Vol. XIII (2), 1976

HIGHLIGHTS OF THE INTERNATIONAL SYMPOSIUM ON GENETIC CONTROL OF DIVERSITY IN PLANTS

Amir Muhammed and Abdur Rehman*

The achievement of an accelerated agricultural productivity and a surging economy is an objective that has overwhelmingly dominated our national aspirations and triggered an interplay of forces, which if articulated in proper perspective, should bring forth production potentialities of far-reaching implications. Perhaps the most outstanding and crucial of these forces is the infusion of science and technology in designing action strategies to transform agriculture from brawn to brains, from a way of living to a way of making a living and from a fixation on traditionalism to a state of progress and dynamism. The hitherto slow tempo of agro-economic advancement in this country must in large part be attributed to misplaced emphasis, or lack of it, in the application of science and technology to the whole art and practice of agriculture. It was an unfortunate failing, a technological lag, of which the Peoples' Government has taken due notice and moved, with idealistic realism and foresight, to build up the necessary infrastructure for developing science and technology and their use in the nation building programmes and projects. We are yet way behind in this field and have just not accomplished in keeping with the available human and physical resources. We certainly can do much more. What is needed is a burning awareness in our scientific and educational institutions of their obligations to fulfil their missions of research and leadership in the socio-economic development of our country. Our men of science need really to be men of vision and action, passionately devoted to pursuits of excellence. In such pursuits of excellence, the element of motivation is undoubtedly the most critical, which comes from a keen observation and comprehension of the relevant facts and fancies, personal contacts and communications with creative minds inspired men and inspiring materials. The week-long International Symposium on "Genetic Control of Diversity in Plants" was organised at Lahore from March 1-7 to provide a forum where such contacts and communications could take place in an atmosphere of intellectual effervescence.

The symposium has evidently fulfilled its purpose. From the scholarly presentations on the varied aspects of genetic diversity in plants has emerged

*Vice-Chancellor and Professor of Plant Breeding & Genetics, respectively, University of Agriculture, Lyallpur.

a stimulating mass of knowledge studded with novel ideas, revealing discoveries and inspiring leads. A remarkable feature of the symposium was vivacious, thought-provoking discussions generated during the regular sessions of the symposium as well as at personal levels, in which our young scientists and post-graduate students were also enthusiastically involved. Such intellectual involvement and interaction must have broadened their visions, filled them with new faith and confidence and opened for them new vistas of scientific thought and curiosity. Besides the motivational content, the symposium provided the participants an excellent opportunity to forge personal acquaintances which would in all probability develop into life-long relationships and help promote the cause of science and the general well-being of mankind.

The central theme of this symposium was to discuss the question of food production in its various ramifications and relate it to the advances made in genetics right from the classical to the modern molecular era. The technical presentations in the symposium were preceded by a revealing analysis of the alarming problems of population growth and food supplies made by Mr. Wheeler, Director, U.S. AID. His incisive remarks not only placed the subject matter in perspective but also gave a sense of urgency to the discussions that followed.

Conservation of variability

A number of learned papers on the subject were presented. Sir Otto Frankel (Australia) made the opening speech which set the pace. He made candid observations on the need to preserve the rapidly diminishing sources of genetic diversity in their natural environs. His remarkable vision must have convinced the distinguished gathering that today's wild species might have to provide tomorrow's cultivars and, therefore, all concerned should do whatever is possible to save the fast shrinking centres of diversity from extinction—a perilous situation further aggravated by an attitude of indifference and reckless exploitation.

The north-western territory of Pakistan known to be the centre of diversity for different cereal and fruit plants has been explored off and on, but unfortunately the finds have not been properly indentified and documented. A recent expedition jointly sponsored by University of Agriculture, Lyallpur, and University of Wales, U.K., is the latest attempt to scan the area for plant material of evolutionary significance. A similar but independent survey was also conducted by Nuclear Institute for Agriculture and Biology, Lyallpur. Dr. Rao and Dr. Shakoor (Pakistan) reported some promising results of these expeditions. Such efforts and ventures need to be

organised more often and imaginatively to discover new crop plants, varieties and species capable of making valuable contributions to the available gene pools. Amplification and consolidation of the germplasm is, indeed, much too important in plant breeding to be over-emphasized. Plant breeding is a constant process oriented and directed by environmental vicissitudes and the changing needs of the people, and its success largely derives from an ever expanding reservoir of germplasm. Wheat breeding once oriented to tall plant stature has now given way to breeding for short stature characterized by a responsiveness to higher fertilizer application levels. Thus emphasis has shifted from a low to high fertilizer use and this approach may yet undergo a further change as suggested by some participants like Dr. Qureshi (Pakistan) that the available yield potential in wheat has not been fully realized in Pakistan for want of various production inputs, particularly chemical fertilizers This seems to be true. While the necessity to provide increased credit facilities and price incentives to insure regular and adequate supplies is obvious, the need to develop new wheat varieties with still greater potential to respond to liberal fertilization is all the more important to reap richer harvests. The development of bread wheat varieties with branched ears as well as production of new food grains could yet be another exciting possibility that should be explored with skill and ingenuity to obtain greater acre-yields. Some progress in this direction is visible in our research laboratories as observed by Dr. Aslam (Pakistan).

Though conventional breeding has all along been in use to advance genetic improvement of various agricultural crops without any foreseeable loss of its continued efficacy and potential, the use of induced mutations can further strengthen the conventional effort as was so aptly illustrated by Dr. Brock (Australia) in his fairly comprehensive address. Induced mutations have really placed in the breeder's hands a powerful tool which he can wield not only to retrieve mutations already lost but also to create new ones that never existed in nature. The prospects of practising mutation breeding, not exclusively, but as an adjunct to conventional plant breeding, are really bright.

Polyploidy and breeding

Many of our cultivated species of crop and fruit plants are polyploids, an evidence that polyploidy was a vital force in the evolution of many domesticated plant species. The discovery of colchicine in this century as a polyploidizing agent aroused enormous interest and expectation in the artificial induction of polyploid plants economically superior to their progenitors. However, the progress in this field has been slow. It is only

recently that a breakthrough has been achieved in creating a new polyploid cereal, i. e., triticale, which, it is believed, holds colossal potentialities to solve the world-wide problems of hunger and malnutrition. The various presentations on the subject provided a new insight into the phenomemon of polyploidy and its practical applications. Besides creating new polyploids of economic value, it appears techniques have been developed for the fractionation of our established polyploids to carry out both inter-and intra-genomic restructuring of their component parts and reassemble the original polyploid with greatly enhanced productivity. Polyploidy, as was so eloquently explained by Dr. Kimber (U.S.A.), and Dr. Siddiqi (Pakistan) has also been put to use in locating genes on different chromosomes and in the understanding of the evolutionary processes through chromosome substitution studies. Dr. Sear's (U.S.A) work in wheat constitutes a great landmark in this field and serves as an inspiring reference for further investigations and to accomplish a kind of breakthrough in this fascinating area of genetic research.

Dwarfism has assumed increasing significance in modern breeding strategies for various field crops, particularly the cereals. Perhaps plant stature has been one of the most intensively investigated characters in wheat, rice, sorghum, etc. The studies have indicated that short stature contributed by NORIN 10, a Japanese dwart wheat, and an almost universal source of dwarfing elements for breeding dwarf wheat, is invariably associated with a degree of meiotic instability. This fact has focused attention on the organization of a sustained effort to search for new sources of dwarfism. We hear, and with a sense of equanimity, that new sources of dwarfing genes have been discovered in the North-Western territory of Pakistan, and this discovery would add new dimensions to our wheat breeding programmes. Genetic analysis of dwarfism in wheat has indicated that dwarfiing genes exercise, in varying degrees, pleiotropic effects on other plant characteristics and this phenomenon ought to be kept in sight in breeding for different plant height levels. Studies by Dr. Gale (U.K.) on gibberellin sensitivity of the known dwarfing genes have yielded very useful information for developing efficient techniques to identify genotypes and thus assist in accelerating the pace of our plant breeding work.

A major part of the symposium was devoted to an exhaustive review of the problems usually confronted in breeding for various constraints and stresses as, for instance, posed by recurrent drought, saline and water-logged soils, weather-induced vagaries water shortage, inadequate fertilizer supplies,

diseases and other pest incidences, etc. These adversities take a heavy toll of crop harvests and need to be checked effectively through breeding varieties incorporating resistance to such hazards and ailments. Knowledge of the host-parasite relationships is of great significance in breeding for rust resistance in wheat and other crop plants. A number of interesting papers were read on this subject, which presented information of value in planning for stress breeding. Both polygenes and single genes, it was illustrated, were involved in the host–parasite relationship and that Flor's model still provided a sound basis for breeding for rust resistance in cereals and other crops.

Breeding for quality and other constraints

Protein starvation, a major affliction of the millions in the developing countries, has lately received greater consideration in crop improvement programmes. Since animal protein is yet scarce, expensive, and hard to come by, breeding for high–protein cereals and grain legumes seems to be the right answer. Dr. Auckland (India) reported that considerable progress has been made in developing high-yielding chickpea varieties with improved protein content by both inter-and intra–specific hybridization. As noted by Dr. Kausar (Pakistan), gram blight and wilt are the two most devastating diseases of chickpea. The developmentof gram varieties resistant to these diseases is an obvious imperative. Some progress has been made in this direction in Pakistan but a great deal more remains to be accomplished. Besides edible legumes, concerted efforts have been focused on the genetic improvement of cereals for protein content andessential amino-acids which have met with considerable success in recent years. The protein content of the various wheat cultivars ranges from 9 to 15% which, as reported by Dr. Johnson (U.S.A.), could go farther up by ingenious genetic manipulation. Some of his derivatives from crosses involving a high-protein wheat variety, Atlas 66, have a protein content as high as 25%. This is an outstanding achievement which has opened up new avenues of hope and a breakthrough in our struggle to correct debilitating imbalances in the common man's diet caused by protein deficiency.

The reclamation and management of water-logged and saline soils resulting, as a necessary evil from indiscriminate and unguarded use of our extensive canal system, is yet another problem which requires attention. Already several necessary measures including the installation of tubewells have been taken, with good results. But even in substantially mitigated conditions, saline soils are going to stay with us in some form or another and ways and means will have to be found to adapt our agriculture to such environments by

breeding salt-tolerant varieties. The prospects of developing a salt-tolerant agriculture were examined in some depth in two brilliant papers by Dr. Bernstein (U S.A.) and Dr. Akbar (Pakistan). Dr Bernstein described the physiological basis of salt tolerance in plants and indicated that low yields and nutritional imbalances induced by salinity can be corrected genetically as well as by a foliar spray of nutrients. The genetic control involved may be both simple and complex in different situations. Rice varieties showing substantial salt tolerance have been developed at NIAB, Lyallpur, from a cross between Jhona 349, a local, coarse and salt-resistant variety and Magnolia, a salt-sensitive introduction from the U.S.A. The results are highly encouraging and replete with enormous possibilities.

Various aspects of storage proteins in cereal and legume seeds, inculding their nutritional significance and genetic control were discussed in detail. The storage proteins of cereals consist of many different proteins. Their synthesis and accumulation in the endosperm depend to a great extent on the availability of nitrogen. Dr. Doll (Denmark) pointed out that in maize, sorghum and barley, prolamines, the most typical and best-known storage protein in cereals, appear to be inversely related to lysine content. Since prolamine content is also positively related to carbohydrate accumulation in the endosperm, the low-prolamine but high-lysine genotypes would give somewhat reduced grain yield. However, there exist real possibilities of improving nutritional value of cereal proteins. In breeding for high protein content due consideration must also be given to its quality as observed by Dr. Boulter (U.K.) since the smaller content of high quality protein should be a more desirable objective than otherwise. He discussed a number of methods for faster screening of protein content including Dye-binding, IR refractance, Air-gap electrode and Micro-Kjeldahl and hoped that the great potential for the improvement of yield in legumes, and for increasing the protein content in cereals would be realised in spite of the relationship implicit in the yield/protein content trade-off. Of the essential amino acids, lysine is one of the most important. This amino acid can be bred into high-yielding varieties of cereals by hybridization and induced mutations. The development of high-lysine maize, sorghum and wheat varieties has made considerable headway and the momentum is gradually picking up. However, essential amino acids like lysine may often appear as components of the low-digestible protein fraction, which fact should be taken into consideration while determining the nutritional status of the cereal varieties.

New horizons in crop improvement

Until now, fixation of atmospheric nitrogen through bacterial activity has been believed to be limited to leguminous crops. The recent discovery by Dr. Dobereiner (Brazil) that such nitrogen fixation also occurs in wheat, sorghum, maize and several forage grasses may become an imposing landmark in cereal research. The development of cereal varieties with high nitrogenase activity and thus capable of fixing atmospheric nitrogen and of producing high grain yields could be a welcome revolution in a world faced with a grim food situation. Recently, greater interest has been evinced in the use of cell and tissue culture in plant improvement. The imaginative observations made by Dr. Ledoux (Belgium), Dr. Scowcroft (Australia), Dr. Zain (Pakistan) and Dr. Melchers (W. Germany) would have one believe that techniques for accurate and more efficient genetic manipulation even in difficult situations presented by intergeneric and interspecific hybridization would be developed and used in the near future. Apparently, plant improvement is now being attempted at two widely divergent scales, i.e., anatomical and populational, the former being cell oriented and more intricate and the latter population oriented and more elaborate.

Plant breeding still based exclusively on the classical units of heredity may in the near future experience a sharp departure from this concept and change over to molecular dimensions as visualised by Dr. Setlow (U.S.A.). She stated that genetic transformation with purified DNA may not have a role to play in agriculture in the immediate future but restriction enzymes do hold a fascinating promise for the future improvement of plant as well as other forms of life.

Improvement in a plant population and the choice of the means of achieving it primarily depend upon the nature and magnitude of genetic variability. Models and methods often employed in estimating the quantitative gene action were described in detail. Such estimates provide a basis for selecting between a number of breeding systems available to the breeder. Dr. Yildirim (Turkey) and Dr. Soomro (Pakistan) explained the application of the diallel analysis in wheat to obtain genetic information in the early generations to select suitable parents and cross populations. The use of selection indices based on yield components was explained by Dr. Yousaf (Pakistan). Selection indices provide more objective selection criteria for population improvement. Dr. Allard (U.S.A.) presented a brief but lucid genetic analysis of co-adaptation and the idea can be usefully employed in breeding for stress.

Dr. Aksel (Canada) discussed a possible relationship between cytoplasmic differences and phenotypic variability and called attention to the difficulties presented by such studies. It would appear that information on such relationships would be vital to a better comprehension of the mechanics of inheritance, and for a possible revision of the breeding methodology.

The symposium served as an elegant forum for highly provocative discussions and deliberations. The participants who went through this intellectual regimen alone can feel the real magnitude of inspirational impact this experience must have produced on them. Apart from its motivational content, this vast academic exercise generated a massive body of knowledge, a new perception and wisdom which we believe are so important to circumvent the perils of misdirection and misconception in scientific pursuits.