R7838: FINAL TECHNICAL REPORT

Rapid Generation Advancement of a Chickpea Population for Farmer Participatory Selection

Executive Summary

The overall goal of the project is to enhance income of the farmers, particularly marginal farmers, in five states (Rajasthan, Gujarat, Madhya Pradesh, Jharkhand, Orissa) of India by increasing productivity and production of chickpea. The average yield of chickpea in India is about 800 kg ha^{-1}, which is less than one-third of that obtained at research stations and in on-farm trials. Over 150 improved varieties of chickpea have been released in India, but only very few varieties have been adopted and become popular with farmers. It has been often emphasized that the varieties will have better acceptability by the farmers, if they are developed through farmers' participatory selection.

Three outputs specified for this project were: (1) Advanced breeding material available for selection from crosses involving Dahod Yellow Local x ICCV 2 and ICCV 2 x Bhawani Patna Local, (2) Understanding of the factors determining farmers' preference, and (3) Economic value of farmers' selections understood. ICRISAT was assigned responsibility for achieving the first Output. The remaining outputs would be achieved by the DFID through NGO and State Agricultural Universities. It was planned to develop a large breeding population from each of these crosses in a short period using the method of rapid generation advancement. The parents involved in the crosses were carefully selected. The desi type (brown-seeded) cultivars, Dahod Yellow Local and Bhawani Patna Local are still popular with farmers in western and north-eastern India, respectively. ICCV 2 is the world's shortest duration kabuli (white-seeded) variety of chickpea developed by ICRISAT and widely grown in India, Myanmar and Sudan. It has resistance to Fusarium wilt, some tolerance to heat and escapes terminal drought due to early maturity. The *kabuli* x *desi* crosses give a wide range of segregants. The farmers will have ample opportunity for selection of desirable types.

A large segregating population (over 20,000 plants) was developed from each of the two crosses, Dahod Yellow Local x ICCV 2 and ICCV 2 x Bhawani Patna local. The F_2 and F_3 generations were grown in the off-season in greenhouse using rapid generation advancement. The F_4 was grown in field and subjected to selection for

maturity duration. All late maturing plants were rejected. The F_4 of ICCV 2 x Bhawani Patna Local was sown in wilt-screening nursery and screened for resistance to Fusarium wilt. The plants retained in F_4 were harvested individually and their seeds were examined carefully. All plants with darker-colored or smaller seed than the local cultivars were rejected. F_5 seeds of selected plants were sent to the NGO Gramin Vikas Trust (GVT) for subjecting the lines to farmers' participatory selection in target states.

The project has made available the required populations for farmer participatory selection in the stipulated time frame. GVT and State Agricultural Universities will subject these to farmers' participatory selection in targeted states. It is hoped that this material will lead to development of some farmers' preferred short-duration high yielding chickpea varieties.

Background

Chickpea (*Cicer arietinum* L.) is the third most important food legume of the world and the most important food legume of Indian sub-continent. It is a good source of protein for millions of people in developing countries. India alone accounts for about two-third of the global production and consumption of chickpea.

Chickpea is generally grown on marginal lands on conserved soil moisture. End-of-season drought is the major yield constraint. Early maturity can help escape losses caused by drought. Chickpea is photoperiod sensitive and only one crop can be successfully grown in a year. A rapid generation advancement technique has been developed at ICRISAT to enhance the breeding process. The present project was aimed at developing fusarium wilt resistant advanced breeding populations from two *desi-kabuli* chickpea crosses by using rapid generation advancement techniques. This technique enables the researchers to develop new varieties in a short time. A variety of segregants are obtained from *desi* x *kabuli* crosses. Farmers from drought-prone areas would be able to select advanced breeding lines of their choice.

Over 150 improved chickpea varieties have so far been released in India, but only limited number of varieties are popular with the farmers. By involving farmers in the

selection process, it is hoped that the varieties selected will be more readily acceptable to farmers. The ultimate aim is to enhance acceptance of the varieties by the farmers and increase production and productivity of chickpea in target areas.

Farmer participatory varietal selection approaches have been tried with success in various crops. The acceptance of varieties selected through the participated approach is better than the traditionally released developed varieties. Kalinga III variety of rice, although not formally released, is liked by farmers for its short duration. ICCV 2, a kabuli chickpea variety, which was not released in Gujarat was preferred by farmers for its short duration and kabuli seed type.

Project Purpose

The purpose of the project is "to enhance effectiveness of plant breeding through farmer participatory research and increasing production and farmer income".

The improved chickpea lines identified through farmers' participatory selection will have better acceptability by farmers. It will help in rapid adaptation of improved chickpea varieties and increase in income of farmers through enhanced chickpea production.

Research Activities

Of the three outputs set in the project, ICRISAT had responsibility for achieving the first output, i.e. Advanced breeding material available for selection from crosses Dahod Yellow Local x ICCV 2 and ICCV 2 x Bhawani Patna Local. The following three activities were planned to achieve this output:

1. Crosses of Dahod yellow x ICCV 2 and Bhavani Patna local x ICCV 2 made.
2. Confirmation of the hybrids

3. Advancement of three generations.

Two chickpea crosses Dahod Yellow Local x ICCV 2 and ICCV 2 x Bhawani Patna Local, were made. Dahod Yellow Local and Bhawani Patna Local are the old varieties under cultivation for more than four decades. The first variety is popular in Gujarat, whereas the latter variety is popular in Orissa and Jharkhand states. ICCV 2 is the world's shorted duration variety of *kabuli* chickpea and escapes terminal drought due to early maturity. The crosses were made in the glasshouse under controlled environmental facilities. The F_1 hybrid seeds were grown in the field to advance the generation. Plastic pots with soil and nutrient medium were used to grow F_2 in the glasshouse under extended lights. Single seed was harvested from each F_2 plant. The F_3 seeds were grown in pots in glasshouse and again one seed from each plant was harvested. The single seeds of these F_4 generations were planted in field at a wide spacing and all the single plants tagged for short and medium duration and harvested separately. The seed of these single plants were classified into different seed types and shapes and bulked according to seed types and maturity duration for farmer participatory selection.

Outputs

1. Advanced breeding material available for selection from crosses Dahod Yellow Local x ICCV 2 and ICCV 2 x Bhawani Patna Local.

   Fully achieved by ICRISAT

2. Understanding of the factors determining farmers' preference (DFID)

   To be achieved by the DFID through NGO and State Agricultural Universities

3. Economic value of farmers' selections understood (DFID).

   To be achieved by the DFID through NGO and State Agricultural Universities

Research Results on the Output 1 achieved by ICRISAT

(a) Cross Dahod Yellow Local x ICCV 2

Population from this cross was targeted for farmers' participatory selection in Rajasthan, Madhya Pradesh and Gujarat states of India. About 390 F_1s were

grown in field during post-rainy season 2000-2001 and self-plants were removed based on morphological traits. F_2 (Feb-May 2001) and F_3 (May-Aug 2001) were grown in greenhouse and extended photoperiod was provided until initiation of flowering for rapid generation advancement. Single seed descent (SSD) method was followed for maintaining population size. F_4 seed bulks were prepared by taking one seed from each F_3 plant. Five such F_4 bulks were made as the individual plants did not produce more than five seeds in greenhouse. First bulk, which contained more than 26,000 seeds, was sown at ICRISAT during October 2001. The second and third bulks (19,000 and 8,000 seeds, respectively) were sent to Banswara and the fourth bulk (2,300 seeds) to Ranchi for planting during post-rainy season. The fifth bulk (960 seeds) was kept in cold store at ICRISAT-Patancheru.

The F_4 plants were classified as early, medium or late based on number of days to flower initiation. All late plants were rejected in the field and the remaining population was harvested as single plants. These plants were further classified based on seed size, shape and color. All plants were rejected which had smaller or darker seed than Dahod yellow. The remaining plants were classified into 18 categories as follows:

	Early maturing		Medium maturing	
Seed coat color	Same size	Bigger size	Same size	Bigger size
Dahod yellow type	338	242	224	174
Light yellow	68	58	70	46
Pink	138	40	92	40
White	128	64	64	26
ICCV 2 type	140	24	-	-

Two lots with equal number of samples were made from each category and sent to GVT Banswara (Rajasthan) during July 2002 for farmers' participatory selection in Rajasthan, Madhya Pradesh and Gujarat.

(b) Cross ICCV 2 x Bhawani Patna Local

Population from this cross was developed for farmers' participatory selection in Jharkhand and Orissa states of India. Over 25,000 F_2 plants were grown in

greenhouse during March-May 2002 and seeds were harvested from 23,700 plants. F_3 generation using single-seed-descent method was sown on 22 May and seeds were harvested from 20,600 plants. Extended photoperiod was provided to both the generations until initiation of flowering for rapid generation advancement.

F_4 generation using single-seed-descent method was planted in wilt sick plot during October 2002. From the survived wilt-resistant plants, the late maturing plants were rejected and the remaining plants were harvested individually. These plants were further classified based on seed size, shape and color. All plants were rejected which had smaller or darker seed than Bhawani Patna Local. The remaining 1460 plants were classified into 20 categories as follows:

Seed coat color	Early maturing		Medium maturing	
	Same size	Bigger size	Same size	Bigger size
Bhawani Patna Local type	33	22	119	98
Brown	118	109	168	42
Pink	35	41	153	116
Light pink	76	48	131	77
ICCV 2 type	30	5	31	8

The seed were supplied to the NGO (GVT, Ranchi) during July 2003 for conducting farmers' participatory selection in Orissa and Jharkhand.

Contribution of Outputs

The populations developed from the two crosses (Dahod Yellow Local x ICCV 2 and ICCV 2 x Bhawani Patna Local) in the project will be subjected to farmers' participatory selection in the targeted areas by the DFID through the NGO Gramin Vikas Trust (GVT) and the State Agricultural Universities (SAUs). The parents of the crosses (Dahod Yellow Local, Bhawani Patna Local and ICCV 2) are already popular with the farmers and each cross has generated a wide range of variability. Many lines combine better traits from both the parents. Large population was advanced in each cross giving ample opportunity for recombinations. The involvement of farmers in the

selection process will ensure that the improved lines identified in this project would have acceptance of the farmers.

The crop varieties in India are released for cultivation either by the Central Variety Release Committee or by the State Variety Release Committee. To qualify for the release by the Central Variety Release Committee, a line needs to be tested in the trials of All India Co-ordinated Research Project on Chickpea for three years and should have at least 5% higher yield than the check cultivars. Alternatively, a variety may be released in a particular state by the State Variety Release Committee if it shows superior performance over the check varieties of the state in multilocation testing over 2-3 years. These stages are generally carried out by the SAUs.