SCHEMES FOR UTILIZATION OF HOST PLANT RESISTANCE

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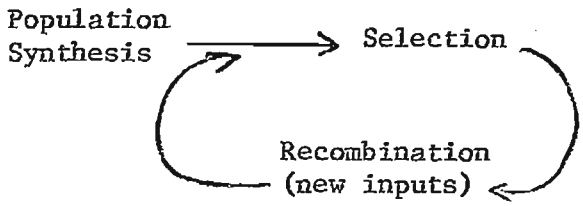
Now that we have more than 100 multiple disease resistant lines of cowpeas it is imperative to utilize them efficiently in the breeding program so that their broad base of genetic diversity is preserved, undesirable linkages broken and recombinants of high yield, desired growth habit and multiple disease resistance recovered.

The hazards of the conventional, short term approach of pure line breeding are well known (Walker 1966, Genetic vulnerability of major crops 1972). History says that releasing homogeneous pure-line varieties feeds the vicious spiral of new varieties selecting new races of disease causing organisms necessitating more new varieties and so on. This vicious spiral causes disease resistance genes to be consumed at such an alarming rate that pathologists searching for host-plant resistance and breeders trying to incorporate it in the desired recombinants lose pace with the evolution of new races of the pathogens.

An alternative to the pure-line approach is to use mixed genotypes called multiline varieties in which different lines of the variety have different gene systems for disease reaction. This approach requires identification of various gene systems of host-plant resistance. The recombination aspect becomes tedious and time-consuming since equivalence of various alleles controlling resistance to different races of pathogens has to be maintained. The selection process becomes even more laborious because of the necessity to select for resistance to various races. The pathologist has to identify and maintain the collection of races on a continuing basis for meaningful selection work for the breeder. Although the potential of this approach is not fully explored it appears to be medium term in the sense that every few years new components for the multilines will be needed. All that this system appears to do is to increase the expanse of the vicious spiral with a prolonged time span between the evolution of new races of pathogens and crop improvement.

What is actually needed to beat the pathogens is improvement on a continuing basis. We need an open ended system where new accessions identified as carrying resistance to different races can be easily incorporated and the products of such a system could be taken out at any stage of development. In this way the core can be expansive and thus the products will be diverse. Population improvement schemes involving recurrent selection will provide a series of multilines on a continuous basis. The pure-line and multiline approaches provide time based discrete stages of crop improvement whereas the population improvement is an ever evolving continuous process.

The population improvement program for cowpeas utilizing genetic male sterility functions according to the cycle:



Operational features of the population improvement for disease resistance are described below.

Population synthesis

The core of the population first is derived from crosses between the elite cultivars and the stocks carrying ms2 ms2 gene. These are advanced to F_2 generation when the male sterility gene will segregate. Multiple disease resistant varieties are stagger planted to obtain flowers over a long duration. These are used as male parents and the same number of crosses are obtained on as many male sterile plants as possible. It is important to make equal number of crosses involving multiple disease resistant lines so as to infuse into the core the same proportion of various alleles controlling disease resistance.

The F_1 plants are grown under optimum conditions and F_2 seeds are obtained. The F2 plants are grown and crosses are made between all the plants using the male sterile plants as female parents.

Subsequent progenies of these crosses will segregate for male sterility and the crosses involving as many fertile plants as possible should be made for at least two more growing seasons before selection can be practiced. This then forms the base population for selection and for infusion of new materials whenever necessary.

Selection

In case of disease resistance, the job of selection is simple as long as all the plants in the population can be subjected to disease stress. At IITA the spreader lines seem to create effective disease stress conditions. They can be planted on alternate hills or at every 2 to 3 meter interval along the row two weeks before planting the population. In special cases like the cowpea (yellow) mosaic virus and bacterial pustule, inoculum of various strains is applied.

Fertile plants showing disease resistance can be subjected to mass selection or plant-to-row method. The fertile plants with desired attributes like growth habit, yield and seed quality may be crossed to disease resistant male sterile plants.

The progeny lines retrieved through plant-to-row method may be incorporated into International Disease Nurseries to identify broad spectrum stable resistance to many different populations of pathogens over a wide range of environmental conditions. Since the ultimate objective of any breeding program is to obtain high yield, these lines should be evaluated for agronomic characters like days to flower, days to harvest and yield. The best performers thus selected should be recombined to further diversify their genetic base of disease resistance.

Recombination

With the advent of simply inherited genetic male sterility controlled by a single recessive ms2 ms2 gene (Rachie et al. 1975) and development of a rapid hand crossing technique (Rachie, Rawal and Franckowiak 1975), recombination in cowpeas is easy. A large number of crosses can be made under field conditions in a relatively short time at minimal expense since hand crossing large flowers does not involve any special skill.

There are two methods in preparing the selected material for recombination. One is to prepare a blend of equal number of seeds from the selected plants, to grow them out under disease stress and to cross the best fertile plants onto the best male sterile plants. The second method is a modified plant-to-row method where all the crosses obtained on the male sterile plant are bulked and a row planted on family basis. The blend of equal number of seeds from fertile plants is grown in alternate rows. The male sterile plants segregating out of the blend are used as recipients whereas the fertile plants are discarded. The fertile plants from the family row are used as donor parents. This method, although operationally more complex than the first, is superior because it is effective regardless of the level of dominance and efficiently utilizes both additive and non-additive gene action.

For the purpose of breeding for disease resistance one cycle of selection-recombination can be achieved at each generation. Since the selection differential (k) determines the rate of genetic gain (G) per cycle, rapid progress can be expected because the value of k is the maximum when only one generation is needed per cycle (Sprague 1966).

The population improvement scheme appears to efficiently use the wide variability available now and to easily incorporate new sources of disease resistance when they are identified. The efficiency of the population improvement would largely depend upon the severity of selection pressure created by the conditions of disease stress.

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