

## Seed Production, Reproductive Capacity and Agrosto-phenology of Graminoid Community of Dachigam National Park, Kashmir.

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### ABSTRACT

Pasturelands and pastoralism form an important capital generating conservative resource/ industry in Jammu and Kashmir state. 79% of the population of the state lives in rural areas and rearing of sheep, goats, cattle and horses forms a subsidiary part of their occupation. The valley and upland pasturelands in which these domesticated animals forage cover an area of about 0.4 million hectares. Live stock farmers are ignorant of the native grass, herb, forb and scrub species that provide forage to their livestock. Irrational utilization of this natural resource of pasturelands and that too beyond their carrying capacity has resulted in their degradation. During the present field-cum-laboratory work, conducted in temperate zone of Dachigam National Park (34° 04' -34° 11' N latitude and 74° 54' -75° 09' E longitude) Kashmir, over 45 species were found to comprise graminoid community with nearly 31 species representing natives and 14 the exotics and 2 species as inedible to domestic animals. Agrosto-phenology of various species was recorded during fortnightly visits by way of making collections, drying of specimens and preparation of herbarium. After making the average counts of seeds per plant in their early maturity, these were sun-dried for sowing in three replicas of sterilized sand dishes maintained indoors (at 6 - 14° C) and supplied regularly with moisture, sterilized sand dishes maintained out doors at the natural atmospheric temperature but provided regularly with water and the ground and sifted soil from the study area maintained out doors. The highest fill of 97% was recorded for *Oryzopsis munroi* and lowest of 2.08% for *Themeda anathera*. The other species with outstanding fill included *Arthraxon lancifolius*(95%), *Stipa siberica*(92%), *Avena fatua*(91%) and *Bromus japonicus* (90%). The germination of *Bromus japonicus*(90%), *Lolium temulentum*(60%), *O. Munroi*(10%), *Poa annua*(62%), *P. bulbosa* (18%), *P. sterilis*(4%), *Sorghum halepense*(55%) and *S. siberica*(65%) occurred in the replica of sterilized sand maintained indoors without their exposure to subzero winter temperature. Comparatively only 80% germination was noticed in the other two replicas maintained outdoors exposed to subzero winter conditions and that too in the ensuing April. The germination in case of *L. temulentum* in the other two replicas was also 60% and occurred in late Autumn prior to their facing of any subzero conditions. 65% germination occurred in case of *S. siberica* in the replicas of outdoor sifted soil and indoor sterilized sand except that in case of sifted soil replica the seeds germinated two months later in the ensuing Spring. Only 50% of the seeds germinated in the replica of sterilized sand maintained outdoors. Higher % germination in *Digitaria sanguinalis*, *Lolium perenne* and *Fulpa myuros* was most probably due to the effect of vernalization. Out of the 23 species the reproductive capacity was found to be highest for the cryptophytic grass *S. halepense*(332.50) lowest for *Daactylis glomerata* (12.22). Existence of *S. siberica* as a dominant grass in the open and buffer areas of the park was found to be because of its being inedible to cattle and sheep, availability to it of suitable dispersing agencies (cattle and sheep) coupled with its higher seed production. Of the 29 species whose agrostophenology was recorded 12 species exhibited their vegetative growth during Spring 15 during Summer and 7 species during both Winter and Spring. Field labeled culms of *O. munroi* and *Pennisetum flaccidum* did not suffer any mortality whereas those of *S. siberica* did suffer of about 50% Winter mortality.

**Keywords:** Reproductive capacity, agrosto-phenology, seed production, percent fill.

S No.	Grass species	Winter			Spring			Summer			Autumn		
		D	J	F	M	A	M	J	J	A	S	O	N
1	<i>Arthraxon lancifolius</i>	1	1	1	1	1	1	1	1	1	1	1	1
2	<i>Avena fatua</i>	1	1	1	1	1	1	1	1	1	1	1	1
3	<i>Bromus japonicus</i>	1	1	1	1	1	1	1	1	1	1	1	1
4	<i>Calamagrostis pseudophragmitis</i>	1	1	1	1	1	1	1	1	1	1	1	1
5	<i>Capillipedium parviflorum</i>	1	1	1	1	1	1	1	1	1	1	1	1
6	<i>Chrysopogon echinulatus</i>	1	1	1	1	1	1	1	1	1	1	1	1
7	<i>Cynodon dactylon</i>	1	1	1	1	1	1	1	1	1	1	1	1
8	<i>Dactylis glomerata</i>	1	1	1	1	1	1	1	1	1	1	1	1
9	<i>Digitaria sanguinalis</i>	1	1	1	1	1	1	1	1	1	1	1	1
10	<i>Echinochloa sp.</i>	1	1	1	1	1	1	1	1	1	1	1	1
11	<i>Eragrostis poaides</i>	1	1	1	1	1	1	1	1	1	1	1	1
12	<i>Festuca ovina</i>	1	1	1	1	1	1	1	1	1	1	1	1
13	<i>Imperata cylindrica</i>	1	1	1	1	1	1	1	1	1	1	1	1
14	<i>Koeleria cristata</i>	1	1	1	1	1	1	1	1	1	1	1	1
15	<i>Lolium temulentum</i>	1	1	1	1	1	1	1	1	1	1	1	1
16	<i>Muhlenbergia hugelii</i>	1	1	1	1	1	1	1	1	1	1	1	1
17	<i>Oryzopsis munroi</i>	1	1	1	1	1	1	1	1	1	1	1	1
18	<i>Pennisetum flaccidum</i>	1	1	1	1	1	1	1	1	1	1	1	1
19	<i>P. orientale</i>	1	1	1	1	1	1	1	1	1	1	1	1
20	<i>Phleum himalaicum</i>	1	1	1	1	1	1	1	1	1	1	1	1
21	<i>Poa annua</i>	1	1	1	1	1	1	1	1	1	1	1	1
22	<i>P. bulbosa</i>	1	1	1	1	1	1	1	1	1	1	1	1
23	<i>P. nemoralis</i>	1	1	1	1	1	1	1	1	1	1	1	1
24	<i>P. pratensis</i>	1	1	1	1	1	1	1	1	1	1	1	1
25	<i>Saccharum rufipilum</i>	1	1	1	1	1	1	1	1	1	1	1	1
26	<i>Setaria glauca</i>	1	1	1	1	1	1	1	1	1	1	1	1
27	<i>Sorghum halepense</i>	1	1	1	1	1	1	1	1	1	1	1	1
28	<i>Stipa siberica</i>	1	1	1	1	1	1	1	1	1	1	1	1
29	<i>Themeda anathera</i>	1	1	1	1	1	1	1	1	1	1	1	1

Fig. 1. Phenology of 29 graminoid species of Dachigham National Park

1. Seed germination
2. Vegetative growth
3. Flowering
4. Seed formation
5. Seed maturation
6. Senescence





## INTRODUCTION

Grasslands/pasturelands of Jammu and Kashmir constitute an important ecological resource and pastoralism plays a significant role in the socio-economy and capital generation of the state in general and of Kashmir valley in particular. 79% of the population of the state lives in rural areas with agriculture as their main occupation. Together with this rearing of sheep, goats and cattle forms an important component of their occupation. These forage in the valley and upland pasturelands which cover an area of 0.4 million hectares (Shashi Kant, 1990). Besides, a huge population of nomadic Bakkerwals depend directly on the products of the mountain meadows and pasturelands for the herds of livestock maintained by them. Unmanaged and unscientific utilization of this natural resource of grasslands/pasturelands and that too beyond their carrying capacity has resulted in their degradation and deterioration. Our livestock farmers have no knowledge of the species of our native grasses that provide pasture for our livestock.

Over 45 species of grasses were recorded from the temperate zone of Dachigam National Park, which along with many forbs, herbs and scrub plants provide forage for the local live stock. Most probably 31 species of these are native while 14 represent exotics. Almost all of the latter are seen to have now become naturalized and grow well. As a consequence of their indiscriminate use and biotic interference of various forms in all wild areas of grasslands/pasturelands these have almost turned into wastelands, many of the native grass species might have already turned extinct and many more might be on the verge of extinction. There is thus a dire need for attending to our native grasses and grasslands. There have been no efforts for the development and conservation of our these native grasses and grasslands. Native grasses have never been used to develop new pastures, meadows or for soil erosion control in our state. As such by performing intensive studies on eco-biology of our native grasses regeneration of thousands of acres of degraded and denuded mountain grasslands, after the implementation of the appropriate recommendations, could be effectively undertaken and the present study is a preliminary attempt in this same concern.

## STUDY AREA AND CLIMATE

Dachigam National Park ( $34^{\circ} 04' - 34^{\circ} 11' N$  latitude and  $74^{\circ} 54' - 75^{\circ} 09' E$  longitude), with a peculiarly interesting undulating mountain-valley topographic system is, as per official records, spread over an area of 141 km square. It is approximately 22.50 kms. long and 8 km wide and covers roughly half of the catchment area of the famous Dal lake. The entire area of the park is distinguishable

into lower and upper Dachigam with an altitudinal range of 1524-3962 m. The park still seems to provide a not much modified natural habitat for rich collections of wildlife flora and fauna. Grasslands cover a major portion of the national park.

The overall climate of the study area is temperate-nival. The temperate Zone encounters four different seasons a year: Spring(March\_ May), Summer (June\_ August),Autumn(September\_ November) and Winter(December\_ February).The usual temperature range in the temperate zone is between -10 C and 37 C while annual rain fall varies between 500mm. And 700mm. Of which over 40% is in the form of snow during winter.

## MATERIAL AND METHODS

Fortnightly visits were performed to the temperate zone of the national park from spring 1986 to Autumn 1987,in order to make collections of whole specimens and panicles of various grasses in their flowering stages. A herbarium of the graminoid community was prepared and the phenological features were recorded during the field observations. For studying/recording/computing reproductive capacity of 43 species, harvesting, processing, extraction and sowing was performed in accordance with Staten,W Hi(1958) and Misra(1989). The collection of panicles of various species was made from the field in their early maturity on different dates. Subsequent to their harvesting the seeds were sun-dried and re-extracted by rubbing between palms. Average counts of the number of seeds per plant were recorded. After their extraction the seeds were again sun-dried. Keeping the ensuing winter subzero temperatures in view and for studying the vernalization effect, if any, the seeds were sown mostly in late Summer and Autumn in the following three replicates:

Sterilized sand dishes maintained indoors at room temperature of the range of 6<sup>o</sup>-14<sup>o</sup>C and supplied with moisture regularly ,the sterilized sand dishes maintained outdoors at the natural atmospheric temperature but supplied regularly with moisture and the ground and sifted soil from the study area maintained out doors. Dates and percent germination up to the ending August,1988 were recorded. In order to assess survival and mortality on account of winter conditions of a few grass species, specimens were labeled and marked in the field (i.e. maintained *in situ* under the naturally prevailing environmental conditions) and increase or decrease in the number of culms/shoots/buds per clustre was recorded through the ensuing seasons regularly. Average number of seed output per plant x % germination / 100 (Misra, 1989) was used for evaluating the reproductive capacity of various grass species. The % germination considered for the parameter of reproductive capacity was from the replica of sifted soil maintained outdoors.



## RESULTS

### Seed Output

Numerical observations related to harvesting, seed output, %fill, weight, modes of dispersal, sowing, %germination and reproductive capacity (interpreted in numbers) of the main grass species of Dachigam national park are presented in Table 1.

The highest of 97% fill was recorded for *Oryzopsis munroi* while the lowest of 2.08% was for *Themeda anathera*. The other graminoid species with significant values included: *Arthraxon lancifolius* (95%), *Stipa siberica* (92%), *Avena fatua* (91%), *Bromus japonicus* (90%), *Lolium temulentum* and *Setaria viridis* (87% each) and *Poa bulbosa* and *Lolium perenne* (85% each).

The eight grass species whose seeds were found to germinate without any exposure to subzero winter temperature in the replica of indoor sterilized sand dishes with their values included: *B. japonicus* (90%), *L. temulentum* (60%), *O. munroi* (10%), *Poa annua* (62%), *P. bulbosa* (18%), *P. sterilis* (4%), *Sorghum heleanse* (53%) and *S. siberica* (65%). Comparatively it was only 80% of the seeds of *B. japonicus* that germinated in each of the other two replicas (i.e. those maintained exposed to subzero winter temperature and that too in April after about a duration of four long months of sowing when in case of indoor replica the germination success was 90% and comparatively only after about one month of sowing (i.e. January).

Only 60% of the seeds of *L. temulentum* germinated in each replica in the first week of November of the same Autumn in which the seeds were sown.

No significant difference in the percentage germination of seeds of *S. siberica* in the outdoor sifted soil and indoor sterilized sand replicas (65% in each) was observed except that in case of indoor replica the seeds germinated in the month of March while the process was delayed in the other case by a period of about two months. Also the germination was low by 15% in case of the replica of sterilized sand maintained outdoors. In *Vulpia myuros* 50% and 60% seed germination occurred in the replicas of outdoor sterilized sand and sifted soil respectively in the first week of April. Higher success in % germination in species like *Digitaria sanguinalis* (76%), *L. perenne* (80%) and *V. myuros* (60%) was presumably accountable to maintaining of these under subzero winter temperatural conditions (vernalization effect).

### Reproductive Capacity

The reproductive capacity of the twenty three grass species of the study area under the given climatic conditions was evaluated and the outstanding ones in their

Table 1. Seed production, % fill, % germination and reproductive capacity of graminoid community of Dachigam National Park, Kashmir.

S.No	Grass species	A*	B*	C*	D*			E*			F*	G*
					a*	b*	c*	a*	b*	c*		
1.	<i>Agropyron striatum</i>	30	NA	500	NA	NA	NA	NA	NA	NA	NA	NA
2.	<i>Agrostis subvarietata</i>	150	NA	75	NA	NA	NA	NA	NA	NA	NA	Grazing mammals
3.	<i>Alpeyranus musclemmonia</i>	400	40	NA	NA	NA	NA	NA	NA	NA	NA	Wind
4.	<i>Arrhenatherum lanceolatum</i>	140	95	40	NA	NA	NA	NA	NA	NA	NA	Wind
5.	<i>Avena fatua</i>	26	91	200	NA	NA	LAU	NA	NA	72	18.72	Grazing mammals
6.	<i>Bathochloa pertusa</i>	130	22	10	NA	NA	ESU	NA	NA	NA	3.90	Wind
7.	<i>Bromus japonicus</i>	107	90	400	MWT	MSP	MSP	NA	NA	NA	85.60	Grazing mammals
8.	<i>Calamagrostis pseudoplethysensis</i>	350	70	20	NA	NA	NA	NA	NA	NA	NA	Wind, grazing mammals
9.	<i>Capillipedium pumiflorum</i>	500	NA	75	NA	NA	NA	NA	NA	NA	NA	-do-
10.	<i>Chrysopogon echinulatus</i>	115	20	80	NA	NA	NA	NA	NA	NA	NA	-do-
11.	<i>Cynodon dactylon</i>	120	45	40	NA	NA	NA	NA	NA	NA	NA	Gravity, wind mammals
12.	<i>Dactyloctenium aegyptium</i>	1210	76	65	NA	NA	LSP	NA	NA	12	12.00	Wind, mammals
13.	<i>Digitaria sanguinalis</i>	340	77	15	NA	NA	LSP-LSU	NA	NA	76	275.60	Wind, gravity, mammal *
14.	<i>Elymus amurensis</i>	45	83	75	NA	NA	LSP	NA	NA	2	0.90	Grazing mammals
15.	<i>Eragrostis poaeoides</i>	256	80	5	NA	NA	LSP	NA	NA	2	5.12	Wind
16.	<i>Festuca ovina</i>	45	88	80	NA	NA	ESP	NA	NA	9	4.05	Wind and mammals
17.	<i>Hordium leucostachyoides</i>	32	NA	NA	NA	NA	ESP	NA	NA	40	12.80	Grazing mammals
18.	<i>Hordium vulgare</i>	28	NA	NA	NA	NA	ESP	NA	NA	47	13.16	-do-
19.	<i>Imperata cylindrica</i>	43	NA	15	NA	NA	NA	NA	NA	NA	NA	Wind
20.	<i>Koeleria cristata</i>	730	70	10	NA	NA	NA	NA	NA	NA	NA	-do-

S.No	Grass species	A*	B*	C*	D*			E*			F*	G*
21.	<i>Lolium multiflorum</i>	68	88	330	NA	NA	MSP	NA	NA	14	9.32	Grazing mammals
22.	<i>L. perenne</i>	18	85	400	NA	NA	ESP	NA	NA	40	14.40	-do-
23.	<i>L. insularis</i>	120	87	700	LAU	LAU	LAU	NA	NA	60	72.00	-do-
24.	<i>Habichtbergia rugata</i>	72	50	15	NA	NA	NA	NA	NA	NA	NA	Wind animals
25.	<i>Dryopteris monnini</i>	145	97	200	EALU	NA	EALU	NA	NA	NA	21.75	Antibirds
26.	<i>Pennisetum flaccidum</i>	16.9	21	130	NA	NA	NA	NA	NA	NA	NA	Wind,ants,birds
27.	<i>P. orientale</i>	120	10	60	NA	NA	NA	NA	NA	NA	NA	-do-
28.	<i>Phanerogone spicosa</i>	NA	NA	NA	NA	NA	MSP	NA	NA	2.0	NA	Wind,grazing mammals
29.	<i>Pharus lanalatum</i>	170	35	15	NA	NA	NA	NA	NA	NA	NA	-do-
30.	<i>Poa alpina</i>	240	32	50	NA	NA	NA	NA	NA	NA	NA	-do-
31.	<i>P. annua</i>	47	77	40	NA	NA	MSU	NA	NA	62	27.90	Wind
32.	<i>P. bulbosa</i>	136	85	200	MW-LWI	NA	MW-LWI	18	NA	10	13.80	Gravity,wind, grazing mammals
33.	<i>P. nemoralis</i>	185	22	2	NA	NA	NA	NA	NA	NA	NA	NA
34.	<i>P. pratensis</i>	510	NA	50	NA	NA	NA	NA	NA	NA	NA	NA
35.	<i>P. stercorata</i>	151	15	20	LWI	NA	ESU	4.0	NA	2.0	1.0	Wind
36.	<i>Trisetum sp.</i>	NA	NA	75	NA	NA	NA	NA	NA	NA	NA	NA
37.	<i>Setaria glauca</i>	120	40	90	NA	NA	LSP	NA	NA	1.00	0.45	Gravity,mammals
38.	<i>S. viridis</i>	185	87	90	NA	NA	LSP	NA	NA	1.00	5.18	-do-
39.	<i>Stiphan Andropogon</i>	750	40	200	MW	NA	MW	33.0	NA	71.0	532.30	Gravity,antibirds
40.	<i>Stipa capensis</i>	128	92	325	ESP	LSP	ESU	45.0	50.0	65.0	85.20	Mammals, ants
41.	<i>Thymus aschersonii</i>	102	2	150	NA	NA	NA	NA	NA	NA	NA	Birds,antigravity
42.	<i>Trigonon parparacense</i>	48	75	NA	NA	NA	NA	NA	NA	NA	NA	NA
43.	<i>Vulpia spicosa</i>	45	NA	100	NA	MSP	MSP	NA	5.0	40.0	27.0	Mammals,wind,ants

A\*—Mean number of seeds produced/plant; B\*—% EL(C\*—wt.(mg) of 100 air dried seeds; D\*—Germination schedule; E\*—% germination; F\*—Reproductive capacity and G\*—Mode of seed dispersal. a\*—fertilized and maintained indoors at room temperature with regular watering. b\*—fertilized and maintained outdoors in open environment with regular watering. c\*—filled soil from the study area. maintained outdoors in open environment. NA=not available; EAU=Early autumn; MAU=Mid autumn; AU=Late autumn.

EN=Early spring; MSP=Mid spring; LSP=Late spring; ESU=Early summer; MSU=Mid summer; LSU=Late summer; EW=Early winter; MW=Mid winter and LW=Late winter.



order of the values included: *S. helepense*(532.50), *D. sanguinale* (273.60), *B. japonicus* (85.60), *S. siberica* (83.20), *L. temulentum* (72.00), *P. annua* (27.00), *V. myuros* (27.00), *O. munroi* (21.75), *A. fatua* (18.72), *L. perenne* (14.40), *P. bulbosa* (13.60), *Hordeum vulgare* (13.16), *H. leporinum* (12.80) and *Dactylis glomerata* (12.22).

The reproductive capacity was found to be highest for the cryptophytic grass *S. helepense* but the grass was mostly found to occur towards the recently protected areas where earlier it was being nibbled by grazing domestic animals along with other edible herbage and as a result did not get chance to develop panicles and seeds to establish itself. *L. temulentum* was also seen to possess higher fill (87%) and reproductive capacity (72.00) but for being an edible species is mostly picked up by cattle and sheep as herbage in early stage of its growth and development. *D. sanguinale* is an edible amphibious crab grass thriving better only towards open moist locations of the study area.

The dominance of *S. siberica* in many patches of the area is attributable to a number of factors. The grass is inedible to cattle and sheep and spreads rapidly because of availability of suitable dispersing agencies (cattle and sheep) coupled with its production of viable / fertile seeds in considerable amounts (i.e. 92% fill and 83.20 value of reproductive capacity) and in being hemicryptophytic.

### **Agrostophenology**

The phenological phases of 29 grass species of Dachigam National Park are delineated in Figure 1.

#### **1. *Arthraxon lancifolius* (Trin.) Hockst.**

A perennial, solitary, tufted and short grass restricted to unapproachable soil filled crevices of cliffs. Vegetative growth during early and mid Summer and flowers in late Summer. The panicles are feathery branched.

#### **2. *Avena fatua* L.**

The common wild oats is a deep green annual Spring weed grass of waste grounds. Its seeds germinate in late Autumn, resist the Winter frost and after its quick vegetative growth in early Spring flowers. Its seeds ripen in late Spring or very early summer. Its panicles are broadly pyramidal, with long widely spreading branches bearing long awned spikelets. The black awns are stout and twisted. Its seeds are



covered with rusty hairs at their bases. The grass is used as forage prior to its bearing panicles.

### **3. *Bromus japonicus* Thunb.**

This is an annual, short spring grass with characteristic hairy cover over the entire plant body. It is a common grass of the areas where there is or has been some kind of biotic interference. Its seeds germinate during moist, warm and sunny intervals of early spring. It flowers in mid spring and the seeds ripen immediately at the approach of summer and the grass withers away. The grass is used as pasture by the hill cattle before the panicles have been developed, as with the formation of these the grass becomes coarse and difficult to digest.

### **4. *Calamagrostis pseudophragmitis***

It is a yellowish green perennial, rare, rhizomatic grass on mountain slopes or near forest edges with a dense, graceful, elongated but compact panicles. It is a coarse grass and thus not a good forage. It is a short grass attaining a height up to 75 cm. It greens up in spring and flowers in early summer.

### **5. *Capillipedium parviflorum***

Perennial, non-rhizomatic, coarse grass common on borders of paddy fields. Vegetative growth completed by late Spring to early summer. Flower formation during mid summer. Panicles loose and flowers purplish, offensively odorous. Harvested as hay and as fodder for cattle before flowering.

### **6. *Chrysopogon echinulatus* Nees**

It is a perennial non-rhizomatic, coarse mid grass begins greening up in early summer, purplish panicles are developed during summer. Like *D. glomerata* and *B. pertusa* it forms dense and compacted masses of shoots on the ground just near the soil surface in which growing regions remain protected. The entire plant body is covered over by hairy processes. It is recognized as a good forage in early summer and as hay in late summer.

### **7. *Cynodon dactylon* L.**

Several strains of this grass have by now been developed throughout world but it is believed to be originally the native of the Old World, probably India. Some strains of this grass are sown for lawns, some for hay, some for forage, some for fowl

and swan pastures etc. Besides its landscape, forage and other values *C. dactylon* is recognized as a blessing grass by ecologists because of its quality of growing on poor soils and capability of reducing soil erosion significantly. The grass is quick spreading, strong, aggressive and really a good soil binder and checks erosion if not allowed to be grazed for some time. It is recognized as highly nutritious, tasty and milk yielding. It is a creeping perennial grass with branched feathery panicles reproducing by means of stolons and seeds. It is a Summer grass growing and spreading vegetatively during summer months also producing panicles during mid to late summer and seeds during late summer and autumn. It is a best quality forage grass for sheep cattle and horses. It is also believed to be of Ayurvedic medicinal value for bleeding cuts, and as diuretic, urinary sedative and infectious jaundice.

#### **8. *Dactylis glomerata* L.**

This grows as a gregarious or dense non-rhizomatic bluish green perennial mid grass, starting its vegetative growth very early in spring (hence cold resistant) and in late spring (May) forms culms 1-1.5m. tall and bears panicles. The panicles are dense, one-sided masses of spikelets. Its compressed vegetative shoot is one of the distinguishing characters. In Dachigam it is seen to grow well under partially shaded areas. It is regarded as a good hay/forage for cattle and is cut immediately after it flowers. Its seeds also germinate during warmer intervals of late winter and early spring.

#### **9. *Digitaria sanguinalis* L.**

The grass is annual, biennial or perennial, stoloniferous, creeping, short or mid, amphibious grass found growing well towards permanently wet areas. Its panicles are feathery, vegetative growth is completed during late Spring and early summer. Flowers are formed from mid Summer onwards. It perennates by seeds and some times also by stolons. It is used as a green fodder and hay for cattle. Its seeds begin to germinate from late spring to mid-summer and germination and growth are locally facilitated whenever there are enough summer showers.

#### **10. *Echinochloa* spp.**

Specimens of the genus were collected both from the temperate and alpine areas. The grass forms an annual weed in paddy fields and is harvested as hay along with other weeds in August. The grass begins to flower in mid summer and seeds are formed from late summer onwards. Several strains of the grass are available in the area.



### 11. *Eragrostis poaoides*

Annual short (0-10cm.), tufted grass common on overgrazed sandy loam soils, inflorescence compressed and spikelets very loosely arranged. flower and seed formation from July to October. The grass reproduces by seeds which are awnless, naked and shiny. Germination of seeds occurs during late spring and early summer. The species is agronomically much valued.

### 12. *E. pilosa* L.

This is also a commonly met species. It is an annual short (upto 45cm.) tuft grass, slightly shade loving bearing flowers in mid Summer and seeds from late Summer onwards. The grass is solitary and hence not of much agronomic importance.

### 13. *Festuca ovina*

It is an annual tufted short grass. Its seeds germinate in autumn and attain vegetative growth during winter and early spring. It develops panicles during mid-spring which shed awned seeds in late spring and early summer. It is not regarded as a good forage. The grass also tolerates some shade.

### 14. *Imperata cylindrica* L.

Perennial gregarious coarse grass of moist clay loam soils, common on paddy field ridges. Rhizomatic, vegetative growth during late spring and early summer, flowering in mid summer. Panicles compressed and bearing cottony mass of silvery shine. Along with other grasses of paddy field ridges it is harvested as hay. The cottony mass on its panicles could be expected to find use in paper and textile industry.

### 15. *Koeleria cristata* L.

It is a perennial hard tuft grass with greyish green leaves and stiff erect culms with very few leaves. The vegetative growth occurs in spring and flowering continues from early till late summer. The panicle is contracted, slender and with purplish shining spikelets. It grows in association with other grasses, specially, *T. anathera* on warm sandy loam soils and on southeast facing mountain slopes. Since the grass bears very few leaves it is of little agronomic importance. Two strains of the grass are recognizable in Dachigam area.

### 16. *Lolium temulentum* L.

It is an annual weed grass common in spring cereal crop fields. It is bluish green in color and attains a height of 50-70cm. Its seeds germinate in mid autumn and it bears flowers in ensuing mid spring completing its vegetative growth during the intervening period which includes winter also. Its seeds ripen in early summer. Two strains of this grass exist locally. Along with other grasses it is supplied as forage to cattle.

### 17. *Muhlenbergia hugelii* Trin.

It is a silvery green perennial tufted grass growing to a height of about 1m. It attains its vegetative growth during early and mid summer, flowers in late summer and seeds ripen in early autumn. This is also a solitary and palatable grass and is now only restricted to the moist locations in the under canopy of some dwarf bushes of the study area.

### 18. *Oryzopsis munroi* Stapf

The densely tufted perennial mid grass with rich green leaves. The panicles are beautifully large with branches spreading in all directions and with many spikelets. The seeds are purplish and shining. The grass flowers in June and July and may continue till September. It is very resistant to winter frost and continues to develop new green baby shoots even during warm intervals of cold winter. Commonly the grass grows under lightly shaded patches of grasslands and roadsides in the protected area and sometimes also among dwarf bushes. It exists as a solitary grass and is not hence recognised as a grass of much agronomic importance locally. Its seeds germinate in September and the plant attains its vegetative growth by May (i.e. late spring).

Ten clustres of field labeled *O. munroi* were watched in respect of culm /shoot count from autumn, 1987 through various seasons till winter 1989. Culm counts both at individual as well as at an average level showed that the new shoots remained unaffected by winter conditions and the grass continued its vegetative multiplication from late summer through winter up to early spring after producing panicles in late spring and early summer (Table 2). However, there appeared to be no increase in culm number during the winter.



Table 2. Average number of culms developed during consecutive seasons in *Oryzopsis munroi*

Autumn 1987	Winter 87-88	Spring 88	Summer 88	Autumn 88	Winter 88-89	Spring 89	Summer 89	Autumn 1989
11.10	16.60	6.60	16.60	35.40	43.70	43.80	43.80	51.90

### 19. *Pennisetum flaccidum* Griseb.

A solitary, rhizomatic, perennial tall grass completing vegetative growth mainly during early to mid summer, flowering in late summer and early autumn and with panicles purplish and contracted. Its rhizome was found to be penetrating the deepest zones of soil among the native grasses both vertically and obliquely. The grass is commonly found to grow among bushes on moist soil and soil-filled crevices of rocky cliffs. It reproduces by means of rhizomes and seeds. As the grass possesses subterranean rhizomes, the ten cuttings bearing portions of rhizomes of equal length with similar number of nodes/buds were grown in separate pots filled with the soil from the study area and placed in open to maintain their exposure to local environmental conditions. The increase in the number of culms was counted through various ensuing seasons commencing from autumn, 1987 till late summer, 1989 (Table 3). Under the given edapho-climatic conditions the grass appeared to develop culms epigeously from spring up to summer.

Table 3. Average number of culms of *Pennisetum flaccidum* developed during consecutive seasons.

Autumn 1987	Spring 88	Summer 88	Autumn 88	Spring 1989	Summer 89
5.70	9.10	13.30	13.40	18.40	23.70

### 20. *P. orientale* Rich.

A rhizomatous perennial mid grass completing most of its vegetative growth during late spring and early summer and developing panicles continuously from mid summer to early autumn. Predominantly reproducing vegetatively. Isolated patches of this grass are found in arable and uncultivated areas. It is used as hay. Dispersal of seeds by ants but seeds are mostly sterile (unfilled). Panicles in the form of a fox tail sharply marked off from the vegetative portion of the plant.

### 21. *Phleum himalaicum* Mez.

It is an annual short grass growing to a height of only 5cm on nutrient poor soils and up to about 20cm on fertile soils. The individual plant is graceful green germinating in early spring and after completing its vegetative growth by mid spring flowers in late spring. Its panicle is a small ovoid contracted structure sharply marked off from the rest of the plant. It has not a much soil conservation or grazing advantage as it is a solitary and shallow-rooted grass and is easily pulled up by sheep and cattle during grazing. Sometimes two or three smaller sized shoots may grow from the base of mother plant.

### 22. *Poa annua* L.

It is a very short annual or biennial or short lived perennial tufted grass. It is usually removed as a weed from *C. dactylon* in managed landscapes. It is one of the earliest growing spring grasses. During spring this grass species inhabits almost every habitat but as the mild spring conditions gradually end the species is found only growing towards moist shady sites and more than one generations a year are usual for the species. In humid - cum- fertile microclimatic areas the grass remains green all the time and continues to flower throughout the year. The seeds germinate specially in early spring but can germinate at any time of the year when the conditions are favorable. It grows quickly producing flowers and ripe seeds in a short span of time. It is regarded as a good grass for sheep grazing.

### 23. *P. bulbosa* L.

This is an early spring grass. During the warm sunny precipitational intervals of late autumn, winter or early spring it completes its vegetative growth and begins to flower in mid spring. It is a short, perennial, edible and clustre grass of meadows. Miniature plants are formed in the panicles (vivipary) so that when they fall they immediately establish roots on moist ground. Sometimes the grass begins to green up even in autumn, when there are rain showers, from its perennating bulbous structures on the soil surface. In Kashmir both qualitatively as well as quantitatively a considerable spring forage to sheep is provided by this grass.

### 24. *P. nemoralis*

The loosely tufted perennial shallow-rooted short spring grass with lean culms, dark green in color and with spreading upper leaves. The panicles are loose, slightly spreading with one flowered spikelets, found growing in partially shaded



places during late spring and in open sunny places during mild climate of early spring. Lengthy periods of drought perish it.

#### 25. *P. pratensis* L.

This is a perennial, soft, highly palatable rich green grass of meadows, pasturelands, woodlands, plains, mountain slopes and alpine areas. Its vegetative growth begins in late autumn, remaining green for the whole winter and flowering in late spring while ripening of its panicles occurs in early summer. It is rhizomatic but its rhizome is incapable of spreading much. It is recognized as a very good quality forage grass by shepherds. It is characterised by its compact and awnless spikelets.

#### 26. *Saccharum* sp.

Perennial, tall, deeply rhizomatic grass growing among tall forest bushes. Vegetative growth during early and mid summer, flowering during late summer and early autumn. Panicles purplish, soft, ornamental and odourous. Propagation by rhizomes and wind spread seeds. Harvested as hay and fodder for cattle but the grass is very rare. Its panicles produce a sweet and refreshing aroma.

#### 27. *Setaria glauca* L.

It is an annual weed grass. Its panicle is compact and contracted. The entire inflorescence appears to be surrounded by hair like processes of short brown awns. It reproduces only by seeds which are formed by the late summer or early autumn. It is an amphibious grass and is common on ridges in paddy fields.

#### 28. *S. viridis* L.

This is another common species found towards road sides and the lower reaches of mountain slopes. Its inflorescence is longer and larger than that of *S. glauca*. The hairy processes which surround the inflorescence are greyish green as is the entire plant body. The grass is a coarser one. It is used as hay and it forms seeds in late summer and early autumn.

#### 29. *Stipa siberica* L.

It is an unpalatable and obnoxious clustre mid grass attaining height of 1.5-2m. Its growing region lies well upon the soil surface. It starts its vegetative growth in late autumn though a considerable number of baby shoots are killed by winter frost.

Fresh vegetative shoots arise and grow in spring, continue growth till late summer. Flowering begins in late summer and seeds ripen from mid to late autumn. It is a cosmopolitan grass of biotically interfered overgrazed dry mountain slopes of the valley. It is absent in the protected grassland areas of Dachigam. Its long-awned seeds are dispersed by cattle and sheep when they stick to their hair. The seeds of the grass were noticed to constitute an important food item of the *Passer domesticus*.

Growing shoots/culms of ten field labeled clustres of the grass were watched and counted through different seasons. Their mean number of culms showed that the grass suffered about 50% mortality due to frost during the first winter(1987-88) and about 58.50% during the second winter (1988-89). A clustre with an average number of 7.2 culms was computed to produce 33.00 culms from spring 1988 till late autumn (Table 4.) This again suffered mortality during the ensuing winter, as a consequence of which the average culm number reduced to 19.30 in spring, 1989. The grass produced panicles in early autumn and the culm multiplication continued from spring till late autumn.

**Table 4. Culm count through various consecutive seasons in *Stipa siberica*.**

Total plants	Mean number of culms in consecutive seasons					
	Autumn 1987	Spring 88	Summer 88	Autumn 88	Spring 89	Summer 89
10	14.30	7.20	17.30	33.0	19.30	26.10

### 30. *Themeda anathera* Nees

This forms the cosmopolitan and dominant grass of the protected grassland areas of Dachigam National Park. Heavy and continued grazing for longer periods has exterminated the grass from unprotected areas of mountain slopes of the valley. This perennial mid- grass begins to green up in early summer and after attaining vegetative growth of 1-1.5m height begins flowering in autumn. It reproduces mainly by means of its subterranean straggling rhizomes. The spikelets are borne right and left on an elongated axis at nodes. In mid and late summer it is cut and is recognized locally as a good forage and hay for cattle. Cultivation of *T. anathera* can be suggested as an effective soil conservation measure for our denuding mountain slopes because of its soil binding rhizomes and roots and its gregarious growth. Autumn cut



*L. anathera* is regarded as a very good hay for sheep and is supplied to various sheep farms of the valley. In Fig 1 are portrayed the phenological features of twenty nine of the studied graminoid species.

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