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Yield Performance of Improved Chickpea (*Cicer arietinum*) Varieties under Pure Stand and Banana Intercrop Methods in Semi-Arid Agroecological Zone of South Western Uganda

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Abstract

Chickpea (*Cicer arietinum*) is increasingly becoming an important crop in East Africa due to its desirable attributes such as high drought tolerance, nitrogen fixation, grain/seed productivity, and market potential. Chickpea is a major source of high quality protein for human diets and has potential of bridging the nutritional gap among rural households during drought periods. With the aim of improving household income in South Western Uganda, National Agricultural Advisory Services introduced several chickpea varieties between 2004 and 2007 in the zone targeting a local agro-producer processor. However, due to the limited capacity of the processor to buy all chickpea produce, most farmers abandoned the crop since there was no other alternative use or markets known. Apart from lack of market, chickpea has the potential to improve nutrition among the vulnerable rural households if its production and consumption are enhanced. Due to chickpea ability to improve soil fertility, and survive under low moisture conditions where other common crops cannot survive, it can also be a source of food especially in period when there is food scarcity. Although, Chickpea had great potential of being adopted in the region, its agronomic performance (grain yields) and adaptability to the existing cropping systems in the semi-arid zone of South Western Uganda is not known. Therefore, this research was conducted to ascertain the potential yields and appropriate cropping method, which will result into higher productivity. Farmer participatory research was conducted to assess grain yields of five improved chickpea varieties (ICCV 96329, ICCV 00305, ICCV 97105, ICCV 92318 and ICCV 00108) using banana-intercrop and pure stand cropping methods. Eighty nine farmers hosted the experiment on behalf of the

community. Results indicated that there was no significant difference ($p > 0.05$) in grain yields among the chickpea varieties. However, grain yields from chickpea planted as pure stand were significantly higher ($p < 0.05$) than that obtained from banana-intercrop. This implies that competition with banana for moisture, nutrient and light significantly suppressed the yielding potential of chickpea in the banana intercrop.

Subject Areas

Biochemistry

Keywords

Chickpea, Cropping System, Varieties, Yields

1. Introduction

The semi-arid areas of south-western Uganda often experience low crop yields mainly due to inadequate rains received and prolonged droughts [1]. Conventional legumes such as beans play a major role in supplying protein among the rural poor, but their production has remained insufficient to meet the increasing protein requirements [2]. This has created shortfall of food reserves exacerbated by sale of limited harvests to cater for household needs. This in turn has resulted into persistent food insecurity and malnutrition among the rural poor households whose protein intake is low. Nutritional related diseases are mainly manifested among the children, women, elderly and persons living with HIV/AIDS [3]. This problem has been exacerbated by high food prices inhibiting the vulnerable households from accessing proteins in the diets.

Chickpea is not traditionally grown in Uganda and was recently introduced in 2004 by the National Agricultural and Advisory Services (NAADS). This crop was introduced in mid highlands of south-western Uganda as a rotation legume to improve soil fertility. Chickpea is one of the under-utilized legumes identified with a great potential that can be harnessed to supplement on the nutrition and food security in rural poor households. This crop is known for high protein content (20% - 22%), rich in fiber, minerals and uncirculated fatty acids [3].

Chickpea can be supported by soil residual moisture and therefore can be grown towards the end of the rain season when annual crops are harvested [4]. This can allow efficient use of available labour in the dry season. With a short maturity period of three months, chickpea provides grains for household consumption at the critical moment when there is food scarcity in the community. It generates large biomass that protects the soil from desiccation from the sun's heat, improves soil physical properties and has high nitrogen fixation capacity (14%). Utilising its own nitrogen, it spares the nutrient for the next crop in the rotation [5].

Due to limited land availability, farmers grow crops with banana intercrop to maximize spaces between stools and to gain other benefits such as management of pests and diseases. Chickpea is an under-utilised crop and its grain yield in banana intercrop is unknown. This research was conducted to assess grain yields of improved chickpea varieties using banana-intercrop and pure stand as cropping methods. Identification of chickpea varieties that perform well in banana intercrop is important for farmers to improve nutrition and food security in the household without changing the cropping method.

2. Materials and Methods

2.1. Description of Experimental Area

The experiment was conducted for two growing seasons of 2016 in Birere and Masha sub counties of Isingiro district in Uganda at 0˚42.01'N, 30˚41.78'E and altitude range of 1367 - 1419 m above sea level. Experimental soils were sandy clay loam and sandy loam in Birere and Masha sub Counties respectively. The experiment was conducted on 90 farmer's field under rain fed conditions. Prior to planting, soils in the experimental fields were sampled at 0 - 15 cm depth to assess the physical and chemical characteristics. During the growing period of March-May average rain fall received was 62 mm with 49 rainy days. In August-December average rainfall was 64.1 mm with 56 rainy days. Average monthly temperatures for the two growing periods of March-May and August-December were 26.7˚C and 21.6˚C, respectively.

2.2. Main Features of Chickpea Varieties Planted

Two Desi varieties of ICCVs 00108 and 97105 and Kabuli varieties of ICCVs 00305, 92318 and 96329 were selected for on farm experimentation. The selected Desi chickpea varieties had plump, medium seed size with a light tan seed coat suitable for whole, dehulled or split seed markets and milling. These varieties were known to be tolerant to ascochyta blight, early flowering, high yielding, tall and erect. Being erect, these varieties were tolerant to lodging. Being early flowering, these varieties were considered suitable for areas such as south-western Uganda with short rains. On the other hand, Kabuli varieties were characterized by high yields, moderate resistance to ascochyta blight, medium to large seeds, light cream beige seed color with typical ram head.

2.3. Experimental Design

In 2015, agronomic performance of five new improved chickpea varieties from ICRISAT was carried out under pure stand and banana intercrop through Farmer Participatory Research (FPR) experiment. The experiment was conducted in the two rain seasons of March-May and August-December that had rainfall totaling to 85.4 mm and 294.4 mm, respectively. Average temperatures for March-May and August-December were 17.4˚C and 24.9˚C, respectively.

Two planting methods were used. Banana fields selected for intercrop were

young not more than two years old that allowed sunlight to reach the ground. While pure stand was planting methods for chickpea planted in the fields alone. Under banana intercrop, plots were demarcated between banana stools and fields that had no mulches and were well pruned.

The seed of each chickpea variety was planted at spacing of 40 cm × 10 cm in plot size 4 m × 2.8 m with three replicates in a Randomized Complete Block Design (RCBD). The experiments were managed by farmers with support from the research team. All experiments were kept weed and pest free by regular hand hoeing and pesticide application when needed. At maturity all chickpea varieties were harvested for grains yields that were dried and weighed. The grain yields were expressed in term of kg/ha. Data on grain yields per variety were entered into the data base computer using an excel spread sheet. Data were analyzed using ANOVA to determine the effect of planting methods on chickpea varieties.

3. Results and Discussion

Variety Yield Performance

There was significant difference in grain yields of chickpea varieties with the planting methods ($p \leq 0.05$) (Table 1).

Chickpea varieties planted as pure stand had significantly higher grain yields compared to intercrop with banana ($p \leq 0.05$). There was no significant difference in grain yields of chickpea varieties under similar planting methods ($p \geq 0.05$). Chickpea variety ICCV 00305 had the highest grain yields when planted as pure stand (1566.0 kg/ha) and intercrop (938.0 kg/ha). Under pure stand planting method, chickpea variety ICCV 96329 had the lowest grain yields of 1312.0 kg/ha. On the other hand, chickpea variety ICCV 00108 had the lowest grain yields of 809.0 kg/ha when planted as intercrop with banana. Low chickpea grain yields under banana intercrop were attributed to low light intensity due to large banana leaves that intercepted sunlight reaching the ground. High humidity under the banana canopy favored fungal pathogens that caused late blight and hence reducing growth of chickpea. Chickpea under pure stand were not significantly affected by late blight and received adequate sunlight that favored flowering.

Performance of chickpea varieties varied with the experimental sites (Figure 1). There were wider interactions of chickpea varieties with planting methods in Birere sub County compared to Masha sub County. In Birere sub County, grain yields varied widely when chickpea was planted as pure stand compared to Masha sub County. Chickpea grain yields were below 800 kg/ha in Masha sub County under banana intercrop. This is because soils in Masha sub County were mainly sandy loam that could not reserve water for longer periods. Competition for water, nutrients and light resulted into low grain yields under banana intercrop in Masha sub County. The higher grain yields in Birere sub County was attributed to clay loam soils that reserved water for longer periods as residual moisture that supported chickpea growth.

Table 1. Effect of planting method of chick pea grain yields.

Variety	Pure-stand	Banana intercrop	LSD ($p \leq 0.05$)
	(Kg/ha)		
ICCV 00108	1539.2	808.5	369.7
ICCV 00305	1566.2	938.4	422.0
ICCV 92318	1353.2	838.5	281.9
ICCV 96329	1312.2	847.5	355.1
ICCV 97105	1423.2	930.5	619.1
LSD ($p \leq 0.05$)	ns	ns	

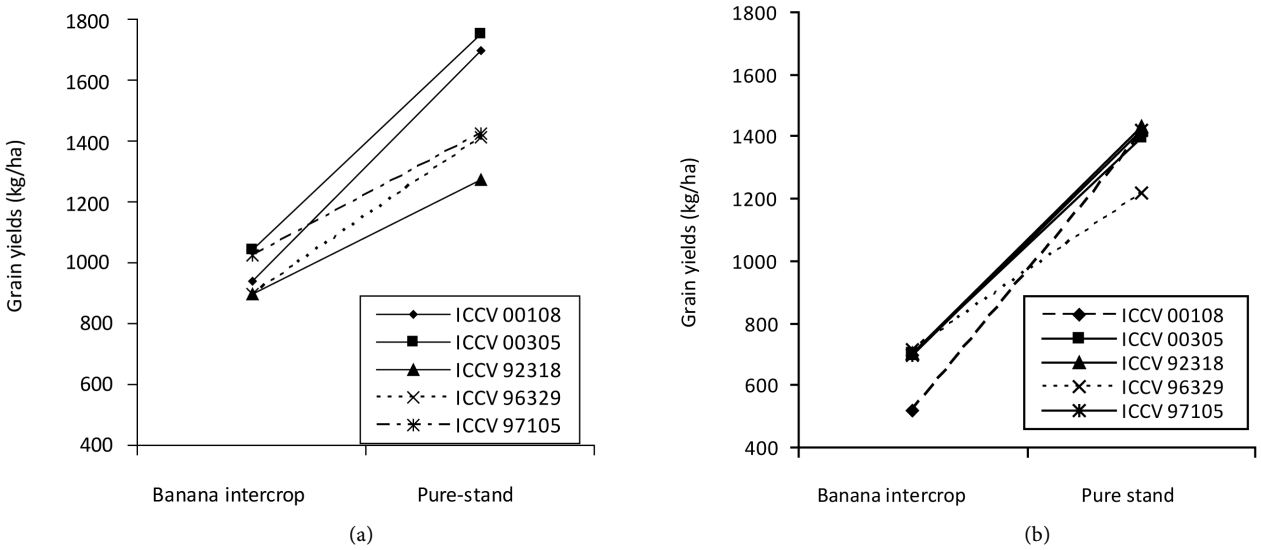

Figure 1. Interaction between planting methods and chickpea varieties in Birere and Masha sub county. (a) Birere sub county; (b) Masha sub county.

4. Conclusion

Chickpea has a great potential to be grown in the semi-arid zone in the banana farming system in southwestern Uganda. However, higher grain yields are realized under pure stand compared to intercrop with banana. Chickpea requires open space for maximum light and low humidity to avoid fungal diseases such as late blight.

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