

Effects of Intercropping on the Performance of Maize and Cowpeas in Botswana

Gabatshele M. Legwaila*, Teko K. Marokane, Witness Mojeremane

Department of Crop Science and Production, Botswana College of Agriculture, Private Bag, 0027, Gaborone, Botswana

Abstract A field experiment was conducted at Botswana College of Agriculture garden to investigate the effects of intercropping maize and cowpeas on the performance of maize and cowpeas. The treatments were sole maize crop, sole cowpea crop, intercrop 1 (spacing of 40 cm between maize and cowpea) and intercrop 2 (spacing of 30 cm between maize and cowpea) served as treatments. The experiment was monitored from November to March. The results show that only maize dry matter was significantly reduced by intercropping. Intercropping reduced the number of cowpea flowers per plant but had no significant effect in the number of seeds per pod and weight of seeds. Cowpea dry matter weight was significantly reduced by intercropping. Planting pattern significantly affected the number of cowpea flowers, number of pods and dry matter weight. Appropriate spacing/ planting pattern should be considered when intercropping cereal and legume.

Keywords Intercropping, Cowpeas, Maize Performance, Yield

1. Introduction

Farmers practice different cropping systems to increase productivity and sustainability [1]. Intercropping is the simultaneous growing of two or more crops in the same field [2] and is a cropping system that has long been used for a long-time in tropical areas. It increases total productivity per unit area through maximum utilization of land, labour and growth resources [3, 4, 5]. Yields of intercropping are often higher than in sole cropping systems [6] mainly due to resources such as water, light and nutrients that can be utilised more effectively than in sole cropping systems [7].

Cereal-legume intercropping plays an important role in subsistence food production in both developed and developing countries, especially in situations of limited water resources [8]. Intercropping of cereal and legume crops helps maintain and improve soil fertility [9] and plays an important role in subsistence food production in developing countries [8] because farmers cannot afford inorganic fertilizers. Legumes fix atmospheric nitrogen, which may be utilized by the host plant or may be excreted from the nodules into the soil and be used by other plants growing nearby [10].

Legumes can also transfer fixed N to intercropped cereals during their joint growing period and this N is an important resource for the cereals [11].

The use of intercropping by smallholder farmers is a

common practice [12] that dates back to ancient times [13] in the tropics [14] and rain-fed areas worldwide [15]. Declining crop yields in the smallholder farmers in dryland cropping systems in Botswana present the need to develop a more sustainable cropping system. Due to high costs of inorganic fertilizers, the majority of smallholder farmers in Botswana grow maize and sorghum in soils deficient in nitrogen, phosphorus and potassium. To maintain productivity in smallholder cropping systems in southern Africa, the use of inorganic fertilizers in combination with available organic fertilizers such as kraal manure, tree litter, herbaceous legume plant residues and compost is required [16].

Intercropping legumes with non-legume in Botswana can be a principal means of intensifying crop production both spatially and temporally to improve crop yields for smallholder farmers. Legume intercrops are a potential source of plant nutrients that complement/supplement inorganic fertilizers [17]. Legume intercrops have several socioeconomic [18], and biological and ecological [19, 20, 21, 22, 23] advantages compared to sole cropping for small-holder farmers [24]. In addition, certain legume crops provide food to humans and livestock [17]. There are several intercrop arrangements which may include row intercropping worldwide. The objective of the present study was to determine the effect of intercropping and planting patterns on the performance of maize and cowpeas in semi-arid Botswana.

2. Materials and Methods

The field study was conducted during the 2006/2007

* Corresponding author:

lgabatshele@yahoo.com (Gabatshele M. Legwaila)

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cropping season (November to April) at Botswana College of Agriculture (BCA) garden. BCA is located at Sebele (Latitude: 24° 34'S; Longitude: 25° 54'E; Altitude: 994m) approximately 10 km north of the Gaborone City along the north to south highway. The study site is characterised by a semi-arid climate with mean annual rainfall of 538mm. Most of the rain fall in the summer starting from late October and continues to March/April. The study area is characterised by shallow sandy loam soils and Acacia trees.

Maize (*Zea mays L.*) and Tswana cowpea (*Vigna unguiculata (L.) Walp*) are two crops used in the present study. The experiment had four treatments, sole maize crop, sole cowpea crop, intercrop 1 (spacing of 40 cm between rows of maize and cowpeas) and intercrop 2 (spacing of 30cm between rows of maize and cowpeas). The experimental design used was a randomized complete block design and the experimental plots were replicated four times.

The experimental field was prepared by ploughing the soil to a depth of 30 cm and harrowing. The size of the plot per treatment was 3 × 3 (9 m²) with 50 cm paths separating adjacent plots and blocks. In the sole maize crop treatment, three maize seeds were sown per hole at a depth of 5cm and later thinned to one seedling/hole at a spacing of 90 × 30 cm. In the sole cowpea crop treatment, two seeds were sown per hill at depth of 5 cm and later thinned to one at 30×15 cm spacing. In the intercrop 1 treatment, there were four rows of maize planted at spacing of 80×40 cm and between every two rows; a row of cowpea was placed at 40 cm from maize rows and 20 cm between plants. In the intercrop 2 treatment, five rows of cowpeas were planted at a spacing of 60×30 cm and a row of maize placed at a spacing of 30 cm from cowpeas and 20 cm between plants. Watering was also done when crops showed water stress and weeding was done manually when necessary. No fertiliser or insecticide

application was made. Specific maize and cowpea plants were tagged for measurements and harvested at end of the experiment to determine dry matter (DM) weight.

The following parameters were assessed: number of flowers, number of pods, number of cobs per plant, weight of 100 seeds and DM weight at the end the experiment. The DM weight or biomass was determined by weighing after oven drying the plant material at 70°C for 3 days. All the data collected were statistically analysed using the analysis of variance (ANOVA) procedure using SAS[25] and Duncan Multiple Range Test was used to separate the means.

3. Results and Discussion

The results on the effect of intercropping on measured maize parameters are shown in Table 1.

The sole crop produced significantly more DM weight than maize intercropped with cowpeas. The maize DM weight was not affected by planting patterns used in the two intercropping systems. Competition among mixtures is thought to be a major factor affecting yield as compared with sole cropping of cereals[26]. The high maize DM weight observed in the sole maize crop could be attributed to high plant density and lack of competition for resources such as light, nutrients and water. Factors that affect competition in intercropping systems were not determined in the present study. However, differences in the depth of roots, lateral root spread and root densities are some of the factors that affect competition between the component crops in an intercropping system for nutrients[27]. Previous studies reported yield reduction in cowpea and maize in maize-cowpea intercrops [28] due lower plant densities.

Table 1. Effect of intercropping on the number maize cobs per plant, weight of 100 seeds and dry matter weight

| Treatment | No of cobs plant ⁻¹ | Weight of 100 seeds (g) | DM (g) |
|----------------------|--------------------------------|-------------------------|---------|
| Sole maize (control) | 2.00a | 24.33a | 197.33a |
| Intercrop 1 | 1.66a | 23.00a | 169.33b |
| Intercrop 2 | 1.66a | 21.00a | 165.66b |
| SEM | 0.30 | 1.30 | 6.55 |
| CV | 29.64 | 9.877 | 6.494 |
| LSD | 1.195 | 5.124 | 26.117 |

Mean values followed by the same letter are not significantly different from each other (P>0.05)

Table 2. Effect of intercropping on flowers, number of pods per plant, number of seeds per pod, weight of 100 seeds and DM of cowpea

| Treatment | No of flowers plant /plant | No of pods plant ⁻¹ | No of seeds/pods | Wt of 100 seeds (g) | DM (g) |
|-------------|----------------------------|--------------------------------|------------------|---------------------|--------|
| Sole cowpea | 28.25a | 24.75a | 14.00a | 15.75a | 62.50a |
| Intercrop 1 | 24.00b | 23.25a | 13.00b | 16.00a | 73.50b |
| Intercrop 2 | 19.75c | 18.50b | 13.75a | 15.75a | 51.25c |
| SEM | 0.73 | 1.27 | 0.14 | 0.43 | 2.47 |
| CV | 6.093 | 11.48 | 2.12 | 5.47 | 7.92 |
| LSD | 2.53 | 4.40 | 0.449 | 1.498 | 8.55 |

Mean values followed by the same letter are not significantly different (P>0.05)

The results of the present study show that the number of maize plant cobs and weight of seeds were not affected by intercropping systems. Similarly there was no significant difference in the two variables between planting patterns (intercrop 1 and 2). This is consistent with results of a study conducted by Agricultural Research Division [29] which reported that a sorghum-cowpea intercrops did not reduce or increase sorghum yield. Our results are also in agreement with Haizel [30], who worked with maize-cowpea, and Andrews[31] and Rees[32], who worked with sorghum-cowpea and Karikari[33] who worked with maize-bambara groundnut and sorghum-bambara groundnut intercrop systems.

The results of different parameters of cowpea in intercrops with maize are shown in Table 2. Sole cowpea produced significantly more flowers per plant than intercropped with maize. Maize is usually taller with a faster growing or more extensive root system; particularly a larger mass of fine roots and is competitive for soil nitrogen [34, 35]. The maize plants in the intercrops in the present study could have shadowed cowpeas reducing the amount of light required to stimulate flower production. These results also showed that the number of flowers per plant was significantly high in intercrop 2 than intercrop 1 probably due to differences in plant density between the two planting patterns. There was no significant difference in the number of cowpea pods between sole cowpea crop and intercrop 1 (wider cowpea spacing). Cowpea plants in both the sole cowpea crop and intercrop 1 produced more pods than the intercrop 2. The narrow spacing in intercrop 2 resulted in high cowpea plant density and hence competition for growth resources. This is consistent with the findings of Ofori and Stern[18] and Alhaji [36] who observed reduction in cowpea yield due to high maize density in the intercropping system. Studies conducted by Agricultural Research Division[29] also reported that intercropping reduced the yield of cowpea.

The results on the effect of intercropping on flowers, number of pods per plant, number of seeds per pod, weight of 100 seeds and DM of cowpea are shown Table 2

There was no significant difference in the number of seeds per pod between the sole cowpea and intercropping 2. Intercrop 1 significantly reduced the number of cowpea seeds per pod when compared to the sole crop and intercrop 2. Higher grain yield under sole cowpea compared to intercropping were reported by Chemedda [24]. Competition for water, nutrients and shading are probably the two factors that reduced cowpea yield under high numbers of maize plants in Intercrop 1[37]. There were no significant differences in the weight of cowpea seeds between treatments. This is in agreement with Chakma et al. [38] who observed no significant difference in weight of 1000 seed weight in a popcorn-mungbean/cowpea intercropping system[39] found that mungbean intercropped with cotton produced seeds similar to those in sole crop of mungbean which is consistent with our findings.

Sole cowpea crop produced significantly lower DM weight than intercrop 1. The sole cowpea crop grew and

matured faster because of lack of competition for resources such as light, water and nutrients. This caused sole cowpea plants to lose some leaves before harvesting for DM weight analysis. The loss of some leaves in the field could have lowered DM weight in the sole cowpea crop. It was observed that intercropped cowpeas matured while still holding leaves and this could be because shading by maize prevented them from drying. Intercrop 1 gave more DM weight than sole been and intercrop 2. At the end of the study, cowpeas in the intercrop 1 were still holding their leaves. Cowpeas in the intercrop 2 produced the least DM probably due to competition for resources due to high plant density.

4. Conclusions

The majority of smallholder farmers in Botswana practice intercropping between cereal crops and legumes, however on the basis of these findings; it is clear that sole cropping performed better than all intercrops. There are benefits derived from intercropping systems such nitrogen fixation by legume which benefits cereal crops and assurance for some crops surviving in the event that there are calamities like drought, pests and diseases.

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