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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

ON-FARM TESTING OF IMPROVED PIGEON PEA (*CAJANUS CAJAN* (L) MILLSP.) CULTIVARS IN KENYA

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Pigeon pea (*Cajanus cajan* (L) Millsp.) is the most important grain legume in the marginal rainfall areas of Kenya, where it covers an area of approximately 100 000 ha annually. Because of its importance in marginal rainfall areas, the pigeon pea improvement project (PPIP) was initiated in the Department of Crop Science, University of Nairobi, in 1975 to improve grain yields under marginal rainfall conditions.

Information on grain yields of pigeon pea in Kenya is lacking. Even figures on national average yields of pigeon pea for Kenya were not available. Work published elsewhere revealed that grain yields of pigeon pea varied widely. The highest pigeon pea grain yields of 7500 kg/ha have been reported by Akinola and Whiteman (1972) from Australia, where the crop was planted in pure stand under experimental conditions. In experimental plots under pure culture and irrigation, Onim and Rubaihayo (1976) reported pigeon pea grain yields of 4250 kg/ha from Uganda. Under mixed cropping in farmers' fields in Uganda, Laker (1970) estimated pigeon pea grain yields at 560 kg/ha, whereas Dunbar (1969), also in Uganda, estimated yields under similar conditions to be 168 kg/ha. Although these yield estimates may not have been accurately determined, the yield gap between the farmer and the researcher is very large. According to the reports of Dunbar (1969), Laker (1970), and Onim and Rubaihayo (1976), this gap between the researcher and the farmer in Uganda is between 659 and 2430% (difference based on farmers' yields). There can be many causes contributing to this tremendous gap. Some causes that are generally blamed on the farmers could be due to one or a combination of the following factors: (1) use of inferior crop varieties; (2) lack of inputs such as fertilizers, pesticides, or sufficient labour; or (3) poor crop husbandry, e.g., late planting, inadequate weeding, or low crop densities.

Studying the effects of these possible causes of low yields at the farmers' level and their interactions is not a simple task. It was decided, therefore, for the purpose of this study, that only one cause would be investigated. The one chosen was the use of improved seed versus the farmers' own cultivars.

DEVELOPMENT OF IMPROVED PIGEON PEA CULTIVARS

A large number of pigeon pea cultivars were collected from farmers' fields in Machakos and Kitui districts of Kenya in 1976 for inclusion in the then existing germ-plasm bank in the Department of Crop Science, University of Nairobi. This germ-plasm collection was evaluated in 1977 at the National Dryland Farming Research Station of the Ministry of Agriculture, at Katumani, and several single plants were selected and selfed. In 1973, 11 of the highest yielding single plant selections were tested further in a replicated yield trial at three research stations located in distinct ecological zones: Kibos in Kisumu, Thika in Central Province, and Kampi ya Mawe in Machakos District. The six highest yielding selections at the three locations were selected for further testing in farmers' fields in 1979.

TESTING OF SIX IMPROVED PIGEON PEA CULTIVARS IN FARMERS' FIELDS IN MAKUENI DIVISION, MACHAKOS DISTRICT

Site Selection

The assistant agricultural officer (AAO) of Makueni Division was approached and asked to select a sublocation where the six improved pigeon pea cultivars could be tested in farmers' fields. Muvau was chosen and the extension agricultural officer of Muvau was then asked to compile a long list of farmers from Muvau. In compiling the list, no selection criteria were to be used so that both better-off and poorer farmers would be included. When the list was ready, every 10th name was chosen and a total of 12 farmers were selected. These were supplied with 3 kg of pigeon pea seed of the improved cultivars (two farmers for each cultivar).

Crop Husbandry

The farmers were told to plant half of their field with the improved cultivar and the other half with their own variety. They were further instructed to use crop husbandry methods of their choice, e.g., intercropping/pure stand, spacing, weeding frequency, etc. At flowering time, the PPIP staff and the extension officer from Muvau began visiting the farmers to monitor crop development.

Data Collection

At maturity, data were jointly collected from the fields by PPIP staff, the extension officer from Muvau, and members of the farmer's family.

A quadrat measuring 3 m X 3 m was placed in a representative part of the field of the improved cultivar and the following data were collected: number of plants in the quadrat, number of wilted plants in the quadrat (wilt caused by Fusarium udum Butl.), plant height of five randomly selected plants, and number of primary branches on the five randomly chosen plants. The plants within the quadrat were then harvested. The same data were collected on the farmer's own variety. A visual estimate of the yields of both the improved and farmer's cultivars was made on the spot by direct comparison. This simply involved counting the number of paper bags (size 25) filled by each of the test cultivars. The three representatives from the project, extension service, and farmer's family then agreed on which of the two

cultivars performed better in the particular field. Eight of the 12 farms were harvested successfully in this manner.

The rest of the field of the improved cultivar was harvested separately and threshed on the spot. The produce was weighed and the farmer was paid for it 2 weeks later.

The pods from the quadrats were taken back to Nairobi where more data were obtained, including: the percentage of pest-damaged pods and seeds, the 100-seed weight, and grain yield from the quadrat. These data were then converted to yields per hectare.

Results

Of the 12 test farmers, four harvested the improved cultivars before we arrived. Therefore, these were not included in the results. In one or two cases, the fields were not properly weeded. In other respects, the experiment was considered to have been well executed.

Some of the data on the improved and farmers' cultivars are presented in Table 1. Plant densities used by the farmers for both their varieties and the improved cultivars were similar in all cases; therefore, a mean of the two estimates has been used for each field. Comparisons between the farmers' and improved cultivars did not show major differences among any of the characteristics measured except grain yields. The mean grain yield of the improved cultivars in eight fields was 2637 kg/ha, whereas that of the farmers' cultivars was 1361 kg/ha. The improved cultivars, therefore, yielded more than the farmers' cultivars by 93.8%. The two varieties with the best grain yield yielded 4262 and 4602 kg/ha respectively. Two of the improved cultivars, however, broke down with Fusarium wilt. In the same fields, the farmer's cultivar suffered a mild attack in one case, whereas in the other the farmer's cultivar showed 100% resistance. In both cases, the farmers were fully compensated for the lost yields due to the susceptibility of the improved cultivars.

The extent of pest damage in the farmers' fields was much lower than had been anticipated. Moreover, the level of pest damage seemed to be much lower in the farmers' fields, with means of 9.2 and 2.5% for pods and seeds, respectively, than the 20.6 and 5.3% obtained for pods and seeds, respectively, under research station conditions (Table 1). From the results of this study, three cultivars were selected for further prerelease testing in farmers' fields. Two kilograms of seed of two of the best yielding cultivars were distributed to 300 farmers in Muvau sublocation for the October 1980 planting, while these high-yielding selections and one more were given to 12 farmers (three farmers per cultivar) in Kitui District for a similar pilot trial -- researcher-farmer cooperative trials -- as was done earlier in Muvau.

The results from this study indicated that more information should be made available on this crop at the farmers' level. Therefore, two surveys were conducted in Machakos and Kitui districts in 1979 and 1980. The primary objectives of these surveys were to determine grain yields of pigeon pea at the farmers' level in Kenya, and estimate losses due to diseases and pest damage on pigeon pea in farmers' fields. Quadrats measuring 3 m X 3 m were used, as described earlier, and similar data were collected. In both surveys, pigeon pea fields approximately 20 km apart along major and medium-sized roads in

Table 1. Plant densities and comparison of grain yields, 100-seed weight, and pest damage between farmers' varieties and improved pigeon pea cultivars in farmers' fields in Kenya.

Field no.	Plant population/ha	Grain yield (kg/ha)		100-seed weight (g)		Pest damage (%)			
						Pods		Seeds	
		Farmer's	Improved	Farmer's	Improved	Farmer's	Improved	Farmer's	Improved
1	11100	1014	1515	22.64	20.47	10.6	5.6	3.0	1.2
2	21100	2093	2197	24.66	19.87	15.5	6.7	3.1	2.0
3	34400	1251	2567	22.16	25.06	7.8	9.8	3.2	3.2
4	14400	731	4262[a]	21.25	17.32	9.0	9.0	3.0	5.0
5	32200	2150	2476[a]	21.72	22.84	3.6	9.5	1.0	2.4
6	23300	1763	4602[a]	22.88	24.08	12.3	4.2	3.5	1.5
7	22200	804	1418	25.57	22.42	13.3	10.0	3.0	3.3
8	22200	1081	2019	24.34	21.42	8.3	10.9	2.7	3.1
9[b]	35600				20.60		22.2		6.9
10[b]	37800				23.60		18.9		3.8
Mean	25430	1631	2637	23.15	21.77	10.1	10.7	2.8	3.1

[a] Cultivars selected for further prerelease testing.

[b] Improved cultivars planted at recommended plant density at Kampi ya Mawe Research Substation.

Table 2. Plant densities, height, number of primary branches, grain yields, and pest damage of pigeon pea in farmers' fields in Kenya.

Field no.	Population/ha		Plant height (cm)		Number of primary branches		Grain yield (kg/ha)		Pest damaged pods (%)(1980)
	1979	1980	1979	1980	1979	1980	1979	1980	
1	23300	11100	347.4	289.0	25.6	17.8	1028	1014	10.6
2	12200	21100	305.6	284.6	27.0	19.6	1186	2093	15.5
3	43300	34400	345.2	259.2	22.6	19.2	1242	1251	7.8
4	18900	14400	274.8	306.0	19.4	28.0	1450	731	9.0
5	17780	32200	333.8	252.2	22.8	19.2	1903	2150	3.6
6	11100	23300	339.4	239.0	26.0	24.6	1532	1763	12.3
7	21000	22200	288.2	217.2	19.4	12.2	1600	804	13.3
8	12200	22200	259.6	293.4	19.2	21.4	1431	1081	6.3
9	10000	35600	263.2	289.0	21.2	23.8	1191	606	22.2
10	11100	37800	264.8	271.8	19.4	14.2	2493	1012	18.9
11	10000	41100	272.2	284.0	23.8	15.2	1229	1553	5.4
12	21100	17800	368.0	213.0	28.0	12.8	2136	691	25.4
13	25600	33300	331.0	199.6	26.6	11.6	980	699	14.5
14	24400	17800	345.6	253.8	26.2	18.8	1019	862	17.0
15	15600	14400	343.0	243.6	26.4	18.0	1868	729	12.0
16	28900	64400	291.6	245.2	24.4	14.2	938	516	15.7
17	18900	10000	325.4	274.4	25.0	18.4	1449	1286	19.5
18	13300	25600	334.2	289.0	30.4	17.2	1866	1186	14.4
19	12200	20000	336.6	301.2	25.6	19.2	1153	2018	13.4
20	31100	18900	351.2	321.6	27.0	18.6	2202	1192	7.3
21	22200		357.8		26.4		1931		
Mean	19251	25900	318.0	266.4	24.4	18.2	1492	1162	13.6

Machakos and Kitui districts were surveyed. Twenty-one fields were surveyed in 1979 and 20 in 1980. The results of these surveys are presented in Table 2.

The mean population density used by farmers in Machakos and Kitui districts in 1979 and 1980 was about 22 600 plants/ha. This density gave mean grain yields of about 1300 kg/ha over the 2 years. The mean plant height was 292 cm and the number of primary branches was 21 over the 2 years, whereas the mean pest damage to pods in 1980 was 14%.

DISCUSSION

The large yield gap between the researcher and the farmer should be narrowed. This can be tackled from two possible angles: (1) Researchers should continue their research at research stations but cost their inputs and view the realized yields on an economic basis. (2) Researchers should test their recommended crop packages in farmers' fields using the farmer's own production system. In this study, both approaches have been used and the results have had a very large impact on the farmers. The wisdom of farmers and their farming experience is often underrated by research workers. Two examples of the farmers' wisdom and expertise have clearly emerged from this study. In the first case, two of the improved cultivars broke down in the farmers' fields with Fusarium wilt, whereas the farmers' own cultivars were able to withstand the disease. In one case, the farmer's cultivar was 100% resistant, whereas the improved cultivar was 100% susceptible. Farmers have had very high disease levels in their fields over the years and they have been selecting for resistant cultivars all along. The farmer has come up with a very resistant cultivar to this wilt disease. We have leased this particular farmer's field to use as a disease nursery for screening germ plasm for Fusarium wilt resistance.

The second case concerns the choice of plant population. The recommended spacing for pigeon pea in Kenya is approximately 40 000 plants/ha. This density is too high for a marginal rainfall area. The farmers, on the other hand, use lower densities. In 1980, the recommended densities (field numbers 9 and 10 in Table 2) resulted in a mean lower yield of 809 kg/ha compared with the overall farmers' average of 1200 kg/ha.

The results presented in this paper indicate that by giving the farmer improved cultivars, yields can easily be doubled. The results obtained in the farmers' fields with their own efforts and inputs are much more convincing to them, and adoption of such cultivars by farmers should be much easier than those released by research stations. The results also show that pigeon pea yields at the farmers' level in Kenya are very high. This makes the estimates of Dunbar (1969) and Laker (1970), in Uganda, rather doubtful.

Pest damage at research stations tends to be higher than in the farmers' fields. There are many reasons for this. This study seems to have brought out this fact, as is shown in Table 1. It is important, therefore, that before making blanket recommendations, which emanate from research stations, researchers should appraise the situation in the farmers' fields.

Finally, this study has been a learning process for both the farmer and the researcher -- a fact that is very encouraging.

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