.56 | 548.56 | - | - | - |
| | | Spring | - | - | - | - | - | - | 48.57 | 340 | 340 | - | - | - |
| | | Average | - | - | - | - | - | - | 53.88 | 377.2 | 377.2 | - | - | - |
| 7 | *D. metel* L. | Summer | 256.04 | 160.88 | 607.6 | 120.67 | 127.28 | 366.88 | - | - | - | - | - | - |
| | | Winter | 231.84 | 140 | 787.36 | 226.47 | 397.28 | 782.8 | - | - | - | - | - | - |
| | | Spring | 1676.46 | 815.12 | 2838.8 | 396.99 | 250.16 | 898.88 | - | - | - | - | - | - |
| | | Average | 721.45 | 372 | 1411.25 | 248.04 | 258.24 | 682.85 | - | - | - | - | - | - |

**Table 3. (Cont'd.).**

| SN | Species name | Altitude | Phase 1 | | | Phase 2 | | | Phase 3 | | | Phase 4 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Seasons | Mean | Min | Max | Mean | Min | Max | Mean | Min | Max | Mean | Min | Max |
| 8 | *P. aphylla* Decne. | Summer | 588.74 | 136.88 | 2354.96 | 233.13 | 106.4 | 551.6 | 26.58 | 186.1 | 186.1 | 84.86 | 80.72 | 258.72 |
| | | Winter | 1414.42 | 166.88 | 5100.08 | 702.05 | 353.36 | 1523.36 | 24.98 | 174.88 | 174.88 | 56.3 | 75.44 | 149.76 |
| | | Spring | 2913.4 | 228.4 | 9828.16 | 231.84 | 230.72 | 624 | 12.35 | 86.48 | 86.48 | 115.38 | 117.6 | 343.92 |
| | | Average | 1638.85 | 177.38 | 5761.06 | 389.01 | 230.16 | 899.65 | 21.3 | 149.15 | 149.15 | 85.51 | 91.25 | 250.8 |
| 9 | *P. granatum* L. | Summer | - | - | - | - | - | - | 7.29 | 51.04 | 51.04 | 56.66 | 86.96 | 139.68 |
| | | Winter | - | - | - | - | - | - | 33.99 | 237.92 | 237.92 | 219.3 | 148.72 | 728.48 |
| | | Spring | - | - | - | - | - | - | 307.39 | 2151.76 | 2151.76 | 121.62 | 231.68 | 254.8 |
| | | Average | - | - | - | - | - | - | 116.22 | 813.57 | 813.58 | 132.52 | 155.79 | 374.32 |
| 10 | *R. stricta* Decne. | Summer | - | - | - | - | - | - | 327.26 | 179.2 | 463.6 | 126.4 | 78 | 234.88 |
| | | Winter | - | - | - | - | - | - | 531.43 | 93.84 | 1211.04 | 398.34 | 103.68 | 1010.7 |
| | | Spring | - | - | - | - | - | - | 1239.7 | 249.12 | 3511.52 | 473.36 | 146.24 | 747.92 |
| | | Average | - | - | - | - | - | - | 699.46 | 174.05 | 1728.72 | 332.7 | 109.31 | 664.51 |
| 11 | *R. communis* L. | Summer | 187.1 | 748.4 | 748.4 | - | - | - | - | - | - | - | - | - |
| | | Winter | 209.56 | 838.24 | 838.24 | - | - | - | - | - | - | - | - | - |
| | | Spring | 1252.66 | 557.2 | 2395.6 | 278.16 | 320.32 | 1163.76 | - | - | - | - | - | - |
| | | Average | 549.77 | 714.61 | 1327.41 | 92.72 | 106.77 | 387.92 | - | - | - | - | - | - |
| 12 | *S. bengalense* Retz. | Summer | 574.4 | 424.4 | 766 | 661.71 | 496.8 | 1046.8 | 167.05 | 225.44 | 392.64 | 27.2 | 47.36 | 61.44 |
| | | Winter | 13800 | 13040 | 15520 | 11918.98 | 3297.68 | 19360 | 2436.27 | 4539.2 | 6992.32 | 1046.5 | 1692.5 | 2493.6 |
| | | Spring | 686.74 | 496.88 | 844.16 | 414.06 | 229.92 | 559.28 | 174.29 | 236.24 | 383.52 | 74.2 | 71.84 | 224.96 |
| | | Average | 5020.38 | 4653.76 | 5710.05 | 4331.58 | 1341.46 | 6988.69 | 925.87 | 1666.96 | 2589.49 | 382.64 | 603.89 | 926.67 |
| 13 | *S. spontaneum* L. | Summer | 101.86 | 190.96 | 216.48 | - | - | - | 31.68 | 101.68 | 120.08 | 77.22 | 308.88 | 308.88 |
| | | Winter | 840 | 1280 | 2080 | - | - | - | - | - | - | 301.68 | 1206.72 | 1206.72 |
| | | Spring | 307.8 | 1231.2 | 1231.2 | - | - | - | 40.571 | 95.12 | 188.88 | 28.96 | 115.84 | 115.84 |
| | | Average | 416.55 | 900.72 | 1175.89 | - | - | - | 24.08 | 65.6 | 102.98 | 135.95 | 543.81 | 543.81 |
| 14 | *W. coagulans* (Stocks) Dunal. | Summer | - | - | - | - | - | - | 225.87 | 169.76 | 850.4 | 62.68 | 49.52 | 201.2 |
| | | Winter | - | - | - | - | - | - | 368.54 | 100.16 | 1355.04 | 260.7 | 310.32 | 732.48 |
| | | Spring | - | - | - | - | - | - | 936.46 | 199.52 | 3520.8 | 247.34 | 449.04 | 540.32 |
| | | Average | - | - | - | - | - | - | 510.29 | 156.48 | 1908.75 | 190.24 | 269.63 | 491.33 |
| 15 | *Z. nummularia* (Burm.f) W & A. | Summer | - | - | - | - | - | - | 149.92 | 50.56 | 322.96 | 73.34 | 123.5 | 169.84 |
| | | Winter | - | - | - | - | - | - | 1958.34 | 312 | 7350.56 | 215.54 | 340.32 | 521.84 |
| | | Spring | - | - | - | - | - | - | 1267.1 | 571.04 | 3327.12 | 605.82 | 717.28 | 1706 |
| | | Average | | - | - | - | - | - | 1125.12 | 311.2 | 3666.88 | 298.23 | 393.7 | 799.23 |

## Conclusion

In this study we realized in different sites the total fresh ground biomass of all shrub species common in Tehsil Takht-e-Nasrati. This study provides a valuable contribution to biomass research in general. However, it should be kept in mind that the range of fuel characteristics on which the relationships were based represents the range of conditions under which it is possible to use the relationships generated through this study.

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