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**IMPROVING FOOD AND AGRICULTURAL PRODUCTION**

# **THAILAND**

**BREEDING FOR RESISTANCE TO DISEASES IN COTTON**



**UNITED NATIONS DEVELOPMENT PROGRAMME**



**INTERNATIONAL ATOMIC ENERGY AGENCY**

**VIENNA 1992**

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Report prepared for  
the Government of the Republic of Thailand

by

the International Atomic Energy Agency  
acting as Executing Agency for  
the United Nations Development Programme

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## BREEDING FOR RESISTANCE TO DISEASES IN COTTON

### ABSTRACT

At the request of the Government of Thailand, an IAEA expert undertook a 20 day mission (from 5 Nov 1990 to 24 Nov 1990) to the Department of Agriculture, Bangkok, Thailand, within the framework of project " Improving Food and Agricultural Production with Nuclear and Related Technology" (THA/85/004-11-03 THA/1/031-034). The expert discussed the status of cotton breeding, production practices and problems with Department of Agriculture personnel. Travel to cotton producing regions of the Central and Northern areas of the Country provided opportunity to discuss ongoing research, pest problems, and social factors affecting cotton production with scientist at satellite research centers. Observation of local cotton farms and visits with cotton merchants provided an inside look at the social and economic factors associated with the cotton farmer. The expert advised on selection of plant types and alternate sources of germplasm.

The following recommendations were made:

1. The severity of diseases in cotton justifies the full time attention of a plant pathologist working with breeders to identify pathogens and develop artificial inoculation techniques for screening a large number of plants.
2. A seed storage facility should be established to facilitate the increase of currently available germplasm.
3. Cultural practices could be greatly improved. Research in the area of row spacing, plant population, insecticide application, and planting date should be analyzed to establish standard guidelines for different growing regions.
4. In order for the above information (no. 3) to be of value, an aggressive program of extension education must be implemented. Any program or policy which would encourage the formation of much larger farms under the direction of a single responsible farm manager has the greatest potential for improving the success of extension education and therefore cultural practices utilized and overall production.

## I. INTRODUCTION

### A. Terms of Reference

- a. To advise on cotton breeding for disease resistance (leaf roll, bacterial blight, wilt) and assisting the screening techniques.
- b. Advise in general aspects of improving cotton production (high fiber quality).
- c. Lecture on screening techniques.

### B. Background Information

#### Status of Work

The host of adversities encountered in Thailand by the growing cotton plant presents a formidable challenge to the cotton breeder to increase production through breeding for host plant resistance. The challenge is compounded by the lack of chemical control of insects and the long growing and harvest seasons.

Considerable progress has been achieved in breeding efforts to identify lines resistant to insects (especially jassid) and diseases (primarily leaf roll and wilt). For identifying lines resistant to the Fusarium wilt pathogen, a disease nursery has been established by Dr. Jinda at Tak Fa. Every location in which cotton is grown provides a site for the evaluation of resistance to the major insects encountered in Thailand. The breeding nurseries observed exhibited a high level of insect damage which was attributed primarily to the bollworm and jassid. An interesting approach to increase yield has been the selection of plants with "compensation", or the ability to produce productive monopodial and sympodial branches after the mainstem terminal has been destroyed by insects.

Efforts to increase resistance to the leaf roll disease has apparently been accomplished through breeding for plants possessing the pilose trait (dense covering of leaf hairs) which impedes aphid infestations, the suspected vector of this pathogen. Although no symptoms of bacterial blight were observed, Dr. Jinda has developed a quick and easy method of inoculating germplasm in the field. A foliar pathogen of some type (suspected to be Cercospora) was

observed to be quiet severe in some locations and in some breeding lines. Selection against the foliar pathogen has resulted in resistant lines. A method of inoculating healthy plants from infected plants with the leaf roll virus in the greenhouse appeared to be a promising technique for screening germplasm for resistance. Improved resistance to diseases and insects in current breeding lines provide evidence of progress in current selection techniques.

The few cotton cultivars currently available to the Thai farmer are characterized by medium to good fiber quality in terms of the world market. A mutant from an irradiated Deltapine cotton has been utilized as a source of good fiber quality and yield. There is room for improvement in fiber quality, however, there tends to be a decrease in yield when improving fiber quality, and it appears that greatly increasing fiber quality should not be at the top of list of priorities in view of the problem with diseases, insects, cultural practices, and low yields.

#### Staffing

The staff at each location visited were gracious and appeared to be well educated in their area of expertise. Although most disciplines appeared to be represented, research in the area of insect and disease control needs to be given a higher priority. The severity and incidence of cotton diseases justifies the full time attention of a plant pathologist. It is believed that the commonly observed wilt in cotton is caused by Fusarium oxysporum f. sp. vasinfectum (Atk.) Snyder & Hans, however, this needs to be confirmed through isolation before seeking germplasm specifically for fusarium wilt resistance. In addition, it should be determined if nematodes play a significant role in the wilt disease in the cotton growing regions and how the nematodes are distributed.

In the case of the frequently observed leaf roll disease, very little is known about the pathogen (viral) and the suspected vector (aphid). The cooperation of pathologists as well as an entomologist (to identify vector) may be required to define and characterize this economically important disease of cotton. An efficient method of artificial inoculation needs to be developed

for screening large numbers of progenies for resistance to the leaf roll pathogen.

An unidentified foliar disease (perhaps Cercospora) was frequently observed at a level of severity great enough to result in a loss of yield. This disease also needs to be investigated more thoroughly.

The general health of a cotton plant, the ability to resist pathogens, and yield potential is influenced by soil fertility. Nutrient deficiencies can often compound the problem of diagnosing a disease and should be addressed by a soil fertility expert in order that general fertility guidelines can be recommended for different locations (soil types).

#### Equipment and Facilities

The facilities observed are adequate for cotton breeding research, however, dedication to cotton pathological work may require the expansion of laboratory and greenhouse space. A plant pathology laboratory located at Kasetsart University devoted to defining and characterizing the most important diseases (wilt, leaf spot, leaf roll) of cotton would contribute greatly to the progress of genetic improvement of germplasm and provide an important subject of applied research for students. Equipment for working with viruses may be needed if not currently available.

The amount of land available or utilized for breeding purposes appeared to be a limiting factor. Large numbers of progenies and potential parental germplasm lines need to be evaluated at the Sic Samrong and Nakorn Sawan Research Centers. The rate of progress in identifying resistant lines is limited by plot space. A reliable seed storage facility is greatly needed to preserve current germplasm and for maintaining germplasm obtained from outside sources.

## II. Work Program (Chronological)

Mon Nov. 5 - Arrive in Bangkok. Visit the Department of Agriculture and meet counterpart, staff, National Chief Technical Advisor, and Chief Technical Advisor UNDP/IAEA. Began a 5 day tour, 07 3 hosted by Dr. Jinda, Dr. Siripong, and Dr. Srisuk, of cotton research and production in the area North of Bangkok. Traveled to Tak Fa to visit with the owner of a local cotton gin and discussed how cotton was purchased from the farmer, and what factors (moisture content and color) determined the price. We also discussed the owners role in promoting cotton production through the establishment of credit and supplying of chemicals. A wilt disease nursery was located directly across from the gin. Plants with both vascular and foliar disease symptoms were observed. Discussion with the counterpart revealed the lack of characterization of these two prominent diseases in Thailand.

Tues Nov. 6. - Visit Si Samrong Field Crops Experiment Station and meet director to discuss problems of cotton production. Assisted counterpart in making plant selections in his breeding material. A severe level of insect damage was observed and the advantages and disadvantages of pilosity as a resistance mechanism were discussed. The leaf roll disease was also observed at this location. The lack of knowledge concerning the causal agent, a virus, and its vector were discussed.

Wed Nov. 7 - Observed local cotton production in Sukhothai Province. Discussed problems of extension education of the farmer concerning the application (timing and rate) of insecticides to cotton with the staff at Ban Dan Loi Hoi Agricultural Extension Office. The extension staff stressed the difficulty in getting the farmer to comply with recommendations even with aid of demonstrations and free insecticides. Toured the Moser Horticultural Experiment Station to observe the wide range of agricultural crops grown in the "Hills" and the unique production practices associated with each.

Thur Nov. 8 - Visited the Chai Nat Field Crops Research Center and discussed the use of biotechnology (embryo rescue) in Mungbeans to recover germplasm from interspecific crosses. Toured the Nakhon Sawan Field Crop Research Center and discussed the possibility of short season cotton production with the director. Apparently more research needs to be conducted in the area of date of planting if this information is not currently available for local conditions. The possibility of utilizing a faster maturing cultivar with a later planting date was discussed. Meet and discussed with the agronomist the potential use of a plant growth regulator as method of increasing insecticide coverage and efficiency. Assisted the counterpart in making plant selections from segregating material in his breeding nursery. A relatively high incidence of disease (leaf roll) and insect damage (late and early season) was observed. The difficulty in selecting the best genotypes under such conditions was discussed. Visited with a local cotton merchant to discuss how a farmer sells his cotton and what problems are encountered.

Fri Nov. 9 - Visited Suphumburi field Crop Research Center to observe cotton research plots. Visited the Plant Genetic Engineering Unit at Kasetsart University. Discussed the application of biotechnology (Bt. gene and nuclear-polyhedrosis virus) to cotton with the director.

Sat Nov. 10 - Free

Sun Nov. 11 - Free

Mon Nov. 12 - Presented a one day seminar on USA Cotton Production, Research, and Breeding for Disease Resistance to the faculty of the Department of Agriculture, Field Crops Research Institute. Discussions following the seminar focused on screening techniques. Meet the senior cotton breeder from the Nakhon Sawan Field Crop Research Center and discussed the problem of a lack of germplasm in Thailand for breeding purposes.

Tues Nov. 13 - Toured Chiang Mai hosted by Virod Kitisri.

Wed Nov. 14 - Visited with Head of Administrative Offices (former cotton breeder). Discussed reasons for the decline of cotton production in Northern Thailand and the loss of the 1985 cotton crop due to the leaf roll disease. Discussed production practices (intercropping) and cultivars planted.

Thur Nov. 15 - Visit cotton hand loom operation outside of Chiang Mai and discuss operation with owner.

Fri Nov. 16 - Observed cotton research plots at Chiang Mai field Crops Research Center in Phrao. Discussed with Head of Administrative Offices research concerned with row spacing, intercropping cotton with peanuts, and insecticide application. Examined plots of G. barbadense, a species which may have a place in cotton production in parts of Thailand. Visited a local cotton farmer to observe production practices and view the condition of the cotton crop. Meet with a local cotton merchant in Fang to discuss buying and selling cotton, and problems of fiber quality (the farmer picks and mixes very poor cotton with the good cotton).

Sat Nov. 17 - Visited several cotton fields near Fang to observe production practices and the condition of cotton. Observed cotton planted with mango trees and also cotton planted on rather steep hillsides. Severe insect damage (both bollworm and jassid) was observed in each field.

Sun Nov. 18 - Return to Bangkok. Meet with buyer for textile company in Bangkok to discuss the importance of fiber quality and the social and economic variables which limit cotton production. Discussed with counterpart the general status of the typical farmer (economics, size of operation, education, and traditions) that hinders significant cotton production increases.

Mon Nov 19 - Toured the operation of a Bangkok roller gin mill.

Visited with the Managing Director about the difference in quality of lint ginned by a saw gin versus a roller gin, fiber requirements, and the problem with poor quality cotton.

Tues Nov. 20 - Visited the Division of Plant Pathology and Microbiology laboratory and greenhouse and discussed the mutation breeding work being conducted by pathologists on mulberry. Preparation of report.

Wed Nov. 21 - Preparation of report.

Thur Nov. 22 - Preparation of report.

Fri Nov. 23 - Preparation of report.

Sat Nov. 24 - Depart Bangkok

### III. CONCLUSIONS AND RECOMMENDATIONS

#### A. Government

In summary, funding for cotton research and extension indicates that significantly improving cotton production in Thailand is not a top priority. This conclusion is drawn from the apparent lack of a coordinated effort by experts (breeders, pathologists, entomologists, soil scientists, nematologists, and extension staff) acting as a team with common interests. This is not due entirely to a lack of cooperation but rather a lack of scientists (as a result of funding) to adequately covers all the crops grown in Thailand. A breeder cannot carry out all phases of germplasm improvement alone.

The evaluation of the potential value of germplasm requires testing over numerous locations. Restrictions on availability of plot space and support for travel will greatly hinder the rate of progress in breeding.

It is suggested that the Plant Genetic Engineering Unit at Kasetsart University, Kamphaengsaen, Nakorn Pathom, be greatly encouraged and supported to pursue the possibility of developing the technology necessary to transfer host plant resistance genes (such as the "Bt." gene) into cotton.

The education of the common cotton farmer appears to be a significant factor influencing cotton production. It is recommended that an all out effort be made through various programs to educated the farmer on proven cultural practices (row spacing, planting date, chemical application, harvesting etc.). It is realized, that with numerous small farmers, extension education success may be limited, therefore, any program to encourage the incorporation of larger farm operations with a single responsible manager would probably have the single greatest impact on improving production. Any new practice is slow to gain acceptance among farmers in any country, however, if it is proven successful, traditional practices should be discarded.

## B. Counterpart Institution

Counterpart researchers in cotton are spread relatively thin in view of the challenge at hand. In terms of breeding for improved cultivars, the cotton growing regions of the country should be divided according to climate (or cultivar x environmental interaction), such as North and South, and less widely adapted cultivars developed. The collection of available germplasm should be greatly increased, provided a seed storage facility is provided.

The pilose trait utilized for imparting resistance to the virus vector results in increased susceptibility to the bollworm. If an efficient method of screening for resistance to the leaf roll virus can be developed, it is suggested that germplasm with a mechanism of resistance other than the pilose trait be sought after.

Fiber quality must be at a level acceptable to the market but the first priority in breeding should be in the area of production or lint yield (regardless of percent ginturn) to insure survival of the cotton farmer. This implies that identification of host plant resistance should be top priority. What the farmer wants in terms of plant structure or growth habit type may not be the most economical plant to grow, therefore it is suggested that more consideration be given to genotypes with different growth habits (earliness, determinant, more compact plant, etc.). Early or fast maturing genotypes should be more thoroughly investigated (in conjunction with planting date) as a measure to reduce insect damage and reduce the risk of growing cotton.

C. Agency

The current IAEA/UNDP project is near termination, should the project be extended or a similar project developed, it is suggested that funding be directed towards areas identified in current projects as top priorities. For example, it will be difficult to make significant progress in breeding for leaf roll resistance utilizing a source of resistance other than pilosity, without the aid of a pathologist and laboratory. This in turn will require the establishment of a seed storage facility for preserving germplasm from sources outside the country and for newly developed lines.

Ted P. Wallace  
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IAEA Expert  
5 November - 24 November 1990

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## ANNEX

## LIST OF PERSONS CONTACTED AND INSTITUTIONS VISITED

<u>Name</u>	<u>Position</u>	<u>Institution</u>
Vichitr Benjasil	Director	DOA - Bangkok
Amnuay Tongdee	Director	DOA - Tak-Fah
Srisuk Poonpolgul	Pathologist	DOA - Bangkok
Payon Koumpai	Cotton Breeder	DOA - Tak-Fah
Sman Keoboonrueng	Pathologist	DOA - Bangkok
Jittiwan Mahisarakul	Nuclear Scientist	DOA - Bangkok
Dhanit Sophanodora	Agronomist	DOA - Suphumburi
Chuteemun Panichsukpatana	Pathologist	DOA - Bangkok
Hansa Chakrapan	Physiologist	DOA - Bangkok
Amphai Satrusajano	Soil Scientist	DOA - Bangkok
Manoon Poomklom	Head Admin. Office	DOA - Chiang Mai
Virod Kitisri	Staff	DOA - Chiang Mai
Siripong Kumchai	Pathologist	DOA - Bangkok
Jinda Janorn	Cotton Breeder	DOA - Bangkok
Carl Lamm	Chief Tech. Advisor	UNDP/IAEA THA/85/004
Patoom Snitwongse	Nat. Chief Tech. Adv.	UNDP/IAEA THA/85/004
Somchai Kirdpanich	Managing Director	Bangkok Ginning Mill Ltd.
Panor Prigsuwan	Cotton Merchant	The Thai Textile Co Ltd.
Supat Attathom	Dir., Plant Engineering	Kasetsart University
Pornpimol Chaiwanakupt	Head, Isotope Lab.	DOA - Bangkok