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ABSTRACT

Forage germplasm resources, their distributions, potential agronomic characteristics and genetic aspects of the perennial grasses originating in Xinjiang northern regions are discussed. Grass diversity in the natural grasslands is immense for the range of environments to which it is endogenously adapted. Among the perennial species in the mountain area are summer growing and winter-dormant ecotypes, whereas in the plain outland summer-fast-growing, summer-dormant and winter dormant ecotypes occur. Flowering uniformity within the grass tribe provides the chance for gene exchange. The genetic variation for growth rate, tiller development, regrowth and yield between species and within a species has provided plant breeder with abundant material for pasture improvement both in the native and introduced grasses. Because of overgrazing, reclaiming, destroyed woodlands and hedgerows the threat to the loss of genetic diversity in the natural grasslands must be a matter for our concern.

INTRODUCTION

There are 70 genera and nearly 300 grass species in northern Xinjiang natural grasslands (1,2), one fourth of which are present in all of the pastures and primarily provide support for grazing animals and herbivores. They belong to the Mediterranean and other Eurasian temperate species. A feature of these species is that each of them is encountered endogenously over a vast range of environments, and the individual members of a species represent a considerable genetic resource that is adapted to many environments. The northern Xinjiang regions including Yili, Tachin, Altai, Bltala, Changji and Urumqi districts from the north of Tiansan to the south of the Altai mountains are composed of 206.7 million hectare of pastures. Water and temperature are the two main factors limiting growth and development of local vegetation. Temperature is similar to drought-desert climates. However, Tiansan mountains east-west stretched over in south provide a natural defense for the area and bar the way of Atlantic and Antarctic wet currents form the western gap. This results in more rainfall and partly eases the influence of the typically continental climates. In addition, within the regions topography rises and falls, providing more rainfall which could reach to more than 300-350 mm with an average temperature 5°C in the mountains, but can also be less than 250 mm with 2-7°C in the plains or basins. Therefore, although the area has drought-desert climates the geological backgrounds which create the local climate with water and temperature, especially in the mountains, provide the temperate grasses an ideal environment for growth. Due to their environmental condition the Xinjiang natural pastures are among the world's richest in greater diversity. On the basis of such a condition and vegetation, there are traditionally unique grazing regimes of four-seasonal round and bia-seasonal round in Xinjiang natural grasslands for use. Areas of greatest diversity have inevitably been the central places grazed by animals and herbivores. It was found that among the perennial grasses in the mountains summer-growing and winter-dormant pastures occur, whereas, in the plain low-land summer-fast-growing, summer-dormant and winter-dormant ecotypes occur. But the annual species occupy and survive the hot-summer and cold-winter by fast growth and seed dormancy.

GERMPLASM

Agronomic characteristics and adaption to the environment

Research on agronomic characteristics including plant development, forage yield, forage quality, and other concerned factors were selected in order to evaluate the potential for use as pasture species.

Plant development

The plant development of the pasture species is one aspect of successful survival and adaptation to the indigenous environment, and causes major differences in plant yields. The Xinjiang environment is characterized by long cold winter and hot dry summer. According to field observations the perennial grasses such as *Dactylis, Bromus, Poa, Agrostis, Elymus, Phleum, Elytrigia* and *Alopecurus* grow in areas that receive more that 350 mm precipitation. These grasses germinate at the end of April. As temperature increases their growth rate slows down. Their growth is rapid by the middle of June and reaches its peak by the end of July. By the end of the July the plants flower and set seed. Growth of most grasses at higher elevations is completed by the middle of September. Although some species such as *Agrostis gigantea* can extend their growth to the end of October. The perennial grasses of the genera *Achnatherum, Leymus, Agropyron, Aeluropus* and *Calamagrostis*, which grow in the lowland plain, complete their development early because rainfall is limited and maximum summer temperature often exceed 40°C. For these species their seed is formed and summer-dormancy occurs before the end of July or the beginning of August. If sufficient water becomes available they can initiate growth in autumn. Annual species typically have short stature and complete their growth and development by the end of July and winter over as seeds. This pattern of growth in annual species is controlled by the seasonal distribution of rainfall and changes in temperature. The perennial grasses escape the influence of grazing by tillering intensively and allowing a greater opportunity for flowering and subsequent seed production.

The seasonal yields and variation

The yield is a multiple index measuring the assimilating efficiency to minerals, water, sunlight and CO_2 in their environments by the plant itself. It is controlled not only by their inherited process but also outer environmental conditions. As usual the yields of perennial grasses in the mountain area appear in a skewed curve with single peak neither between or within ones, but as the environments are varying yields are different due to growing height, tiller development and regrowth rate (Table 1). Based on the present data genotype differences within and between species is evident.

The variation observed strongly supports a genotype (species) environment interaction. Forage availability of annual species is seasonal, resulting from growth and development each year. Therefore, the yield differences, both between and within a species, is due to the nutrient utility in their environments and disparities exiting in the height and growth rate. However, within present and traditional grazing patterns, there is relatively high selective pressure on the less grazing tolerant species. This pressure will soon cause a species composition change from highly desirable forage grasses to those much less palatable species (*Achnatherum splendens* and *A. inebrians*). The short- and long-term planning should include education on grazing management and the improvement of the degraded grassland pasture with improving cultivars of grasses and legumes breed for grazing and salinity species.

Flowering response and adaption to the environment

The perennial temperate grasses are cross-pollinating, self-pollinating and sexual in their reproductive characteristics. Cross-pollination among perennial temperate grasses is predominately wind driven. When pollen exchange between the different individuals is accomplished by the wind, their genetic materials would have presumably been exchanged. Evans *et al.* (1964) reported on the uniformity among members within the grass tribes on their response to environmental factors in inducing reproduction (3). According to the side study, the flowering period of the grasses in mountain areas is mainly from July to August except in extreme alpine systems, where flowering may be in June. However, flowering period in the plain low lands, where it is hot and dry is from

Table 1. The height, tiller yield and weight/thousand of grass species.*

Species	Accession #	Origin	Height cm	Tillers	Yield ha	Weight/ 1000
Dactylis glomerata	XJG02-1-1	Altai	113.25	5.6	7.24	0.8706
	XJG02-1-3	Yili	113.63	13.9	5.34	0.4542
	XJG02-1-5	Tachen	124.38	7.3	9.25	0.8558
Bromus inermis	XJG01-1-1	Yili	122.75	12.9	8.24	2.8037
	XJG01-1-4	Altai	131.25	12.6	9.91	2.6595
	XJG01-1-5	Tachen	113.75	9.3	5.23	4.1428
Agrostis gigantea	XJG05-1-1	Yili	78.38	20.0	2.88	0.1074
	XJG02-2-9	Altai	82.25	12.6	6.68	0.1092
	XJG05-5-6	Tachen	84.65	9.3	4.95	0.1220
Psathyrostachys juncea	XJG09-2-1	Altai	123.4	39.0	12.39	2.1170
	XJG09-2-2	Tachen	129.4	80.1	12.89	3.1853
Leymus angustus	XJG10-2-1	Tachen	136.3	55.9	8.31	3.5738
	XJG10-2-2	Yami	122.0	44.2	4.31	4.1234

*The data is from the station of the south mountains in Urumqi.

June to July. their is a slight variation within species with regard to flowering data based on different environments with latter maturing species related to an increasing latitude. This flowering uniformity will insure the constant gene exchange within a species with limited exchange between different species. Based on the present data, it appears that flowering uniformity, frequency of gene exchange and genetic variation would exert an influence on species in the process of adaption and evolution. The variation observed in weight/one thousand seeds of *Dactylis glomerata*, *Bromus inermis* and *Agrostis gigantea* (see Table 1) would support the presenting genetic diversity for seed weight within the above grass species.

Morphological and biological deterrent

The economic benefit of animal grazing on forage species is dependent upon their morphological characteristics. Grasses that have been selected under heavy grazing pressure tolerate the defoliation, or have evolved avoidance mechanism, that makes it unpalatable. Possible examples within the Xinjiang grazing pastures include *Stipa* species which have a very long awn on the seed, and *Achnatherum inebrians*, which contains alkaloids at toxic level and if grazed may be fatal to animals. However, the majority of grass species can tolerate treading and grazing of animals and maintain a lush level of tillers, regrowth and rhizome development. The forage quality of grass species declines and becomes coarse due to a silica gel that increases under a dry climate. However, the crude protein and digestible carbohydrates remain remarkable high 8 to 42% respectively, during seed set. Thus, they provide a highly nutritious and palatable forage to animals, which constitutes the major source of forage for grazing animals within the Xinjiang natural grassland husbandry.

Genetic aspects

Grasses generally have a large degree of genetic variability with species and many species are closely related. Many species have arisen from hybridization and further hybridization. *Dactylis glomerata* and *Poa pratensis* are two examples where extensive hybridization has occurred. Natural grasslands of Xinjiang cover a wide range of environments, and changes in temperature and rainfall occur within a short distance in the steep mountainous terrain found in Xinjiang. This allows considerable opportunity for gene exchange within a species or even between species because of flowering uniformity and possible cross pollination. This situation creates conditions for heterozygosity, mutation and polyploids. Under species environments, co-adapted gene complex have evolved over a long period of time by selection. During this selection process the perriality and tiller development are far more favorable in the survivability and development of this new species ecotype. Due to a high level of environmental variation observed within the Xinjiang natural grasslands, there is an abundance of different ecotypes. Such raw genetic stock have provided an abundant source of materials for forage breeders, for the improvement of natural pastures and establishment of artificial pastures. One must conclude that grasses have are well adapted to a wide range of environments and that they exhibit considerable genetic variability for many characteristics. Unfortunately, the grasses of Xinjiang have not been studied in detail.

Genetic conservation

In comparison with cereal crops, forage germplasm comprises a large number of families, genera, and species. The forage species of Xinjiang have co-evoluted with indigenous herbivores and domesticated grazing animals through a long period of time. Although man's participation in this process has been relatively recent, the effects have been disastrous. The clearing of woodland, hedgerows and especially over-grazing has disrupted the original balance among species. This situation is not the same as that for cereals with the loss of landraces and their replacement by a single cultivar. The natural pasture area for hay production in Xinjiang grasslands has been reduced from 26.7 million hectares in the 1960's to 15. Three million hectares in 1990's, and forage yields have been reduced by 20 to 30%. Degenerated and deserted pastures are increasing by about 66.7 thousand hectares each year and is causing an ecological crisis. The genetic diversity of Xinjiang grasslands is seriously threatened. This genetic diversity is very important to our environment and food production and is being lost unnoticed. The effect of the loss of this germplasm is difficult to precisely evaluate, but will certainly have an impact on further generations. Because permanent pastures continue to represent a large proportion of the land area that comprises the forage diversity of Xinjiang, forage germplasm from these areas must be urgently collected and preserved.

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