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MAGNITUDE OF PHENOTYPIC VARIATION IN PRIMITIVE WHEAT LANDRACES FROM SKARDU REGION (N. PAKISTAN)

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Forty eight landraces (accessions) of primitive wheats collected from 39 villages of mountainous and sub-mountainous regions of Skardu (Northern Pakistan) were evaluated for their genetic potential as manifested by their phenotypic characteristics. Among these populations, the adaptive capacities and magnitude of variability pertinent to number of mature tillers, stem height, heading time, area of flag leaf, length of ear, number of florets per spikelet, the number and grain yield per plant were enormously high. The heterogeniety at single plant level was even greater and possessed desirable attributes. The utilization of this germplasm can prove useful if it could be reintroduced in the areas of their endemism after necessary trials; its incorporation in breeding programmes may prove an asset of much greater significance.

INTRODUCTION

Wheat (*Triticum aestivum* L.) shows a wide range of adaptability—to nearly all the ecological zones of Pakistan. Towards the autarky of this commodity, phenomenal progress has been made through the evolution of high yielding varieties. But the gap is persistently widening due to the explosion of population growth, To invigorate the breeding programmes, exploitation and utilization of incredibally rich germplasm of primitive cultivars may prove an asset as a large and diverse gene pool can cope with the everchanging demands, opportunities and challenges of the future agriculture.

To chart out efficient and realistic gene pool, the Bangor-Lyallpur Universities Expedition was organized to collect the primitive cultivars of wheat from five valleys of the Northern Areas of Pakistan. The explored area comprized of dry farm lands with an annual rainfull of nearly 25 cm but was irrigated through streams. The fields were generally flat but occasionally terraced with loamy, sandy loam to sandy soils showing a pH of over 7.0. Winter generally is long and severe followed by mild summer. The altitude of collecting sites ranged from 1460 to 3080 meters.

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The studies were initiated to assess the magnitude of phenotypically expressed desirable attributes of these primitive wheats, their qualities as elite parents, additionally, and their adaptability in Faisalabad. Estimation of their population structure in a smaller geographical unit (Valleys) was also the object of these investigations.

MATERIALS AND METHODS

Forty randomly selected seeds (caryopses) of 48 accessions of polyploid wheats collected from 39 villages of Northern Pakistan were raised in the experimental area of University of Agriculture, Faisalabad. Seventy five lbs. of nitrogen and 18 lbs. of phosphorus was added to the field in the form of urea and P_2O_5 respectively before sowing. Efforts were made to keep the supply of irrigation, spacing and other environmental conditions uniform to a possible extent.

The qualitative and quantitative data (table 1) were recorded on 10 plants of each accession. However, the number of plants recorded in seven accessions was less than 10.

Table 1. *List of Characteristics Recorded.*

1. Habit of plant.	8. Length of top internode.
2. Number of tillers per plant.	9. Length of main ear.
3. Height of stem.	10. Length of awns.
4. Days taken to heading.	11. Number of florets in central spikelet.
5. Colour of auricle.	12. Number of grains in the main ear.
6. Area of flag leaf.	13. Total grain weight per plant.
7. Disease reaction.	

The materials included spring and winter types of wheats but they were not subjected to vernalization. The habit of plant as prostrate, semi-erect and erect was recorded in the juvenile growth stage. The days taken to heading commenced when the first plant of the field showed half emerged ear. The attack of disease and colour of auricle were recorded through visual observations. The averaged length of awns was calculated from basal, middle and apical awns of the ear. The area of flag leaf was calculated by multiplying its length with breadth x 0.75. To determine the population structure of smaller geographical units, the area of exploration was divided into five distinct valleys namely Shyok, Eastern Indus, Shigar-Pakhora, Nangaparbat, and Hunza depending upon their geographical locations. The data of a character pertaining to accession were averaged to make them representative of a particular valley.

RESULTS AND DISCUSSIONS

The most significant feature of these primitive cultivars was that nearly all the seedlings after emergence grew to maturity in an environment different from that of their origin. This indicated their wide ranging adaptability and suitability for further use in wheat research. Bennett (1970) reported that genetic variability confers adaptability to primitive genetic stocks and that is the most desirable feature of them. She further stated that quantitative variation permits sensitive responses to even minor environmental influences and it reflects adaptive norm.

The wheat accessions included are predominantly the cultivars of *Triticum vulgare* L. but with sparse distribution of *T. compactum* and *T. sphaerococcum* in the Shyok valley.

Regarding qualitative characters, the anthocyanin pigmentation of auricle was shown by 24 per cent of the accessions and were confined to the Shigar-Pakhora and Eastern Indus valleys only, perhaps due to decreased intensity of sunlight. Only 20 per cent of the accessions escaped the attack of stem and leaf rusts, while these populations in their original environments showed none to insignificant attack of these diseases. The disease-free populations predominantly belonged to the Hunza and Nangaparbat valleys. The frequency of awnless and awned accessions was 73 and 27 per cent respectively. The awned wheats were also confined to the above named valleys but seldom in a pure stand.

Regarding the quantitative characteristics of agronomic and physiological nature the range and extent of genetic variability recorded is given in table 2 which shows the maximum and minimum values of each character along with the variance and the number of accession. It may be pointed out that it is not a standard technique to draw conclusions from non-replicated experiment on agronomic or physiologic characters. The pre-existing intra-accessional heterogeneity in the materials of this experiment prevented this exercise. However, the excellent performance exhibited by some genotypes cannot be ignored either, because it showed a number of promising strains possessing superior agronomic and adaptive traits. This is in confirmity with Bennett (1970) and Simmonds (1962) who stated that primitive cultivars peculiarly possess adaptive gene complexes associated with special condition of cultivation. In the beginning, it was suspected that the bulk of the accessions would fail to survive/mature at this locale.

The occurrence of *T. compactum* Host. in the Shyok valley showed wider distribution than that reported by Kuckuck (1970) who delimited its distribution to the alpine region of Europe only. In the absence of any concrete evidence, it is concluded that this species in mixture with other species extended its geographical range up to Pakistan after originating in the Fertile Crescent. The spreading juvenile habit of growth in certain winter accessions coupled with increased infertile tillers and delayed earing is assigned to under doses of vernalization. This phenomenon has already been reported by Rao and Saeed (1977), Witcombe and Rao (1976) and Lorenzetti *et. al.* (1971).

It can be seen from table 2 that the highest number of mature tillers recorded among accessions and plants was 22.0 (acc* 21B) and 47.0 (acc 17) and many plants were mono-tillering. This high tillering capacity provides an excellent material to bring about improvement in the bread wheats. The number of days taken to earing ranged from 110.4 to 147.2 days (accessions 57B and 15C respectively). Accessions 59B, 76, 53 and 59A were noted for the early earing ranging from 114.6 to 121.0 days. Among individual plants this variation was even wider, varying from 107.0 to 167.0 days. The earliest flowering spring or day-neutral entries can prove useful in many parts of the country particularly the area of exploration having a short growing period during the year. It was a common observation to find fully ripened and vegetative plants growing together in a field in the area of exploration particularly at high altitudes. It is apparent that these populations have not been subjected to artificial selective pressures for early maturity due to the absence of such factors as damaging birds, abrupt and sharp temperature fluctuations, wind storms and low intensity of cropping.

Accession 15C (alti. 2440 m) took 167.0 days to heading but 59A (alti. 2990m) was the earliest (107.0 days), while serveral accessions from lower altitudes headed later than 59A showing that heading time does not show any relationship with the altitude. The differences in heading period among individual plants are not related to the altitude either; therefore, photoperiod and temperature variations might have influenced this character. The

* acc = accession

Table 2. *Showing Mean Values for the quantitative Characters among plants and accessions.*

S. No.	Name of Character	Among Accession					Among Plants				
		Maximum	Acc. No.	Minimum	Acc. No.	Variance S^2	Maximum	Acc. No.	Minimum	Acc. No.	Variance S^2
1.	Number of mature tillers	22.0	21B*	1.4	79	3.3	47.0	17	1.0	13A	441.4
2.	Stem height (cm)	126.7	20C	64.0	73	112.5	144.0	20C	60.0	75	528.1
3.	Days taken to heading	147.2	15C	110.4	57	93.5	167.0	15C	107.0	59A	228.5
4.	Area of flag leaf (cm^2)	67.1	21A	27.7	15C	37.4	101.5	20B	18.0	78	561.2
5.	Length of top internode (cm)	46.0	73	19.0	75	49.2	52.0	76	6.0	65	141.8
6.	Length of ear (cm)	16.5	15A	7.0	84	4.5	20.0	20A	6.0	84	21.5
7.	Length of awn (cm)	4.4	19B	1.7	76	1.2	6.6	57B	1.0	59A	4.83
8.	Number of florets per spikelet	7.3	85	4.0	90	0.4	8.0	85	4.0	57B	3.6
9.	Number of grains/main ear	64.6	59A	29.6	20B	26.1	120.0	59A	3.0	13A	693.7
10.	Yield per plant (gm)	14.3	59A	0.2	73	14.4	39.3	59A	0.2	73	160.4

*The number corresponds to the village of collection and the alphabets A, B, C following the number indicates that more than one collections were made from that village.

mixture of winter and spring genotypes together in some accessions confused the issue.

The area of flag leaf among accessions ranged from 27.7 to 67.1 cm^2 depicted by accessions 15C and 21A respectively. Among plants, its value ranged from 18.0 to 101.5 cm^2. This provides a great opportunity to select and utilize the long and broad flag leaf towards well filled grains.

Stem height among accessions varied from 64.0 to 126.7 cm in accessions 73 and 20C respectively; but the numbers of tall stemmed wheats, in general, were more pronounced. The dwarf accessions were 73, 89, 59A, 75 and 88 measuring from 64.0 to 89.0 cm. This character was even more variable among plants where it ranged from 60.0 to 144.0 cm. The screening of dwarf genes for lodging resistance and fertilizer responses, etc. holds a promise for future exploitation. The length of top internode among accessions and individual plants varied from 19.0 to 46.0 cm and 6.0 to 49.0 cm. respectively. The dwarf stemmed entries have a tendency of possessing shorter internode and tall ones are on the reverse.

Among accessions, the length of ear ranged from 7.0 to 18.5 cm., the longest ears were possessed by accession 15A and the shortest by accession 84. among plants it measured 6.0 cm in accession 83B and the longest in accession 20A measuring 20.0 cm. The number of grains in the main ear among accessions ranged from 29.0 to 64.6 and among plants this value varied from 3.0 to 120.0. The total weight of the grains per plant was extremely a variable character, among accessions it varied from 0.2 to 14.3 gm and among plants from 0.2 to 37.7 gm.

It is plausible to imagine that components of yield such as tillering, long ears, heavier and larger number of grains per plant got the selective advantage of artificial selection for higher yields, therefore, other components of yield such as higher number of florets per spikelet and bigger and wider flag leaves naturally got selected in many of the superior genotypes. It may be interesting to note that high yielding Hunzoid wheats were the result both of the ingenuity of the forward-looking Hunzoids and genetic adaptations to fertile soils. Winter type tall stemmed Hunzoid wheats maturing in relatively shorter period show a genetic adaptation to one of the shortest growing season available to these wheat in Hunza Valley.

The magnitude of the genetic variability exhibited by the primitive wheat accessions in general and the individual plants in particular, confirms the findings of Vavilov (1951), Harlan (1951) and later studies by Witcombe and Rao (1976), Rao and Witcombe (1977) and Rao and Saeed (1977) who reported a great amount of genetic variations in primitive cultivars from a gene centre. Apart from genetic systems, it seems that the heterogeniety of environments proved an additional mechanism for the promotion of genetic diversity.

The great store of useful genetic variability may prove very good in future research endeavours. The selections of superior genotypes could be reintroduced for general cultivation in their original ecological niche.

Table 3 pertinent to valleys showed that the magnitude of variation regarding tillering capacity is very high and so is the stem height. However, the difference in heading time is least variable among the valleys showing that uniform social and natural selective pressures exist there. On the contrary, the altitudinal variation has not been able to influence them.

Table 3. *Showing the Range of Variability among Valleys*

Altitude (m) Valleys

S.No.	Name of Character	Shyok 2604.0	Eastern Indus 2396.6	Shigar-Pakhora 2110.9	Nanga Parbat 2648.2	Hunza 2354.4
1.	Number of tillers	9.1	4.0	5.5	10.4	13.2
2.	Stem height (cm)	111.6	99.1	96.8	106.8	114.3
3.	Days taken to heading	131.4	133.9	137.0	126.4	133.3
4.	Area of flag leaf (cm^2)	28.9	25.6	30.1	28.9	29.3
5.	Length of ear (cm)	11.8	11.6	11.0	12.3	13.7
6.	Length of awn (cm)	1.7	Awnless	Awnless	3.1	3.7
7.	Number of florets	5.4	5.3	5.2	5.5	6.5
8.	Number of grains/main ear	—	—	—	61.6	41.9
9.	Grain yield per plant (cm)	4.7	1.6	1.4	6.3	8.5

Characters like area of flag leaf, length of ear, number of florets/spikelet do not differ much. However, the number of grains per ear and their weight between Nangaparbat and Hunza show marked variation. The grain yield/plant exhibited a huge variation, too. The Northerly located Hunza valley and the Southern Nanga Parbat were the best performers and other valleys were the poorest. The 'performance norm' has been unique and variable characteristic of each valley, thus the gene flow among the valleys has been negligible. The adaptability and yield potential of certain single plants and accessions from each valley was remarkable.

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