RESEARCH HIGHLIGHTS

Michigan State University Bean/Cowpea CRSP

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Developing Cowpea Varieties with Improved Yield Under Conditions of Extreme Drought and Heat

Senegal/University of California-Riverside/Hall

Drought has returned to the Sahel zone of Africa with increased severity. In 1983, crops were sown one month later than normal in the densely populated semiarid zone of Senegal due to the late arrival of the rains. The total rainfall during the growing season was the lowest ever recorded, and crop yields were extremely small. For the previous year, rainfall was also much less than average in semiarid Senegal. The Sahel zone is close to the Sahara Desert, and in addition to being dry, it is hot. In these hot, dry, and harsh conditions, cowpea and various millets appear to be the only crops with the ability to produce useful quantities of food during dry years. In 1982 and 1983, farmers in semiarid Senegal had to rely more heavily on cowpeas because their other crops failed to produce much food.

A Bean/Cowpea CRSP project conducted by the Senegalese Institute for Agricultural Research (ISRA) and the University of California (UC Riverside and UC Davis) is developing improved cowpea production systems for this harsh environment. Over the short period of three years, this project has enabled ISRA and UC to develop a cowpea research team which is working on many critical aspects of cowpea production systems. The University of California is providing the Senegalese members of the team with cowpea strains having improved adaptation to drought and heat, technical advice, and training opportunities. The ISRA scientists are conducting the research in Senegal needed to develop and evaluate new varieties of cowpeas and improved management methods.

Varieties with improved drought adaptation will make an important contribution to the development of improved cowpea production systems for the harsh conditions of northern Senegal. ISRA scientists have determined that early-maturing cowpea varieties would be useful in this region. Summer conditions in California are ideal for selecting early cowpea strains that are insensitive to day length.

Scientists at UCR crossed cowpeas from Senegal and California and selected erect strains having extreme earliness and excellent seed quality. ISRA scientists have now evaluated these strains in comparison with local cowpeas. Performance trials conducted in two locations in the semiarid zone of Senegal over three years have demonstrated that, even with low rainfall and an extremely short growing season, the best early cowpeas from UCR can produce moderately high yields. In 1982 at Louga on dry, sandy soil and with high moisture evaporation, these cowpeas yielded 1,000 kg/ha during a growing season of only 60 days with only 180 mm of rain. Forty-nine days after sowing, the early UCR cowpeas had substantial numbers of mature pods (plate 1), whereas Sahelian cowpeas sown at the same time only had just begun to produce pods (plate 2). During the record drought of 1983 with rainfall of only 130 mm, the best cowpeas from UCR and UCD produced 50% more than the best local cowpeas in the trials. In addition, these

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studies indicate that one of the prostrate cowpeas from Senegal has the ability to produce excellent yields in dry years, providing the growing season is not too short. Trials are now being planned to test the best cowpeas from Senegal and UC on farmers' fields. We anticipate that farmers who plant both types of cowpeas — the prostrate cowpeas from Senegal and the early erect ones from UC — will have a more stable food supply in this harsh environment where rainfall is highly variable.

This project is cooperating with other organizations which receive financial support from USAID. The ISRA scientists associated with this CRSP project are testing cowpeas from the International Institute for Tropical Agriculture in Nigeria and have found that some of their early strains may be useful in the north of Senegal, whereas other insect-resistant strains show considerable promise for the wetter regions to the south. In addition, the project has provided advanced cowpea strains to the USAID-funded Western Sudan Agricultural Research Project. Provisional data from yield tests in the Sudan in 1983 under harsh conditions in a dry location there indicated that the best strains from ISRA and UCR produced seven times more yield than the best local Sudanese cowpeas.

Longer-term research is being conducted to develop cowpeas with greater drought resistance. At UCR, a field method has been developed to select cowpeas with more extensive roots under drought. Cowpea strains have been discovered which have differences in rooting and moisture extraction from the soil. Crosses have been made to combine the desirable characteristics that confer adaptation to drought, and the progeny will be screened in California in the summer of 1984. At UCD, cowpeas with different branching and fruiting patterns have been developed. The extent to which they incorporate carbohydrates into seed is being evaluated because increased partitioning of dry matter to seed should be a desirable characteristic for dry environments. Cowpeas selected by the research projects at UCR and UCD will be made available to the ISRA scientists for testing in Senegal the following year.

Substantial progress has been made in solving what may be a major problem for cowpeas in the tropics — heat stress. Scientists at UCR have demonstrated under con-

Plate 1: Varietal test in 1982 at Louga, Senegal with early UCR cowpeas shown 49 days after sowing.

Plate 2: Varietal test in 1982 at Louga, Senegal with Sahelian cowpeas at 49 days sown at the same time as *Plate # 1*.

trolled environment and field conditions that the high night temperatures which often occur in tropical areas, such as Senegal, can cause cowpeas to have inadequate pollination, poor pod set, and low yields. Many of the cowpeas from Africa, that we have tested, cannot tolerate high temperatures at flowering. Fortunately, we have discovered a few African cowpeas which have substantial heat tolerance. We are now incorporating this desirable characteristic into varieties for West Africa. Our Senegalese colleagues chose the best Senegalese heat tolerant varieties for use as parents, based upon their yield trials. Scientists at UCR crossed them with the other heat-tolerant cowpeas, and the progeny were then screened under extremely hot field conditions during the summer in Imperial Valley, California. Some of the progeny had substantial heat tolerance as indicated by their ability to set pods in extremely hot conditions (plate 3). Most cowpeas set very few pods in these hot conditions (plate 4). Seed of heat-tolerant selections was given to our Senegalese colleagues at our last annual meeting. They will grow them in Senegal in the summer of 1984, evaluate their performance, and select those strains which are best adapted to farmer conditions and requirements in Senegal. We have analyzed temperature data from tropical countries in different parts of the world and consider that improved heat tolerance should improve cowpea yields in many areas where cowpeas are grown, especially in parts of West Africa and India.

The essence of this project is that African scientists and farmers are working to solve their own food production problems in collaboration with UC scientists in key areas. The approach is to design modifications to the existing systems used by farmers (such as improved varieties with resistance to drought and heat, and improved low-input management methods) that can be adopted by farmers and that do not require substantial increases in supplies of credit, equipment, or agricultural chemicals which are difficult to obtain.

This project is located in one of the harshest environments for agriculture on earth, and for the majority of the farms water is not available for irrigation. It will not be possible to achieve the high yields possible with the methods of the "Green Revolution" here. However, even modest increases in cowpea yields would have a major impact on the

Plate 3: Cowpea selected for heat tolerance growing under extremely hot conditions at Imperial Valley, California in 1982.

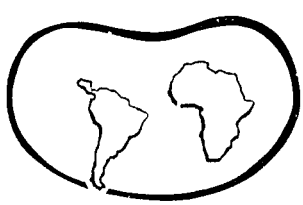
Plate 4: Conventional heat sensitive cowpea growing under the same hot conditions in Imperial Valley, California as the plant in *Plate #3.*

standards of living of the many subsistence farm families who depend on rainfed crop production in hot, semiarid Africa.

A major advantage of working collaboratively with colleagues in countries such as Senegal is that the work has more likelihood of long-term continuation than projects mainly conducted by US scientists. A disadvantage of this overall approach is that it may require longer time. A critical mass of national program scientists must receive substantial professional training if the programs over the long term are to develop improved technology that is specifically adapted to the harsh conditions which confront African farmers throughout the region. However, it should also be recognized that long-term support for collaborative research projects has additional benefits — the essence of true cooperation is that it can be mutually beneficial. The cowpea germplasm with heat tolerance obtained by this project in Africa is now being used by scientists at UCR to develop improved varieties for hot regions of the US. The cowpeas with improved partitioning of carbohydrate to seeds being developed at UCD will be useful in the US as well as Africa and elsewhere. Finally, it should be recognized that the improved understanding among people that can be gained from long-term collaborative projects has substantial value, especially for relations among the people of the US and the turbulent continent of Africa.

THE BEAN/COWPEA CRSP

An international community of persons, institutions, agencies and governments committed to collectively strengthening health and nutrition in developing countries by improving the availability and utilization of beans and cowpeas



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