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Short communication

Genetic divergence of paddy landraces in Nanakosi micro-watershed of Uttarakhand Himalaya

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Abstract

Thirteen landraces of paddy, collected from the Nanakosi microwatershed in Almora district of Uttarakhand, were evaluated for the pattern of genetic diversity using multivariate analysis of Mahalanobis D^2 statistics. These landraces formed seven distinct clusters, three with one landrace each, two with two, and the rest had three landraces each. Most landraces showed characters such as intermediate maturity, tall to medium stature, aroma, slender grain type, red or white grain colour, and had 1:1 grain to straw ratio; but they were mostly not tolerant to drought. This study reconfirms that the farmers in the focal area traditionally used landraces of paddy having ability to withstand climatic exigencies and provide not only grains but also paddy straw.

Keywords: D^2 analysis, Genetic divergence, Genetic erosion.

It is well known that on-farm diversity and wild relatives are fundamental sources of genetic traits needed for coping with environmental stresses, plant diseases, and pests. In Uttarakhand Himalaya, farmers cultivate several locally adapted landraces of paddy (*Oryza sativa* L.), which evolved over thousands of years of dynamic interaction between nature and the farmer's selection and breeding processes. Although these traditional varieties/landraces appear to be inferior to modern types in terms of yield potential, they possess many vital qualities such as pest resistance, drought-resistance, high protein content, flavour, and the like. Due to agricultural intensification, however, on-farm losses of traditional crop varieties are increasing, as most farmers prefer high yielding modern varieties (Maikhuri et al., 2001). FAO (1997) estimated that about three-quarters of the original varieties of agricultural crops have been already lost from the farm fields between 1950 and 1995. Therefore, to maintain crop diversity, collection, characterization, and conservation of traditional landraces are vital. Multivariate analysis with the aid of D^2 statistics (Mahalanobis, 1936) is a potent tool to quantify the extent of divergence in biological populations at genetic level. The present study aimed to assess the genetic divergence of rice landraces currently cultivated by farmers of Almora District in Uttarakhand state, a representative mid-elevation region in central Himalayas.

A field experiment was conducted at the G.B. Pant Institute of Himalayan Environment and Development, Kosi-Katarmal, Almora, Uttarakhand during the 2002-03 cropping season (April to October) to evaluate different landraces. Thirteen rainfed traditional landraces/cultivars (Table 1) that are currently grown by the local farmers were collected and sown in a randomized block design experiment with three replications. Row to row distance was kept at 20 cm and plant to plant at 10 cm in

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Table 1. Clustering pattern and cluster mean with coefficient of variation for different characters for 13 landraces from Nanakosi micro-watershed of Uttarakhand Himalaya.

Cluster no.	Total no. of landraces in each cluster	Name of landrace	Effective tiller number	Plant height (cm.)	Panicle length (cm.)	Spikelet no./ panicle	Seed no./ plant	100 grain weight (g)	Grain yield/ plant (g)	Root yield/ plant (g)	Recycled biomass/ plant (g)
I	1	Lal dhan	2.87	118.23	19.44	4.59	**90.73**	**2.86**	**6.3**	**1.4**	**0.84**
II	2	Dud,Uprau gajai	2.76	129.43	18.9	**4.53**	128.87	2.09	3.55	1.12	0.58
III	2	Jhokia, Jauli	2.29	**132.45**	**21.94**	5.08	**144.37**	2.59	5.37	1.04	0.47
IV	1	Khimu	2.27	119.83	**18.46**	5.63	125.2	2.52	4.24	**0.7**	0.6
V	3	Lal jhiruli, Bakul, Bauran dud	**2.1**	120.77	21.65	4.88	94.98	2.48	3.94	1.03	0.65
VI	1	Kauthuni	**4.53**	**91.3**	19.01	4.76	133.8	**1.6**	3.79	0.52	**0.25**
VII	3	Jhusyav, Bagseri dhan, Dangoli dhan	2.27	116.51	21.11	**5.13**	98.71	2.45	**3.29**	**0.7**	0.42
Mean			2.97	121.80	20.78	5.31	165.64	2.39	4.47	1.05	0.64
Coefficient of variation			28.62	10.42	6.67	7.09	16.98	15.95	23.15	30.22	32.12
Relative contribution (%) towards total genetic divergence			33.36	21.62	18.61	9.19	6.32	4.92	3.01	1.6	1.36

For each character the maximum and minimum values of cluster means are shown in bold.

1 m^2 plots. Seeds were direct-sown manually after incorporating 25 t ha^{-1} of farmyard manure per local practice. Agronomically important observations were recorded on five randomly selected plants in each replication, excluding the border plants, for effective tiller number, plant height, panicle length, spikelets per panicle, seeds per plant, 100 grain weight, grain yield per plant, root yield per plant, and recycled biomass (biomass left unharvested in the field) per plant. Genetic distance between landraces were worked out using Mahalanobis (1936) D^2 statistic and the grouping of genotypes was done following Tocher's method as described by Rao (1952).

Analysis of variance revealed significant differences among the landraces for all agronomic characters studied. Simultaneous test of significance based on Wilk's criteria for pooled effects of all characters (916.51 at 108 degrees of freedom) also showed pronounced differences among the genotypes. Based on the relative magnitude of D^2 values, the 13 focal landraces formed seven clusters (Table 1). This grouping reflects the wide genetic divergence among the genotypes, and is consistent with the previous reports (e.g., Sarawgi et al., 1998; Soni et al., 1999). Furthermore, the wide variability in Mahalanobis generalized distance ranging from 3.101 (average genetic distance between cluster V and VII) to 9.829 (between cluster I and VI) implies that the paddy landraces of Uttarakhand have been subject to continuous selection and adoption by the indigenous farmers who interacted with diverse agroecological conditions.

Among the seven clusters, I and VI were the most diverse with maximum (9.829) inter-cluster distance (Table 2). Highly divergent landraces would produce a broad spectrum of variability attributes enabling further selection and improvement. Conversely, the inter-cluster distance between the cluster V and VII was the minimum (3.101), indicating that the genotypes involved are closely related. Unidirectional selection practiced in the past to meet certain edapho-climatic exigencies might have resulted in uniform features with limited divergence among the genotypes.

The averages of cluster means and coefficients of variation for different characters (Table 1) also showed

Table 2. Inter and intra-cluster Mahalonobis generalized distance between various clusters for 13 rainfed landraces from Nanakosi micro-watershed of Uttarakhand Himalaya.

Cluster	I	II	III	IV	V	VI	VII
I	0						
II	7.16	**1.51**					
III	5.694	4.688	**1.17**				
IV	8.126	4.718	5.199	0			
V	5.646	4.581	3.377	5.983	**1.82**		
VI	9.829	6.972	7.925	8.322	7.173	0	
VII	7.736	4.517	4.01	4.257	3.101	6.752	**1.92**

Bold figures indicate intra cluster distance

a clear picture of diversity. Among the agronomic characters contributing to genetic divergence among the focal landraces, effective tiller (33.36%), plant height (21.62%), panicle length (18.61), spikelet number per panicle (9.19%), and seed number per plant (6.32%) were prominent. Coefficient of variation for different characters indicated that the major forces/ factors of discrimination were recycled biomass per plant, root yield per plant, effective tiller number per plant, grain yield per plant, and seed number per plant. These characters, therefore, can be used for selecting parents from distinctly placed clusters to obtain high heterotic effects, as noted by Sardana et al. (1997).

Overall, the clusters could be regarded as useful sources of genes for yield and its components and the genotypes from these clusters, therefore, could be used in crop improvement programmes to incorporate superior agronomic traits. This study also reconfirms that the farmers have been constantly selecting the most appropriate cultivars considering the prevailing soil physico-chemical characters, moisture availability, energy subsidies accessible, and the like. However, the traditional landraces currently grown in this area may be replaced and thus lost forever, if the farmers feel compelled to cultivate modern varieties. It is, therefore, necessary to preserve the traditional paddy germplasm of mid-Himalayas, to prevent further genetic erosion.

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