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PROCEEDINGS

Crop Improvement in Eastern and Southern Africa

Research Objectives and On-Farm Testing

A regional workshop held in Nairobi, Kenya, 20-22 July 1983

CANADA

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Crop Improvement in Eastern and Southern Africa:

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Editor: Roger A. Kirkby

RÉSUMÉ

Un atelier a réuni un petit groupe représentatif de scientifiques travaillant à des programmes d'amélioration des cultures alimentaires en Afrique orientale et australe, pour discuter de la planification, de la conduite et de l'élaboration de ces programmes. Le débat a porté surtout sur les aspects méthodologiques, communs à la majorité des cultures réalisées par les petits fermiers et les plus susceptibles de permettre l'utilisation des résultats de la recherche.

On s'intéresse donc ici aux cultures locales et aux pratiques culturales, à l'organisation de l'aide institutionnelle pour améliorer les cultures, aux objectifs particuliers des programmes et au mode d'établissement de ces objectifs, enfin aux méthodes d'évaluation employées pour formuler une nouvelle recommandation sur les travaux de vulgarisation. On résume aussi la séance de discussion qui a porté sur l'organisation des programmes d'amélioration des cultures, l'établissement des objectifs techniques, l'application des critères de sélection, la méthodologie pour les essais tous terrains et sur les fermes et, enfin, l'orientation de la recherche.

RESUMEN

Este seminario reunió un pequeño grupo representativo de científicos que trabajan en programas de mejoramiento de cultivos alimenticios en Africa oriental y meridional con el ánimo de discutir la planificación, la ejecución y el desarrollo de tales programas. El énfasis de la discusión recayó en aquellos aspectos metodológicos, comunes a la mayoría de los cultivos sembrados por los pequeños agricultores, que tienen la probabilidad de influir más en que los resultados de la investigación sean utilizados por el agricultor.

Entre estos trabajos se encuentran breves recuentos de las variedades locales y las prácticas de cultivo empleadas actualmente, la organización institucional para el fitomejoramiento, los objetivos específicos de los programas y su sistema de establecimiento, así como los procedimientos de evaluación empleados para llegar a las nuevas recomendaciones para los trabajos de extensión. También se incluye en este volumen un resumen de la sesión de discusión sobre la organización de los programas de fitomejoramiento, la fijación de los objetivos técnicos y la aplicación de los criterios de selección y la metodología para las pruebas tanto en fincas como en localización múltiple. Varios temas de política fueron identificados.

CONTENTS

PULSE AND GROUNDNUT IMPROVEMENT IN TANZANIA

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Early man recognized the value of legumes as food for both human and animal consumption. Legumes are important because they are rich in protein. This is especially true of their seeds, which in many species contain 20-30% protein by weight, although up to 50% protein by weight has been reported in some soybean cultivars. Legumes that are cultivated for their mature seeds, for human consumption, are called pulses or grain legumes.

In addition to their importance as food, legumes are important because they replenish soil nitrogen. Nitrogen is the most limiting factor in primary production in spite of the fact that it is one of the dominant elements in nature, in the form of elemental dinitrogen (N_2). This form of nitrogen is unavailable to plants until it is converted into utilizable forms. There is an ever-increasing demand for nitrogen to maintain soil productivity. The global consumption of nitrogen fertilizer in 1973 was 40 million metric tonnes and it is estimated that the requirement for nitrogen fertilizer will be 200 million metric tonnes by the turn of the century (Hardy and Havelka 1975).

Tanzania, occupying an area of 930 000 km^2, contains different agroecological zones ranging from wet humid tropics to dry semi-arid areas. Due to its diverse ecology, it is well suited to growing different types of grain legumes. Prominent among them are kidney bean, groundnut, cowpea, soybean, green gram, pigeon pea, chick-pea, and bambara nut. These grain legumes are grown mainly for local consumption. However, attempts are being made to increase their production to alleviate protein deficiency among Tanzanians and to use some of them for oil extraction as well as for export. Unfortunately, there has not been much success in this direction, resulting in high market prices.

In view of the importance of grain legumes in Eastern African countries, in general, and Tanzania, in particular, coupled with their low productivity and high demand, a research project was developed in 1979. The project envisaged the inclusion of four grain legumes, namely: groundnut, soybean, green gram, and bambara nut. The choice of these legumes was based on the desire to keep the project at a

manageable level. As well, some of the other grain legumes were included in other projects.

The broad objectives of the project were germ-plasm collection, evaluation, and, where necessary, to breed suitable varieties for the different agroecological zones of Tanzania. The specific objectives included: (1) development of cultivars that are high yielding, with high protein and oil content (groundnut and soybean), (2) development of early- and late-maturing varieties suitable for the different agroecological zones of the country, (3) incorporation or identification of drought resistance, (4) development of insect- and disease-resistant cultivars, (5) development of an agronomic package for farmers, and (6) training of personnel.

It may be pertinent at this point to deal with one crop in some detail instead of discussing all four legumes. This is because the methodology used for all of these crops is similar and the progress made also follows along similar lines. Therefore, this paper will review the progress, problems, and future of soybean improvement research within the scope of the project.

BACKGROUND TO SOYBEAN IMPROVEMENT RESEARCH

Soybean (Glycine max (L) Merrill) is said to be as old as the 5000 year old Chinese civilization (Senanayake 1982). It appears that it took about 4900 years for soybean to arrive in Tanzania (then Tanganyika), when it was first introduced in 1907 at Amani by Germans. Further introductions were made in 1909 (Auckland 1970; Mbaga 1974). Soybeans have since been grown at different times and places in Tanzania. During World War II, the British tried unsuccessfully to grow soybean in Kagera region. The low yields obtained could be attributed to poor varieties.

A renewed attempt was made to develop suitable soybean varieties at Nachingwea in 1955 and this program culminated with the development of varieties in 1963 that were suitable for low altitudes (0-900 m above sea level). Currently, most of the soybean is growing in Mtwara, Lindi, Kilimanjaro, and Morogoro regions (Anonymous 1974). Soybean is grown in monoculture as well as under intercropping.

PROBLEMS OF SOYBEAN PRODUCTION IN TANZANIA

Soybean has not been a popular crop in Tanzania, but it is becoming increasingly attractive to the peasant farmer as a result of some improvement in the pricing and marketing policy of the government. These improvements are in response to rising demands for vegetable oil, a protein source, and animal feed (Makena and Doto 1982). The current drive to boost soybean production is aimed at maximizing the full utility of the crop.

One of the major problems facing soybean is the lack of suitable varieties for the different agroecological zones of the country as well as poor nodulation with indigenous rhizobia. The latter problem is exacerbated by the uneconomic use of chemical fertilizers. Therefore, the present project was designed to address these problems and devise appropriate solutions.

INSTITUTIONAL ORGANIZATION OF THE PROJECT

The major portion of the investigations is conducted at the farms and laboratories of the Faculty of Agriculture, Forestry and Veterinary Science, University of Dar es Salaam, Morogoro. The faculty has a well-established farm of over 2300 ha in addition to well-equipped laboratories and supporting technical, laboratory, and field staff.

The pulses and groundnuts project funded by the International Development Research Centre (IDRC) is under the leadership of Dr. B.J. Ndunguru, who also serves as the legume agronomist. Responsibility for the success of the project also rests with the plant breeder because the major emphasis of the project is the improvement aspect of the crop. The plant breeder enjoys the collaboration and cooperation of two plant pathologists, three entomologists, one soil microbiologist, and a statistician. Essentially, the project is handled by a multidisciplinary professional team under the leadership of the project leader.

Project implementation and evaluation is an annual event involving all collaborators. At the end of each cropping season, the results of every experiment are discussed collectively and necessary changes or amendments are made in line with the objectives of the project.

There is a fair amount of cooperation between the faculty and various national institutions involved in agricultural research, e.g., Tanzania Agricultural Research Organisation (TARO), Uyole Agricultural Centre (UAC), Mbeya, and Tropical Pesticide Research Institute (TPRI), Arusha. From time to time, collaborative research is undertaken with these organizations. As well, the faculty has enjoyed a cordial relationship with various international agricultural research institutes such as the International Institute of Tropical Agriculture (IITA), Centro Internacional de Agricultura Tropical (CIAT), International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), International Rice Research Institute (IRRI), and Centro Internacional de Mejoramiento de Maiz y Trigo (CIMMYT). This relationship has contributed to the continuing exchange of germ plasm and to the training of personnel.

PROGRAM OBJECTIVES

The general objectives of the project have already been outlined, but the specific objectives in the case of soybean improvement are the development of: (1) high-yielding, nonshattering, lodging resistant, determinate types with pods between 12.7 and 15.2 cm from the ground for mechanical harvesting; (2) high-yielding, nonshattering, lodging resistant types but with no specifications with respect to habit, as they will be harvested by hand; (3) yellow, small seeds that will bring premium prices in the oriental market; (4) high oil and protein content types; (5) short-duration cultivars to be grown under irrigation, in rotation with major crops such as rice (Anonymous 1979); (6) adaptability to local environmental conditions; and (7) resistance to insects and diseases.

SPECIFIC OBJECTIVES AND SELECTION CRITERIA USED IN THE SOYBEAN IMPROVEMENT PROGRAM

Short-Stature and Short-Duration Plants

In Tanzania, most of the soybean crop is grown under marginal rainfall conditions where the rainfall is erratic and unreliable. Therefore, it is essential to have a short-duration crop so that maximum utilization of available moisture can be made. Plants that are of short stature require minimum nutrients and moisture and are easier to harvest.

Plants with Biological Nitrogen Fixation (BNF) Ability

The soybean varieties presently available in the country with high yield potential are poorly nodulated (Chowdhury 1977). Thus, they require additional nitrogen in the form of chemical fertilizer, making the crop uneconomical. There is a need, therefore, to develop soybean varieties that can nodulate with indigenous rhizobia.

Development/Selection of Soybean Varieties Resistant to Insects and Diseases

Even if one develops agronomically acceptable soybean varieties, if they eventually fall to insect and disease damage they will have to be replaced. Therefore, along with the development of short-stature and short-duration plants with BNF ability, regular screening against insects and diseases is required.

Presently, the important soybean diseases in Tanzania are cowpea mild mottle virus (CMMV), peanut mottle virus (PnMV), bacterial pustule (Xanthomonas compestris pv. phaseoli), Cercospora canescence, and Phyllosticta glycine. Phyllody, probably a mycoplasma-like organism, has been observed in Morogoro and Ilonga for the past several years. Among insect pests, termites (Odonototermis lationotus and Odonototermes zambesiensis) cause considerable damage during drier periods. In addition, stinkbug (Nazara viridula) and aphids (Aphis glycine and A. gossypi) can be a problem.

Soybean Varieties with High Oil and Protein Contents

This criterion is mainly included in our soybean improvement program in view of the acute shortage of cooking oil and animal feed in the country.

METHODOLOGY

The soybean improvement program at Morogoro is being carried out along the following lines: (1) germ plasm collection; (2) germ plasm multiplication; (3) single-row trials for preliminary screening; (4)

replicated trials within Morogoro Region; and (5) replicated multi-location trials.

While conducting (3), (4), and (5), the following observations are taken: Disease and insect damage is assessed to identify resistant varieties. BNF ability is studied to identify cultivars/lines that have the ability to nodulate with indigenous rhizobia and, thus, fix atmospheric nitrogen. The acetylene-ethylene reduction method is an easy and fast method of testing for BNF ability (Hardy et al. 1968). Regular screening of crosses is made for oil and protein content to identify suitable germ plasm for hybridization or multiplication purposes.

SUMMARY OF METHODOLOGICAL ISSUES

Although only the soybean improvement program has been discussed in this paper, the four legumes (i.e., groundnut, soybean, green gram, and bambara nut) studied in the broader project are treated along similar lines. However, in view of logistics/manpower, transport, materials, germ plasm, and limited irrigation facilities, considerably more emphasis has been placed on groundnuts and soybean. So far, no hybridization has been conducted in the case of green gram and at present the accessions are being evaluated. Similarly, bambara nut, with only 11 accessions, is being increased. The work on groundnut and soybean is progressing well and we hope that it will continue in the future.

The grain legume improvement project is only a little more than 2 years old. Therefore, it would be unrealistic to pinpoint the specific achievements of the project. However, it may be mentioned that above-average progress has been made with respect to hybridization between soybean varieties Bossier and 1H/192. Some of the selections now in the F_8 stage are better than both parents in terms of our defined objectives, i.e., size, short duration, BNF ability, and yield (Chowdhury and Doto 1982). This material should go into multilocation trials in December 1983 and a couple of lines may be released as varieties by 1985.

In the case of groundnuts, we have a good germ-plasm collection that includes lines/varieties from India, Tanzania, Mozambique, Zimbabwe, Malawi, Zambia, Kenya, and Uganda. Initial crosses between several lines/varieties have already been accomplished and during the coming season the material should undergo further trials across other locations, apart from Morogoro.

More than 70 lines of green gram are being evaluated for various agronomic characteristics and yield. Selections from these trials will go into the hybridization process during the coming season.

The weakest area in the project is bambara nut, of which we have been able to collect only 11 samples. To pursue this crop vigorously we need to acquire more germ plasm, especially from West Africa.

Although this project is being undertaken at Morogoro, Tanzania, we aim to develop various grain legume varieties that could be beneficial not only to our country but also to other neighbouring countries (three lines of our soybeans have already been sent to the International Soybean Program (INTSOY)) with similar agroclimatic

conditions. We hope to achieve these goals with close cooperation between researchers from other countries.

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