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North-Western Himalaya—A Centre of Maize Diversity

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Exploration and germplasm collection programme undertaken recently in the hilly region comprising interior pockets in the districts of Rajauri, Poonch, Udhampur and Doda/Kishtwar and adjoining Chamba district of Himachal Pradesh in the North-Western Himalaya (Pir Panjal and Shiwalik ranges) and also in the foothills of Himachal Pradesh with contiguous Ambala district of Haryana, showed the occurrence of rich landrace diversity in both flint and dent types. The analysis of diversity was made on natural populations comprising distinct types by grouping the collections in four categories based on their regional/agro-ecological adaptation. The mean, range and coefficient of variability estimates were obtained regionwise. The results showed existence of high genetic variability for most of the cobs and seed characters. Genetic variability was evident in attributes such as height (1-5m) and adaptation to varying altitudinal ranges (upto 3000 m elevations). Cob size, shape, number of grain rows/cob and colours exhibited considerable polymorphism and similar variations were observed for grain size, shape and colour. Both, dent and flint types are cultivated and landraces exhibited definite patterns of distribution. Several types possessed small cobs and irregular grain arrangements on the cobs. The shelled cobs also showed remarkable variability in shape, size, thickness and also in cupule shape and size. The maize landraces also showed considerable range for crude protein content as also the total grain yield, lodging, stiffness of straw and including that of rachilla. The study shows that the North Western Himalayas is potential centre of landrace diversity in maize.

Exploration and germplasm collection programme was undertaken intensively in the hilly region of North-Western Himalayas. The occurrence of rich diversity in maize in different zones comprising distinct ecological niches/microniches, suggested that North-Western Himalaya also constitutes a centre of diversity for maize. The paper highlights the richness of genetic variability and its distribution patterns.

MATERIALS AND METHODS

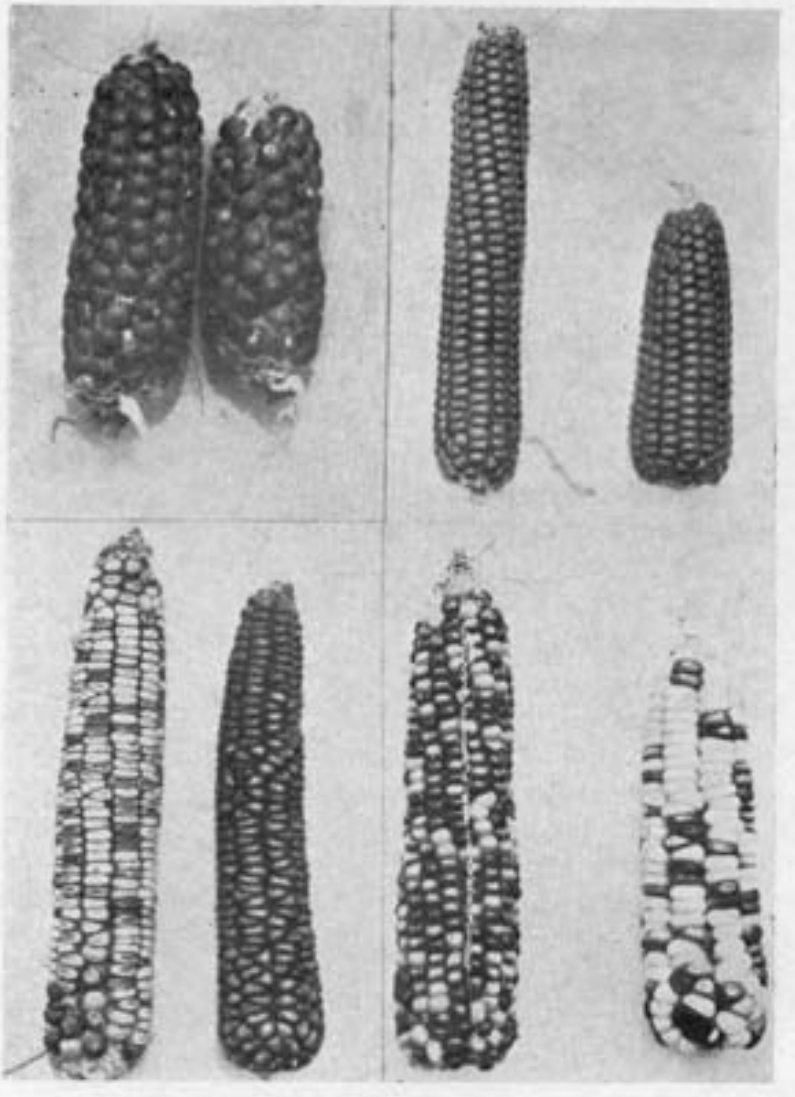
Explorations were undertaken in the Jammu hills and ecologically diverse locations with varying altitudes (500-2000 m). Population samples from each ecological region/niche were obtained by randomly sampling 10-15 plants per

accession/site. Detailed passport data on each accession were collected and studies were made on population samples. One hundred and ten germplasm accessions of maize were collected from five agro-ecologically distinct regions of North-Western Himalayas, namely, Poonch, Rajauri, Udhampur, Bhadarwah and Kishtwar in Jammu and Kashmir. These collections were studied for various morpho-agronomical traits, such as plant height, cob size, kernel number per cob, grain rows per cob, 100-kernel weight, endosperm colour and total protein percentage. The per cent protein was analysed using automatic protein analyser based on micro-Kjeldahl principle. Forty five of these accessions exhibited wide variation for per cent protein and were utilised for electrophoretic analysis. The polyacrylamide gel electrophoresis (PAGE) of total soluble protein, isozymes of peroxidase and esterase were conducted following Davis (1964). A random sample of 10 kernels was allowed to imbibe water overnight and the embryos were excised alongwith the scutellum and homogenised in 0.1 M Tris-HCl (pH 7.4). The homogenate was contrifuged at 10,000 rpm in Remi R-21 centrifuge and the supernatant was used for the electrophoresis. An equal volume of each extract containing an equal quantity of protein estimated following Lawry's method (Lawry *et al.*, 1951) was loaded on 4.5 per cent stacking gel. The protein fractions were resolved in polyacrylamide gel (7.5%). The total protein fractions on the gels were localized by staining with Coomasie brilliant blue. The peroxidase and esterase isozymes were visualized following the techniques described by Shaw and Koen (1968) and Scandalios (1969) respectively.

RESULTS AND DISCUSSION

Study of the natural populations and analysis of data showed that considerable genetic diversity in maize existed in North-Western Himalayan region of India, particularly in remote hilly pockets due to variation in ecology, microniches and spatial isolation imposed by different mountain ranges. Dwarf to very tall (1-5 m) landraces continue to occupy the landscape differing widely in adaptation to varying altitudes (500-2000 m) and soil conditions from valleys to hill tops. Early (70 days) to extremely late types (140 days) were still under cultivation. Variations were prominent for growth, vigour, leaf size and their placement on main shoot. Both narrow and broad leaf types were common.

Much variation occurred in cob size (8-30 cm) (Fig. 1a, 1b), prolificity of cobs (1-3 per plant), internode length, rachilla length (1-10 nodes), and stiffness of rachilla. Amazing diversity existed for cob girth, shell type, grain colour, size, shape and grain yield per cob. Earlier reports (Grant and Wellhausen, 1955; Wellhausen, 1965) suggested that Indian maize varieties seemed to be of two general types; an early yellow flint with a long slender ear somewhat enlarged at the butt with light yellow endosperm and shallow grains closely resembling the early yellow flint grown in the North-Eastern parts of United States of America. The other general type was a flint with short compact ears, deep yellow colour with orange endosperm and shallow grains. This type looked very much like some Cuban yellow flints found in the Caribbean region.



a

Fig. 1a. Diversity in land races of maize.

In contrast to the above observations, both flint and dent types alongwith their intergrades were found to be predominent under cultivation in North Western Himalayan region.

Variations were pronounced for ear (cob) shape (conical, cylindrical or slender-tapering types). Number of rows per cob varied from 8-18. The weight of individual cob ranged between 43.67 and 282.00 g. The grain yield per cob varied between 35.67 and 234.00 g. Grain shape and size was variable and 100 grain weight varied between 10.44-56.86 g. The Rajauri/Poonch region exhibited high coefficient of variability for most of the ear and grain characters. The analysis of data

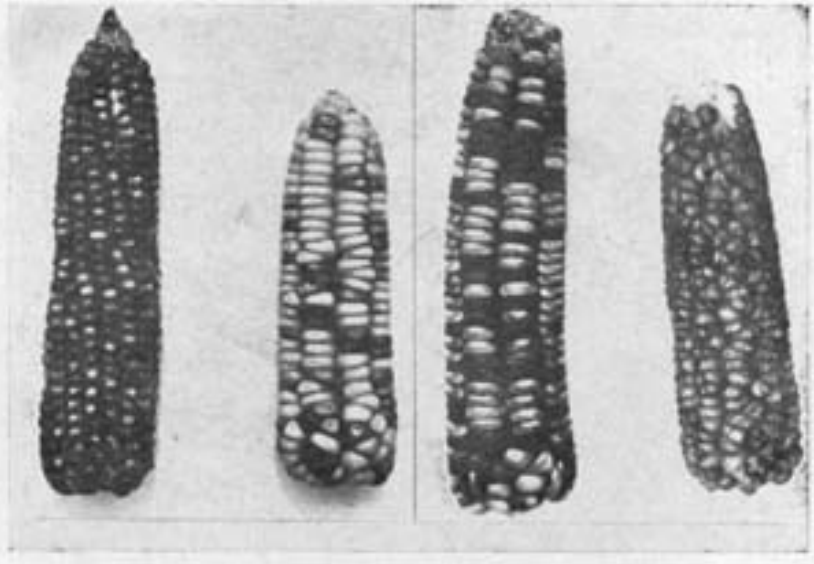


Fig. 1b. Diversity in landraces of maize.

(details being presented elsewhere) showed that remarkable variability existed in the landrace populations for weight of cob, grain yield per cob, 100-grain weight, grain size and colour. Flint and dent types both occurred in varying proportions, flint types with white, yellow or purple grain types had high coefficient of variability in Jammu hills. Besides, purple grained types in flint corn were restricted only to a few accessions. Variation for kernel rows per cob showed interesting features as majority of the landraces had regular kernel rows, though in some, irregular rows occurred suggesting primitiveness of these landraces. The inter-regional comparison showed that variability was high in Rajauri/Poonch region, closely followed by Gull hills and also in Mantalai hills (Udhampur district). The diversity compared well with genetic variability reported earlier from North-Eastern region of India (Anderson, 1945; Stonor and Anderson, 1949; Dhawan, 1964; Singh, 1974, 1977; Sachan and Sarkar, 1982; Sachan, 1985).

The per cent protein in assorted population samples indicated that the variation was higher among the collections from Gull hills in Udhampur region. Wide variation observed for morphological characters, viz, cobs and seed traits and protein content was further confirmed by the differences in the electrophoretic mobility of soluble protein fractions (Plate I. e, f.) and isozymes peroxidaze (Plate *i*, a, b) and estrases (Plate I, c, d). However, a strong similarity of 5 out of the total of 15 fractions resolved through electrophoresis was indicative of local build up of diversity in ppulations of maize. The variation in the electrophoretic mobility of protein fractions was maximum for lines from Gull hills (Udhampur area) and moderate for collections from Rajauri/Poonch and the least for populations from Bhadarwah/Kishtwar region. This was further substantiated by thepresence of

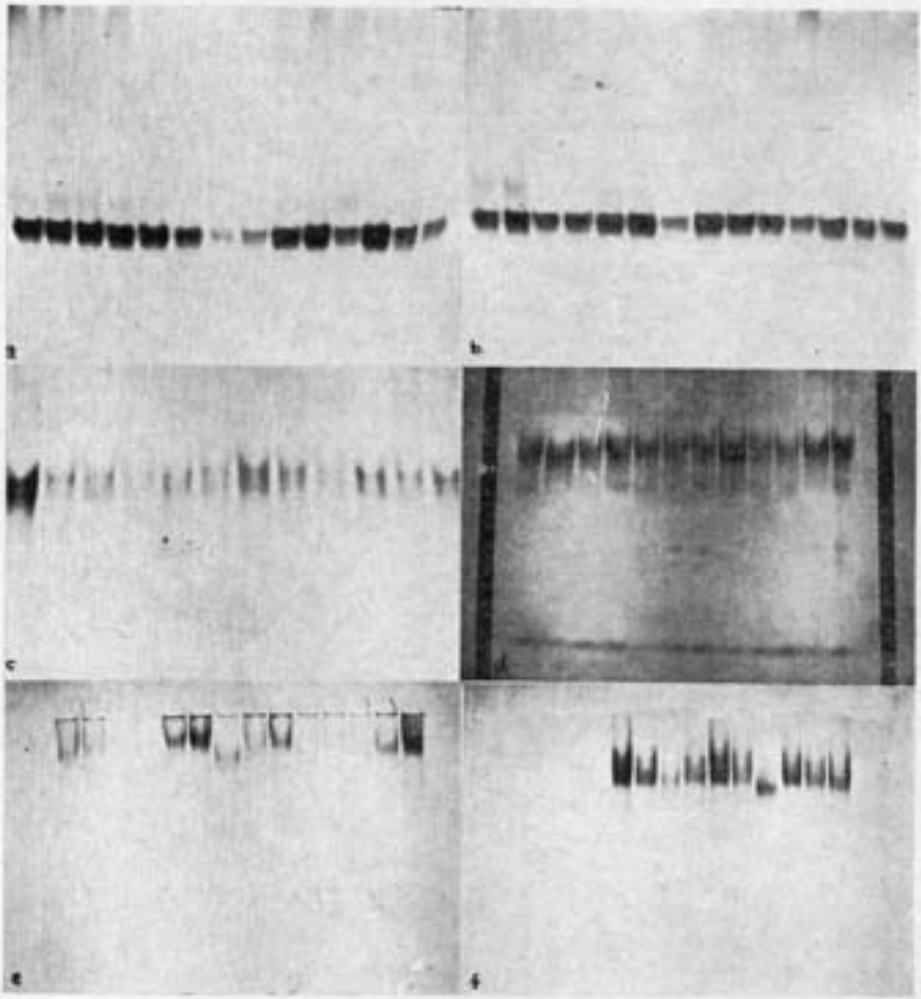


Plate 1. Electrophorograms of per oxidases (a, b), esterases (c, d) and soluble protein (e, f) from North-Western Himalayan maize land races.

a fast moving fraction of peroxidase in these populations. The esterase zymogram (Plate 1c to d) also confirmed the prevalence of variations between the maize populations under cultivation in the regions explored.

REFERENCES

Anderson, E. 1945. What is *Zea mays* ? A report of Progress. Chron. Bot. 9 : 88–92.

Davis, B. J. 1964. Disc electrophoresis II. Method and application to human serum proteins. Ann. N. Y. Aca. Sci. 121 : 404–427.

Dhawan, N. L. 1964. Primitive maize in Sikkim. Maize Genet. Co-op. Newsletter. 38: 104–106.

Grant, U. J. and E. J. Wellhausen. 1955. A Study of Corn Breeding and Production in India. Ministry of Food and Agriculture. Government of India p. 1–27.

Lawry, O. H., N. J. Roseburgh, A. L. Farr and R. J. Randal. 1951. Protein measurement with the folin phenol reagent. J. Biol. Chem. 193 : 265-275.

Sachan, J. K. S. 1985. Characterisation of North Eastern Himalayan maize. National Seminar on Integrated Management Approach for Maximising Crop Production in Rainfed and Problem Areas (Abstract) p. 49 .

Sachan, J. K. S. and K. R. Sarkar. 1982. Plant type of Sikkim primitives. Maize Genet. Co-op. Newsletter, 56 : 122–124.

Scandalios, J. G. (1969) Genetic Control of multiple molecular forms of enzymes in plants. A review. *Bioch. Genet.* 3 : 37–79.

Shaw, C. R., Koen, A. L. (1968) Zone electrophoresis of enzymes. In Smith I (ed.), Chromatography and Electrophoresis, 2nd ed., Interscience Publishers, New York.

Singh, B. 1974. The Eastern Himalayan region as a centre of diversity of maize. SABRAO J. 34A : 22–25.

Singh, B. 1977. Races of Maize in India. Indian Council of Agricultural Research, New Delhi. pp 106.

Stonor, C. R. and E. Anderson. 1949. Maize among the hill peoples of Assam. Ann. Mo. Bo.-Gard., 36 : 355–404.

Wellhausen, E. J. 1965. The origin and breeding of maize. Indian J. Genet., Proc. 3rd Intern. Symp. Spl. Vol. : 45–59.