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Research Article

Adopting Additive Intercropping for the Production of Maize and Mungbean

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ABSTRACT

A study was conducted between 2016 and 2017 cropping seasons, aimed at determining the yield and productivity of maize and mungbean under additive intercropping. The research was carried out at Ebonyi State University Abakaliki, Nigeria. A Randomized Complete Block Design (RCBD) was employed in the experiment. The major treatments were two sole crops; maize and mungbean and its four additives series intercropping system. The field data were subjected to Analysis of Variance and means separated using Least Significant Difference (LSD) at the 5% level of probability. Mono-cropped maize produced highest kernels in a cob (357.00), fresh cob yield (7.50 t/ha) and grain yield (2.96 t/ha), which is superior to additives three (100% maize + 75% green gram) and four (100% maize + 100% mungbean) respectively. Similarly, sole planted mungbean produced highest pods (43.00), fresh pod yield (4.46 t/ha), grain yield (1.93 t/ha), compared to four additives averaged across the years. The plants in the sole cropped mungbean had comparable pods to additives one (100% + 25% mungbean) and two (100% + 50% mungbean) respectively. However, the land equivalent ratio was much higher than one in the four additive intercrops. The competitive ratio and aggressivity index values of mungbean were lower than that of maize in all the additive series, which implied that mung bean is less competitive and aggressive than maize. It was concluded that maize and mungbean additive intercropping systems, especially additive two and three do have more efficient land resources use, considerable yield advantage, moderate competitive ratio and aggressivity index values relative to their monocrops, and should be adapted.

Key words: Maize, Mungbean, Crop diversity, Mixed cropping, Productivity assessment

INTRODUCTION

Mixed cropping had been an age-long farming system of the farmers of Southeast Nigeria. However, the advent of green revolution and the attendant sole cropping package, the farmers embraced the advance cropping system. But in the recent past, the farmers had started recording drastic reduction in yield and even complete crop failures attributed to soil fertility, pests and disease problems. There is therefore the need to re-examine the green revolution package and adopt a more scientific approach indigenous to the farmers' technology in cropping systems. Restoring a diversified cropping system that is close to nature could be a viable alternative to ensure agricultural sustainability. Many researchers believe that applying intercropping patterns in the cropping ecosystems could be a major means of enhancing the diversity of these systems (Bybee-Finley and Ryan, 2018). Intercropping offer numerous benefits through enhanced land-use efficiency, increased light capture and use, water, nutrients, weed control, insect pests and diseases management and increase in length of cropping cycles (Bybee-Finley and Ryan 2018; Chen et al 2018). Among farmers in the Southeastern Nigeria, cereal - legume intercrops are no longer common compared with their corresponding monocrops, as a result of adoption of the green revolution package.

Adopting cereal-legume intercropping system or any other certified mixed cropping systems could insure the farmers against complete crop failures since there are always alternative crops in the system to fall back on in the case of a single component crop failure. This study assessed influence of maize – mungbean additives on yields, yield components, of maize and mungbean, and quantify their productivity.

MATERIALS AND METHODS

The study was conducted in 2016 and 2017 within long. 06^0 45′ N; lat. 08^0 30′ E and elevation of 447m above the sea level, Southeast Nigeria. The climate is characterized with daily temperature range of 22℃ to 32℃.

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The area has a bimodal rainfall pattern from April to November with peak at July and September. The area had rainfall ranging from 1700 mm – 2000 mm, whereas relative humidity ranged from 60 – 80%. The soil of the area is an Ultisol.

A randomized complete block design was employed in the study with for replications. Test crops used were maize (Oba Super II) and Mungbean (green gram) from Natural Cereals Research Institute, Badegi, Nigeria.

The treatments were two sole cropped maize (Mz;) and green gram (Gg) and four crop mixture using additive intercropping technique according to Ebwongu et al (2001): 100% Mz + 25% Gg, 100% Mz + 50% Gg, 100% Mz + 75% Gg and 100% Mz + 100% Gg.

Minimum tillage method of land preparation was employed. There were six plots, each measuring 6 m^2 (3 m x 2 m).

Maize and green gram were simultaneously sown using the plant spacing of 50 x 50 cm for maize and 25 x 50 cm for green gram in early May of 2016 and 2017 cropping seasons respectively. Weeding was done manually by hand at three (3) and six (6) weeks. Granulated fertilizer (NPK 20:10:10) was applied by line method, 3weeks after planting (WAP) at 250 kg per hectare. The insecticide, cypermethrin (10% EC) at the rate of 100 ml per 20 litres of water was used, to control insect pests of green gram at flowering and podding stages.

The green gram was harvested in July whereas maize was harvested in August of each planting season, from a net plot area of $2m^2$ (2m x 1m) in each plot.

Composite soil samples were collected from the experimental area at a depth of 0 – 20 cm and analyzed for physical and chemical properties according to the methods of Okalebo et al (2002).

Measurements were taken at harvest on maize cob length, kernels in cob, and fresh cob yield, whereas grain yield per hectare was calculated after thrashing and drying the grains to 15% moisture content. Data taken on green gram were pod length (cm), number of pods per plant, fresh pod yield per hectare and grain yield per hectare, after thrashing and drying to 15% moisture content.

The productivity assessment of the intercrop was determined from mean yield data of both monocrop and the intercrop, using the following indices as provided by Mbah and Ogbodo (2013).

Land equivalent ratio (LER) was calculated; LER = $pL_m + pL_{mb} = [(Y_{im}/Y_{sm}) + (Y_{imb}/Y_{smb})]$, where pL_m and pL_{mb} = partial LERs of crops 'm' (maize) and 'g' (green gram), Y_{im} and Y_{ig} for the yields of intercropped maize and green gram respectively, while Y_{sm} and Y_{sg} for the yields of mono-cropped maize and green gram respectively.

Competitive ratio (CR) was determined; $CR_m = [(LER_m / LER_g) + (Z_{gm} / Z_{mg})]$ for species m (maize), and $CR_g = [(LER_g / LER_m) + (Z_{mg}/ Z_{gm})]$ for species g (green gram). Where LER_m = land equivalent ratio for maize, LER_g = land equivalent ratio for green gram. Z_{mg} = proportion of maize grown in association with green gram, Z_{gm} = proportion of green gram grown in association with maize.

Aggressivity (A) index was calculated. A_{mg} (maize) = $[Y_{mg} / (Y_{mm} \times Z_{mg})] - \{Y_{gm} / (Y_{gg} \times Z_{gm})]$ and A_{gm} (green gram) = $[Y_{gm} / (Y_{gg} \times Z_{gm})] - [Y_{mg} / (Y_{mm} \times Z_{gm})]$, where Y_{mm} and Y_{gg} are yields of maize and green gram as monocrops respectively, Y_{mg} and Y_{gm} are yields of intercropped maize and green gram respectively, while Z_{mg} and Z_{gm} are proportions of maize and green gram respectively.

RESULTS AND DISCUSSION

Soil physcico-chemical characteristics: Soil of the experimental area was very low in fertility status. Such soils definitely would require adequate amendments in order to support any meaningful crop production (Table 1). There is the indication that the inclusion of legume crop in the cropping mixture did not ameliorate the low fertility status of the soil. This reflected in the observation that mono-cropped maize had higher yield compared to maize-green gram intercrop. The high soil acidity adversely affected nutrient availability, buffer capacity and crop yield.

Yields: The mono-cropped maize (100% maize) significantly produced the highest number of kernels per cob (357), fresh cob yield (7.50 t/ha) and grain yield (2.96 t/ha), compared to additives three (100% maize + 75% green gram) and four (100% maize + 100% green gram) respectively. The superior yield components of the monocropped maize did not differ significantly with additives one (100% maize + 25% green gram) and two (100% maize + 50% green gram) treatments respectively. The percentage increase of sole maize relative to additive three and four were 8 and 17% for number of kernels per cop, 25 and 30% for fresh cob yield and for grain yield, 21 and 25% respectively.

Similarly, sole planted green gram (100% green gram) had higher fresh pod yield (4.46 t/ha) and grain yield (1.93 t/ha), compared to additive one (100% + 25% green gram), additive two (100% + 50% green gram), additive three (100% + 75% green gram) and additive four (100% + 100% green gram) averaged across the years. The pods in the sole cropped mungbean is comparable to that of additives one (100% + 25% mungbean) and two (100% + 50% mungbean) respectively. The percentage increase of monocropped green gram compared to its intercrops for number of pods per plant were 8 and 15% for three and four additives, for fresh pod yield were 45, 50, 53 and 61%, and for grain yield were 46, 50, 61 and 73% for additives one, two, three and four respectively.

Among the additive intercropping, highest yield components and yield were achieved under maize-additive one followed by additive two, while maize-additive four had the least yield components and yield, which may due to the highest planting population density and the attendant competition for feeding area, nutrient resources and light.

Banik and Sharma (2009) ascribed such reduction in green gram yield and its components under additive intercrop of maize probably due to shading effect of maize on green gram.

Productivity assessment: The partial land equivalent ratio (pLER) shows that the intercropped maize and green gram produced higher yields on equal land area than their monocrops. The results revealed that between 36 and 43 % of more land would be required under mono-cropping systems to obtain similar amount of yield compared to intercropping. The finding agrees with study by Mbah and Ogbodo (2013).

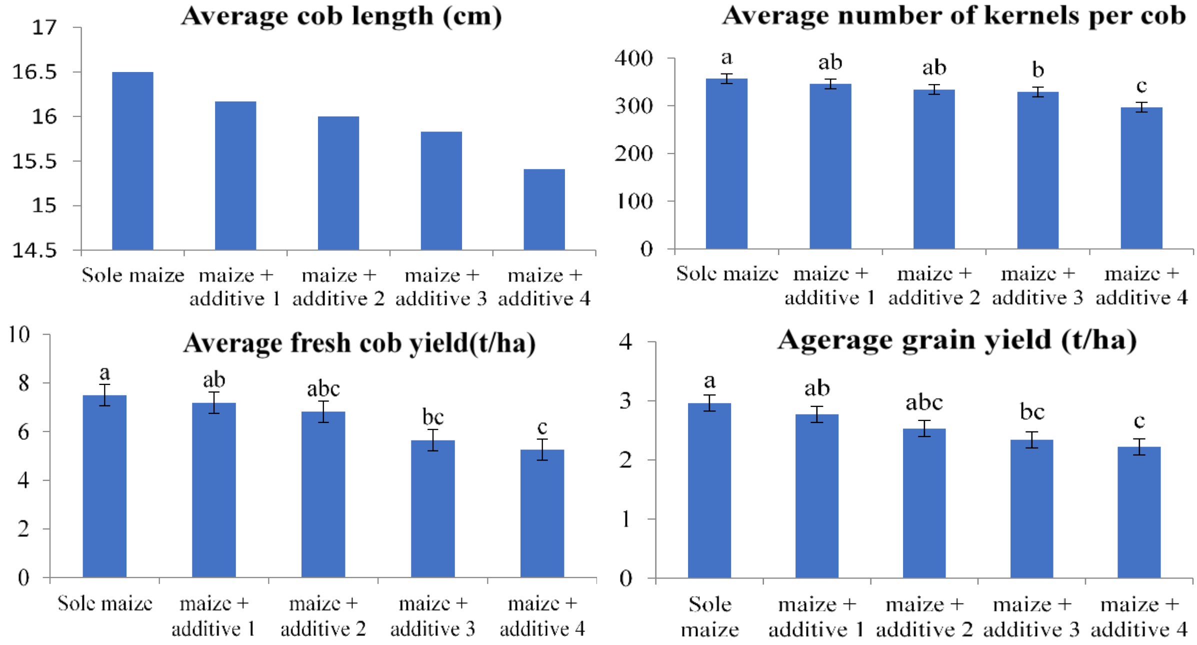

Fig. 1: Effect of additive intercropping on yield and yield components of maize.

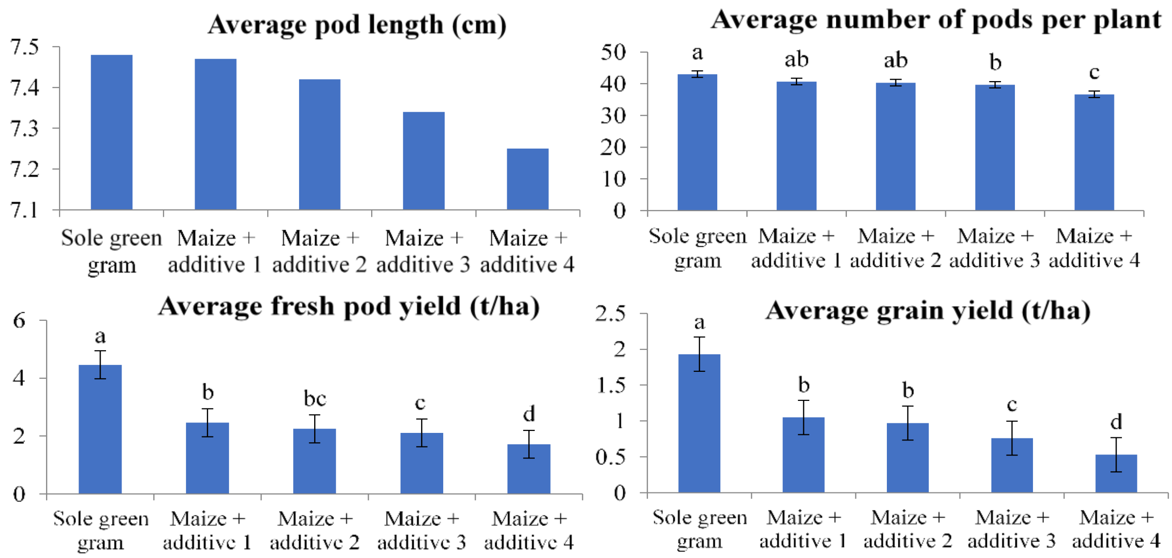

Fig. 2: Effect of additive intercropping on yield and yield components of green gram. Sole maize and green gram (100%); Maize + Additive 1 = 100% maize + 25% green gram; Maize + Additive 2 = 100% maize + 50% green gram; Maize + Additive 3 = 100% maize + 75% green gram; Maize + Additive 4 = 100% maize + 100% green gram; Means (n = 4) that do not share a letter are significantly different at P<0.05.

Table 1: Soil Properties

	Pre-Cropping	Post-Cropping
Physical properties		
Sand (%)	58.00	56.00
Silt (%)	27.47	31.40
Clay (%)	17.00	17.80
Textural class	Sandy loam	Sandy loam
Chemical properties		
pH (H_2O)	4.23	4.10
Available Phosphorus (mg/kg)	25.3	21.50
Total Nitrogen (%)	0.08	0.09
Organic carbon (%)	1.58	1.55
Calcium (Cmol/kg)	1.38	1.12
Magnesium (Cmol/kg)	0.87	0.86
Potassium (Cmol/kg)	0.18	0.15
Sodium (Cmol/kg)	0.08	0.06
Exchangeable Acidity (Cmol/kg)	0.39	0.46
ECEC(Cmol/kg)	2.90	2 .65

Table 2: Productivity index in maize-green gram intercropping system.

Treatment	Land equivalent ratio			Competitive ratio		Aggressivity	
	Partial		Total	Maize	Green gram	Maize	Green gram
	Maize	Green gram					
Sole maize	1.0	-	1.0	-	-	-	-
Sole green gram	-	1.0	1.0	-	-	-	-
Maize + additive 1	0.88	0.51	1.39	4.68	0.22	0.69	0.27
Maize + additive 2	0.82	0.59	1.41	3.93	0.33	0.20	0.08
Maize + additive 3	0.79	0.64	1.43	3.21	0.39	0.11	0.04
Maize + additive 4	0.64	0.72	1.36	2.62	0.44	- 0.09	0.03

Sole maize and green gram (100%); Maize + Additive 1 = 100% maize + 25% green gram; Maize + Additive 2 = 100% maize + 50% green gram; Maize + Additive 3 = 100% maize + 75% green gram; Maize + Additive 4 = 100% maize + 100% green gram.

The changes in crop performance between the intercrop treatments could be assigned to difference in total crop population per unit land area, particularly for green gram, resulting in variations in the inter-plant competition.

Competitive ratio and **aggressivity**: intercropped maize always had a better competitive ratio than the intercropped green gram, indicating that maize has higher competitive ability compared with the green gram (Table 2). The aggressivity index values revealed maize as the predominant species in the crop mixture, except at 100 % maize intercropped with 100 % green gram. Maize exhibited its dominancy in the intercrops, because it is a tall stature and exhaustive plant when compared to green gram that has short stature (Banik and Sharma 2009).

Conclusions

The maize-green gram additive intercropping systems, especially additive two and three should be adapted because they had more efficient land resources use, considerable yield advantage, moderate competitive ratio and aggressivity index relative to their mono-cropping.

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