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Effect of inter-row spacing and plant stand per hill on the yield of cowpea.

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Abstract

Field experiments were conducted to determine whether change in inter-row spacing and plant stand per hill affects grain yield of the new improved cowpea lines. Yield was used to determined the best inter-row spacing and plant stand per hill for three new improved high yielding cowpea Vigna unguiculata lines at Serere Agricultural and Animal Production Research Institute (SAARI). Three inter-row spacing (30 x 30, 45 x 30, and 75 x 30 cm) were compared with the recommended spacing of 60 x 30 cm, while one plant per hill compared with two plants per hill. The widest inter-row spacing (75 x 30 cm) gave the lowest yield in the three lines. The same trend was observed in both first and second rainy seasons. The highest yield was obtained at a spacing of 45 x 30 cm. Under this spacing (45 x 30 cm) one plant per hill resulted in higher yields, while under 75 x 30 cm, spacing two plants per hole gave the highest yield. Thus a spacing of 45 x 30 cm appears to be the optimal for the three cowpea lines, with one plant per hill instead of two plants. Line DVTB consistently out yielded DVTA and DVT. Lighter rains of second rains of 1997 favoured cowpea grain yield resulting in highest yields obtained in this season. The effect of seasons on the three lines was not consistent.

Key words: Inter-species competition, plant population, *Vigna unguiculata*

Introduction

Cowpea *Vigna unguiculata* is the third most important grain legume crop in Uganda. It is particularly grown in the districts of Northern, West Nile and Eastern regions of the country. It is grown in an estimated 58,000 ha (MAAIF, 1997) giving grain yield of 48,000 metric tons. Cowpea is consumed in various ways the tender leaves make good vegetable which can be boiled and eaten, groundnut or sesame paste is often added. The green tender pods can be boiled and eaten, while the dry grain can be boiled whole or dehulled and split and boiled to make stew to be eaten with cereal foods or root crops like cassava and sweet potatoes.

Despite its immense importance, cowpea yields in farmers' fields are low. In a recent survey (Sabiti *et. al.* 1994, Anon., 1995), it was established that one of the main reasons for low yield of cowpea in Uganda was poor spacing. Farmers plant cowpea by broadcasting the seed, resulting in some parts of the field to have either very high or low plant population, (Mye, 1940; Anonymous, 1995).

In Uganda, some experiments have been carried out to assess the effect of spacing on the grain yield of cowpea. Masefield (1946) reported that the spacing of 60 x 30cm gave significantly better yields than the spacing of 30 x 30 cm. Mehta (1970) found out that close spacing (23 x 23cm and 15 x 15cm) depressed yields, but found no significant difference in grain yield with spacings of 30 x 30, 45 x 45, 60 x 30, and 60 x 60 cm. However, Mehta's experiments were performed in one season. Kayode and Odulaja (1985) working on inter- and intra-row spacing in Nigeria reported 60 x 20 cm spacing to be optimal for cowpea production, but this may not be applicable to Uganda's case because of difference in soil types and climatic conditions. In all these studies, the effect of plant stand per hill on yield was not assessed. With the introduction of high yielding cowpea varieties, there is need to determine the optimum inter-row spacing and plant stand per hill (hole) since spacing depends on the growth characteristics of the cultivar. The objective of this research, therefore, was to establish the appropriate plant stand per hole and optimal inter-row spacing for the three high yielding cowpea lines due for release to farmers.

Methods and materials

The study was carried out at Serere Agricultural and Animal Production Research Institute (33° 27' E, 1° 31' N, 1000 m above sea level) during the second rains of 1996, first and second rains of 1997. Mean monthly rainfall during the experimental period averaged 171.4, 137.9 and 112.7 mm while average temperatures were 27.0, 28.6 and 29.1°C for the three seasons, respectively. SAARI soils are Ferrallitic, i.e. have characteristics of Ferralsols which are weathered tropical soils with kaolinite mixed with clay mineral and with total cation exchange capacity of less than 16 me per 100g clay and poor in bases (K, Ca, and Mg). Two experiments were conducted in this study as explained below:

collection was resumed by the breeder in 1960 collecting from individual farmers, open markets and shops throughout the country. The only passport data recorded was geographical origin, local variety name, seed colour and size. By 1984 a total of 204 landraces were collected, mainly of *Phaseolus vulgaris* but also with a few samples of *P.lunatus*, *P.acutifolius* and *Vigna mungo*. As the hybridisation programme progressed, 130 breeding lines (K- series) and 445 introductions were added to the collection. Unfortunately most of this material was lost in the 1982-85 period of civil strife (Male-Kayiwa et al, 1992)

However more germplasm got introduced in the country unofficially and farmers continued to nurture the diversity thus obtained, while at the same time natural selection favoured some genotypes over others.Collection was resumed in 1986 covering most districts in the country , with samples obtained from individual farmers, markets, shops and from agricultural extension staff. In addition numerous breeding lines of different nurseries were obtained from CIAT and other collaborators on bean research especially within East, Central and Southern Africa region. However, not all acquired breeding lines are retained in the collection. Presently (1998) over 600 accessions are in the collection. The collection carried out in the period 1986-1997 represent a wide range of seed types, some of which were collected as mixtures while most were obtained as pure lines. Nearly all districts of the country have representative samples though some districts have more entries than others, depending on the accessibility as well as the importance of the bean crop in the area. Collection focuses on varieties grown by the farmers, which usually constitute a rich source of adaptation to local conditions.

Germplasm diversity

High yielding improved varieties increase average grain yield per hactare as well as the national production. However, with introduction of improved cultivars generally the genetic diversity gets eroded. A survey of 29 districts in Uganda revealed that 135 distinct landraces and cultivars were in use (Grisley and Sengooba, 1993), dominated by Calima seed types, large kidneys and sugar type Kanyebwa. The diversity is further exemplified by the numerous names of the different bean landraces/ varieties though in some cases the same variety would have several names while in other cases different varieties could mistakenly be referred to by the same name. The variation represents both the Andean and Mesoamerican gene pools.Diversity on farm was most prevalent in South-western Uganda where varietal mixtures are more common than in other parts of the country. Another formal survey (Mugisa-Mutetika et al,1995) conducted in districts of Kampala, Mpigi, Iganga and Kabale revealed that domestic food requirements, bean diseases and poor yield were the major factors that led to loss of local germplasm. Farmers tend to resort to local markets for bean seed, whereby some of the varieties purchased are new ones commercially introduced from neighbouring countries e.g Tanzania, Rwanda, etc. Researchers' on-farm variety trials have also introduced diversity on farmers fields and some of the introduced varieties have been recovered in collections. Retention of introduced varieties and their spread is governed by the fact that farmers produce and exchange seed.

Patterns of genetic variation are known to arise from climatic, edaphic, biotic and/or human factors. Therefore the diversity noted within the present bean collection is a reflection of these factors. For example early maturity is highly desirable in areas where rainfall is unreliable and unevenly distributed, while the late maturity is mainly associated with intercrops and long growth cycles. Seed size is another highly variable character with regional preferences reflected. However, inspite of the expressed preferences e.g large seed in most areas apart from the northern region, the seed sizes are found within mixtures grown countrywide. The same applies to seed colours, though reds are most preferred countrywide while blacks predominate in northern Uganda and large white are preferred in Arua region areas bordering Congo. If seed colour and seed size are considered together, the composition of varietal mixtures is in the range of 4 - 24 individual components. Farmers selection criteria include characteristics such as yield, taste, disease resistance, cooking time, maturity period, seed colour and size, growth habit, marketability, etc (Ugen and Wortmann, 1994). Though a number of farmers in different districts grow the lima bean (*Phaseolus lunatus* L.), germplasm of this crop is not assembled since it is ranked low in importance as a crop countrywide.

Characterisation based on agromorphological characters e.g growth habit, flowering dates, pigmentation, seed and pod characteristics, reaction to diseases and pests, tolerance to edaphic factors, etc has revealed a lot of variation. A large array of seed colour and seed size are evident, while the highest percentage of accessions are of bush growth habit Type I or II. The climbing beans are commonly from south-west Uganda and a few introduced lines from Rwanda and CIAT. As a general rule the climbers in south-west Uganda are mostly grown as mixtures.

Germplasm conservation

Simple low-cost technology based on seed drying with silica gel to low moisture which was developed for medium term storage of bean germplasm is utilised in bean germplasm conservation(Fischler, 1993). Development of this technology was necessitated due to power failures and equipment breakdown associated with low temperature storage normally utilised in genebanks. Two bottled bean seed samples per accession are stored at room temperature at Kawanda Agricultural Research Institute in collaboration with CIAT. Regeneration, as is the case for medium term storage, is undertaken after five years in storage. The trials carried out in 1993 and 1995 showed that 85% seed viability was achieved with this method.

Germplasm utilisation

The overall reason for establishing and maintaining a germplasm collection is its potential use in breeding. Bean germplasm is evaluated for adaptation, yield and reaction to stress i.e diseases, pests, and nutrient stress. Selected landraces or breeding lines are used as parents in the hybridisation programme depending on the required character combinations. For example variety K20 had landrace Banja 2 and introduction Dicol Nima within its pedigree as a resistance source for anthracnose disease. This variety K 20 has spread in many East and Central African countries where it has shown high yield and wide adaptation.

Presently a breeding programme to incorporate resistance to bean common mosaic virus, common bacterial blight and angular leafspot into popular landraces Kahura and Kanyebwa and also improvement on multiple resistance of released varieties is under way. Some crosses utilising some introduced CIAT breeding lines and the above mentioned landraces were also made targeting improved nitrogen fixation. The effort to improve on yield per unit area is continuous and parents to be complemented are selected from within the germplasm.

Introduced germplasm has been screened for superior well adapted genotype to release and as a result varieties K 131 (MCM 5001), K 132 (CAL 96), MCM 2001, MCM 1015, OBA 1 have been released while DRK 57, SUG 73 and POA 2 are scheduled for release. All these came in from CIAT. The selection is based mainly on early maturity, acceptable seed size and colour and resistance to most prevalent bean diseases. Climbing bean breeding lines introduced from Rwanda between 1988 - 92 have been evaluated and some lines e.g Vunukingi, Ngwinorare, Gisenyi and Umubano (G 2333) are due for formal release. Evaluation of germplasm is undertaken from time to time as new production constraints (e.g root rots in Kisoro district) are identified and parents are identified within the germplasm. Evaluation of climbing bean genotypes most suited to the lowland areas is being undertaken in Mpigi and Kampala districts. So far an introduction from Rwanda proved high yielding in both highland and lowland areas and is also scheduled for release.

Concluding remarks

Though a lot of germplasm has been assembled its characterisation has been limited as more emphasis in the breeding programme has been on elite lines evaluation for faster releases. The characterisation based on agromorphological data cannot be satisfactorily used to sort out duplicates within the collection. More detailed seed protein or isozyme analysis is essential to sort out similar materials and thus reduce the collection to manageable levels within the resources available. The usefulness of germplasm in bean breeding cannot be underrated especially taking into account the continuous demand for an improved version of the most popular tasty landraces Kanyebwa and Kahura. With continuous introduction of breeding lines for inclusion in the hybridisation programme, there is hope that the desired genotypes will be attained both for the local market and export.

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