

WEED INFESTATION AND PRODUCTIVITY OF MAIZE/SOYBEAN INTERCROP AS INFLUENCED BY CROPPING PATTERNS IN THE SOUTHERN GUINEA SAVANNA OF NIGERIA

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Abstract: Field experiments were conducted during the 2015 and 2016 cropping seasons at the Teaching and Research (T & R) Farm of the College of Agriculture, Kwara State University, Malete, to determine the effect of cropping patterns on weed infestation, growth and yield of a maize/soybean intercrop in the southern Guinea savanna of Nigeria. The experiments consisted of six treatments as follows: one row of maize alternated with one row of soybean (1:1), one row of maize alternated with two rows of soybean (1:2), two rows of maize alternated with one row of soybean (2:1), two rows of maize alternated with two rows of soybean (2:2), sole maize (1:0) and sole soybean (0:1). The treatments were laid out in a randomized complete block design with three replicates. Data collected were subjected to analysis of variance and means were separated by the least significant difference (LSD) at the 5% level of probability. Results showed that sole soybean consistently suppressed weeds and resulted in a higher yield. Similarly, the 2:1 ratio of maize to soybean did not only reduce weed density, it produced significantly higher yields of maize and lower yield of soybean, and had the higher land equivalent ratio and economic returns followed by sole maize.

Key words: Intercrop crop yield, economic returns, land equivalent ratio, Nigeria, weed density.

Introduction

Maize (*Zea mays* L.) is one of the most important staple food crops in west and central Africa. The savanna zone of west and central Africa has the greatest potential for its production due to a relatively higher incidence of solar radiation and a lower incidence of pests and diseases during the cropping season (Badu-Apraku et al., 2006). In Nigeria, maize is an important food,

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fodder and industrial crop grown both commercially and at the subsistence level (Iguisi, 2013). Maize production in Nigeria is becoming an increasingly important feature in both subsistence and large-scale agriculture. Due to poor yields, there has been a growing concern on raising its productivity and profitability. This general decline in yield has been attributed to high weed infestation. Yield losses of between 60 and 80% have been attributed to uncontrolled weed infestation in maize (Lagoke et al., 1998).

Worldwide production of maize is 785 million tonnes, with the largest producer, the United States, producing 42%. Africa produces 6.5%. Nigeria produced about 11.3 million tonnes in 2013, making it the largest producer in Africa (FAOSTAT, 2014).

Soybean [*Glycine max* L.] is one of the most important food legumes in Nigeria and other parts of the world. It is grown efficiently together with other crops in Nigeria, particularly cereals, such as maize, millet and sorghum (Adetiloye et al., 2005). More than 216 million tonnes of soybean were produced worldwide in 2007. Nigeria is the largest producer of soybean in sub-Saharan Africa (SSA), and it currently produces about 500,000 metric tonnes of this crop annually (Anonymous, 2016).

Soybean can be cultivated both as an oil crop and a pulse crop (Thakare et al., 2006). With an average protein content of 40%, it is protein-richer than any of the common vegetable or animal food sources found in Nigeria (Dugje et al., 2009). Soybean can improve soil fertility by contributing to soil nitrogen through nitrogen fixation (Kureh et al., 2005). It is also used for biodiesel production in Brazil (Ferrari, 2005; Barbosa, 2011).

Soybean has been shown to be sensitive to weed interference which is of great importance during the development of the crop. Weeds are strong competitors, not only for environmental resources, but they also release allelopathic substances, interfere in the process of harvesting and are hosts to many pests, insects, nematodes and pathogens that cause various diseases. In certain regions, weed induced soybean crop losses can reach 80% if not properly managed (Gazziero, 2004).

Intercropping is the growing of two or more crops simultaneously on the same piece of land in a manner that will permit the interaction of component crops in a spatial and temporal context (Steiner, 1984). The most common goal of intercropping is to produce a greater yield on a piece of land by making use of resources that would otherwise be utilized by a single crop (Jarenyama et al., 2000). It also provides greater stability in the supply of food and eliminates the risk of crop failure under adverse weather conditions or when there are disease and insect infestations (Sullivan, 2010). Intercropping is an efficient soil conservation practice due to the increased ground cover that it provides as well as the exploitation of different soil layers due to the different depths of the root

systems of the intercrop species (Jarenyama et al., 2000). Intercropping, through more effective use of water, nutrients and solar energy, can significantly enhance crop productivity compared with the growth of sole crops (Hussaini et al., 2001).

Guvene and Yildirim (1999) have reported that intercropping is a safer and more stable system of agricultural production than sole cropping for small farmers, where capital is limited and labor is not available. Many studies have indicated that intercropping with different legumes is more productive and profitable than sole cropping because of the complementary effect of an intercrop (Odion and Idem, 2005; Peter and Odion, 2008). Intercropping suppresses weed growth by providing an early ground cover due to a high plant population or a fast growing component crop, for example soybean. In many intercropping systems, only one weeding is required to produce optimum yield instead of two or three in the sole crop (Moody, 1975). However, the limitations of intercropping include difficulty in harvesting and in the efficient use of improved implements. Furthermore, a higher amount of fertilizer and irrigation water cannot be utilized properly as the component crops vary in their response to these resources and poor yield can occur due to the incompatibility between the component crops (Anonymous, 2015).

A maize-soybean intercrop is a popular cropping system adopted by farmers in Moro Local Government Area of Kwara State. However, there is a dearth of information on the right proportion of the component crops in the intercrop that will improve the productivity of maize and soybean and minimize weed infestation. This study therefore seeks to determine the best cropping pattern that will minimize weed infestation and raise the productivity of soybean and maize. The objectives of the project are to determine:

- the cropping pattern of a maize-soybean intercrop that will be more effective in weed control, and
- the cropping pattern of a maize-soybean intercrop that will raise maize and soybean productivity.

Materials and Methods

The experiment was conducted during the 2015 and 2016 cropping seasons at the Kwara State University Teaching and Research Farm, Malete, Kwara State (Lat. 08° N, 71'; Long. 04°E, 44'), located in the southern Guinea savanna of Nigeria. The experimental site is characterized by a bimodal rainfall pattern, which means that there are two rainfall peaks, in June and September, in the area where the experimental site was located. The soil was easily leached because of its sandy texture and low water holding capacity.

The experiment consisted of six treatments; namely, an intercrop of maize and soybean in the following pattern: one row of maize alternated with one row

of soybean (1:1), one row of maize alternated with two rows of soybean (1:2), two rows of maize alternated with one row of soybean (2:1), two rows of maize alternated with two rows of soybean (2:2). There were two control plots, a sole crop of soybean (0:1) and a sole crop of maize (1:0). These treatments were laid out in a randomized complete block design (RCBD) and replicated three times. The plot size was 4m x 4m with a 1-m alley between the replications and 0.5m between plots.

The land used for the experiment was mechanically plowed and harrowed, after which it was levelled and marked out into plots of 4m x 4m each. A space of 0.5m was left between plots, while 1m was left between replicates. Fertilizers were applied at the rate of 120 kg N, 60 kg P₂O₅ and 60 kg K₂O to maize while 20 kg N, 20 kg P₂O₅ and 20 kg of K₂O were applied to soybean. These nutrients were provided by applying NPK 15:15:15 and urea fertilizers. The fertilizer was applied to maize in three split doses: the first dose (a starter dose) was applied before sowing, the second dose was applied three weeks after sowing (3 WAS) and the third, six weeks after sowing (6 WAS).

The sowing was done on the 11th and the 14th of July, 2015 and 2016 respectively. Both maize and soybean were sown at the same time. Three treated seeds of maize (var. SUWAN-1-SR) were placed in a hole, and the seedlings were thinned to one plant per stand, while four treated seeds of the soybean variety (TGX-1448-2E) were planted and the resultant seedlings were thinned to two plants per stand at 3 WAS. Both maize and soybean seeds were treated with Apron Star seed dressing material to protect the seeds against insect and disease attacks. Maize was spaced at 75cm x 25cm, while soybean was spaced at 75cm x 5 cm. The planting was done in a way that soybean rows alternated with that of maize. A hand hoe was used to control weeds.

The harvesting of maize was done first on the 30th of October, followed by soybean harvesting on the 14th of November, 2015, while maize was harvested on the 2nd of November and soybean on the 18th of November, 2016. The maize and soybean crops were harvested from a net plot of 9m². The crops were left on the field to properly dry before further processing was done.

The following data were collected:

Weed dry matter (kg/ha)

Weed dry matter was determined by harvesting weeds within a 1m² quadrat placed randomly in three locations within each plot. The weeds were put in well labelled paper bags and later oven-dried to a constant weight before the final weight was taken. The weed dry matter was determined at 6 WAS and at harvest.

Weed density (No./m²)

Weed density was determined by counting the total number of weeds within each of the 1m² quadrat placed randomly at three locations in each plot. The average of the total number of weeds was recorded as weed density per 1m².

Plant height of maize and soybean (cm)

The plant height of maize and soybean was determined by randomly selecting five plants of each of the crop and measuring their height from the soil level to the apical bud. The plant height per plant was averaged to obtain the mean value per plot.

Leaf area (cm²) of maize

The leaf area of maize was determined using the expression: Leaf area (LA) = Length (L) x breadth (b) x 0.75 (Moll and Kamprath, 1977).

Leaf area was obtained by measuring the length and breadth of the top, middle and bottom leaves of five randomly selected plants from each plot and the average of these measurements was multiplied by a factor of 0.75 to give leaf area per plant of maize.

100-seed weight of maize and soybean (g)

This was obtained by counting 100 grains of maize and soybean harvested from each plot, which were weighed on a bean balance to obtain 100-seed weight per plot.

Number of pods of soybean/plant

The pods of five plants of soybean selected at random per plot after harvest were counted manually. The average of the total number of pods per plant was calculated to obtain the mean number of pods/plant.

Grain yield of maize and soybean (kg/ha)

Grain yield was determined by weighing the grains harvested from each net plot of 9m² which was converted to kilograms per hectares using the equation below:

$$\text{Grain yield/ha} = \frac{\text{Grain yield per net plot kg} \times 10,000\text{m}^2}{\text{Net plot size (m}^2\text{)}} \quad (1)$$

Land equivalent ratio (LER)

The productivities of the sole crop and the intercrops were compared by calculating the land equivalent ratio. This parameter is used to evaluate the yield advantage of intercropping. This parameter was calculated as follows:

$$\text{LER} = \frac{\text{Intercrop yield of crop A}}{\text{Sole crop yield of crop A}} + \frac{\text{Intercrop yield of crop B}}{\text{Sole crop yield of crop B}} \quad (2)$$

where: A is maize and B is soybean.

Economic analysis

Information on the cost of all the cultural practices from land preparation to harvesting and processing was collected from Kwara State Agricultural Development Programme (KWASADP), Ilorin, an agency responsible for extension services in Kwara State, Nigeria. The price of 1 kilogram of maize was obtained from the open market to calculate the income/total revenue. The economic analysis was carried out using partial budgeting (Okoruwa et al., 2005) to calculate the gross margin (profit) as follows:

$$\text{GM} = \text{TR} - \text{VC} \quad (3)$$

$$\text{TR} = (\text{Ys} \times \text{Ps}) \quad (4)$$

$$\text{VC} = \text{M} + \text{L} \quad (5)$$

where: GM = Gross margin/ha for each treatment,

TR = Total revenue, Naira/ha for each treatment,

VC = Variable cost, Naira/ha for each treatment,

Ys = Grain yield of crop (kg/ha) for each treatment,

Ps = Price of crop per kg,

M = Value of material input (seeds, fertilizers, insecticides, herbicides), and

L = Value of labour (land preparation, planting, insecticide and herbicide, fertilizer application, harvesting, processing and packaging). The cost:benefit ratio was calculated using the method of Joshua and Gworgwor (2001) as follows:

$$\text{Cost benefit ratio} = \frac{\text{TCP}}{\text{I}}$$

income/revenue.

Data analysis

The data collected was subjected to analysis of variance (ANOVA) using the Statistical Analysis System (SAS) package and where the F value was significant, the means were separated using the least significant difference test (LSD) at the 5% level of probability.

Results and Discussion

Rainfall

The total amount of rainfall recorded in 2015 was 1010.5mm, with the month of September having the highest rainfall, while January, February, April and August had low rainfall. In 2016, a higher rainfall of 1493.4mm was recorded, which was evenly distributed (Figure 1).

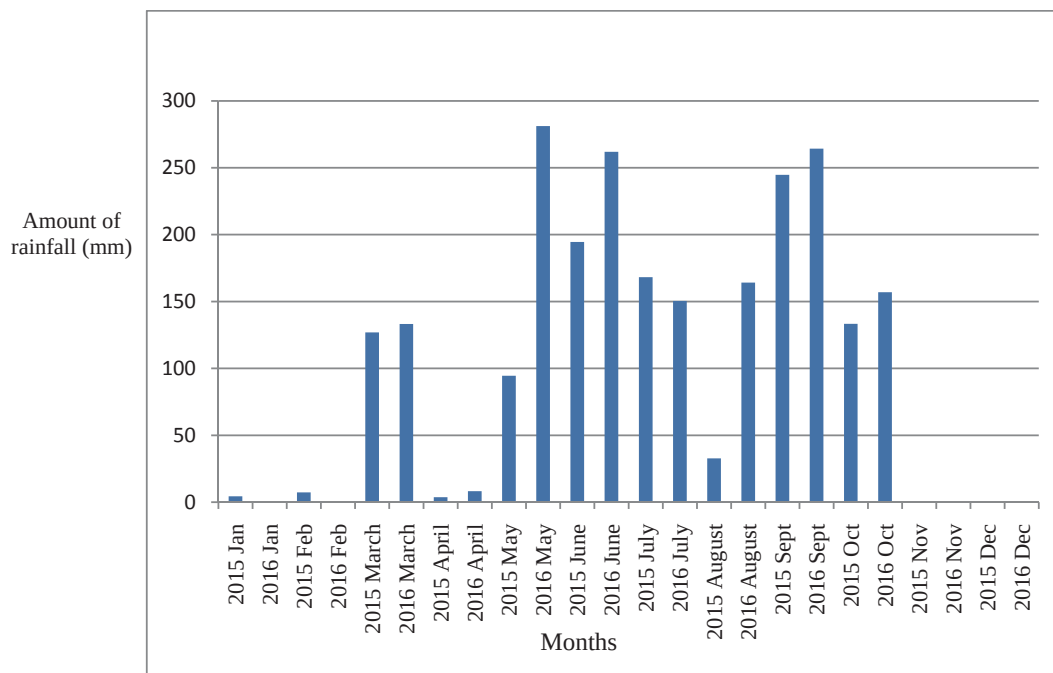


Figure 1. Monthly rainfall (mm) in the 2015 and 2016 seasons from the Teaching and Research Farm of the Faculty of Agriculture, University of Ilorin, Kwara State, Nigeria.

The effect of cropping patterns on weed infestation

Sole soybean (0:1) significantly reduced weed dry matter compared to the other treatments, except the 1:1 ratio of maize to soybean and the 1:0 ratio of maize to soybean cropping patterns, which supported comparable weed dry matter in both years and their means at 6 WAS. However, at 12 WAS, there was no significant difference between the treatments (Table 1). Cropping patterns had no significant

effect on weed density at 6 WAS (Table 2), however, at 12 WAS, the 0:1 ratio of maize to soybean cropping pattern had significantly low weed density which was comparable to other treatments except the 1:0 ratio of maize to soybean which had significantly higher weed density in 2016. This could have resulted from the higher rainfall recorded in the year which enhanced the growth of soybean to achieve early canopy closure that led to the suppression of weeds. This agrees with the findings of Akobundu (1980) who reported that crops like soybean, melon and sweet potato could provide early ground cover and shade out weeds when intercropped with other crops. Similarly, Dalley et al. (2004) have reported that quicker canopy closure and reduction in light penetration occur in narrow-compared with wider-row soybean, which subsequently causes reduction in weed seed germination and the growth of weeds later in the season.

Table 1. Effect of cropping patterns on weed dry matter.

Treatment	Weed dry matter (kg/ha)					
	6WAS ¹			12WAS		
	2015	2016	Mean	2015	2016	Mean
1:1	182.7 ^{a2}	832.4 ^{ab}	507.5 ^{ab}	237.8 ^a	199.9 ^a	218.6 ^a
1:2	230.0 ^a	991.5 ^a	610.8 ^{ab}	272.0 ^a	55.6 ^a	163.8 ^a
2:1	229.3 ^a	1192.9 ^a	711.1 ^a	141.8 ^a	155.6 ^a	148.7 ^a
2:2	245.3 ^a	1095.5 ^a	670.4 ^a	200.4 ^a	311.1 ^a	255.8 ^a
1:0	218.2 ^a	942.0 ^{ab}	580.1 ^{ab}	213.8 ^a	555.6 ^a	384.7 ^a
0:1	197.3 ^a	431.1 ^b	314.2 ^b	192.4 ^a	255.6 ^a	223.9 ^a

1. Weeks after sowing; 2. Means within the same column with the same letter (s) are not significantly different at the 5% level of probability using the LSD test.

Table 2. Effect of cropping patterns on weed density.

Treatment	Weed density/m ²					
	6WAS ¹			12WAS		
	2015	2016	Mean	2015	2016	Mean
1:1	27.3 ^a	36.3 ^{a2}	31.8 ^a	25.0 ^{ab}	22.7 ^b	23.8 ^a
1:2	31.3 ^a	31.0 ^a	31.1 ^a	29.3 ^a	19.3 ^b	24.3 ^a
2:1	15.3 ^a	34.3 ^a	24.8 ^a	17.0 ^b	37 ^{ab}	27.0 ^a
2:2	30.7 ^a	26.7 ^a	28.7 ^a	20.0 ^{ab}	39.0 ^{ab}	29.5 ^a
1:0	25.0 ^a	28.7 ^a	26.8 ^a	18.3 ^{ab}	57.3 ^a	37.8 ^a
0:1	32.0 ^a	30.0 ^a	31.0 ^a	20.3 ^{ab}	19.7 ^b	20.0 ^a

1. Weeks after sowing; 2. Means within the same column with the same letter (s) are not significantly different at the 5% level of probability using the LSD test.

The effect of cropping patterns on plant height, 100-seed weight and grain yield of maize

Plant height of maize did not significantly differ among the treatments (Table 3). Similarly, 100-seed weight was not significantly influenced by cropping patterns. However, sole maize (1:0) produced significantly higher grain yield than the other treatments but was comparable only to the 2:1 ratio of maize to soybean cropping pattern in both years and the mean.

Table 3. Effect of cropping patterns on maize plant height.

Treatment	Plant height (cm)					
	6WAS ¹			12WAS		
	2015	2016	Mean	2015	2016	Mean
1:1	52.6 ^{a2}	85.3 ^a	68.9 ^a	209.1 ^{ab}	171.9 ^a	190.5 ^a
1:2	55.7 ^a	91.3 ^a	73.5 ^a	210.3 ^{ab}	165.4 ^a	187.9 ^a
2:1	53.9 ^a	103.3 ^a	78.5 ^a	221.9 ^a	175.3 ^a	198.6 ^a
2:2	55.8 ^a	102.4 ^a	79.1 ^a	209.3 ^{ab}	173.4 ^a	191.3 ^a
1:0	56.5 ^a	100.9 ^a	78.7 ^a	200.6 ^b	171.9 ^a	186.3 ^a
0:1	-	-	-	-	-	-

1. Weeks after sowing; 2. Means within the same column with the same letter (s) are not significantly different at the 5% level of probability using the LSD test.

Other cropping patterns produced significantly lower yields (Table 4). This could be attributed to the greater plant population of maize in these treatments. Tunku and Ishaya (2012) reported that the higher yield of the sole maize crop could be attributed to higher population of the crop and to the lack of inter-specific competition as a result of the absence of soybean.

Table 4. Effect of cropping patterns on 100-seed weight and grain yield of maize.

Treatment	Grain yield (kg/ha)			Seed weight (g)		
	2015	2016	Mean	2015	2016	Mean
1:1	2,727.3 ^{bc}	1,016.6 ^{a1}	1,871.9 ^{bc}	24.9 ^a	21.6 ^a	23.3 ^a
1:2	1,160.7 ^d	1,077.2 ^a	1,118.9 ^c	25.1 ^a	22.9 ^a	24.0 ^a
2:1	3,597.7 ^{ab}	1,778.9 ^a	2,688.3 ^{ab}	25.6 ^a	20.9 ^a	23.2 ^a
2:2	2,195.7 ^{cd}	852.1 ^a	1,523.9 ^c	25.0 ^a	22.2 ^a	23.6 ^a
1:0	4,620.7 ^a	1,298.2 ^a	2,959.4 ^a	24.8 ^a	20.9 ^a	22.9 ^a
0:1	-	-	-	-	-	-

1. Means within the same column with the same letter (s) are not significantly different at the 5% level of probability using the LSD test.

Similarly, Oyewole and Magaji (2006) attributed the significant increase in the mean yield of millet in sole millet than in the intercrop treatments of millet and cowpea to higher population of the millet crop and the lack of inter-specific competition as a result of the absence of cowpea. Also, the higher yield of maize in the 2:1 ratio of maize to soybean cropping pattern could be due to the stronger competitive ability of maize for growth resources especially light and the reduced inter-specific competition with soybean. Light has been identified as the major factor for low dry matter production in intercrops (Reddy et al., 1990). This result contrasts with that of Tunku and Ishaya (2012), who recommended the 1:2 ratio of maize to soybean cropping pattern as the best combination for good weed control, growth and yield of maize and soybean intercrop.

The effect of cropping patterns on plant height of soybean

Cropping patterns had no significant effect on plant height of soybean at 6 WAS. However, its effect was significant on this parameter at 12 WAS in 2015, as the 1:1 ratio of maize to soybean cropping pattern had significantly taller soybean than sole soybean treatment, but was comparable with other treatments (Table 5).

Table 5. Effect of cropping patterns on soybean plant height.

Treatment	Plant height (cm)					
	6WAS ¹			12WAS		
	2015	2016	Mean	2015	2016	Mean
1:1	25.8 ^{a2}	36.8 ^a	31.3 ^a	61.2 ^a	55.8 ^a	58.1 ^a
1:2	23.2 ^a	37.4 ^a	30.3 ^a	58.3 ^{ab}	60.1 ^a	59.2 ^a
2:1	24.2 ^a	34.1 ^a	29.1 ^a	54.8 ^{ab}	55.6 ^a	55.2 ^a
2:2	23.5 ^a	35.1 ^a	29.7 ^a	58.4 ^{ab}	54.9 ^a	56.6 ^a
0:1	22.5 ^a	30.5 ^a	26.5 ^a	49.0 ^b	58.1 ^a	53.6 ^a
1.0	-	-	-	-	-	-

1. Weeks after sowing; 2. Means within the same column with the same letter (s) are not significantly different at the 5% level of probability using the LSD test.

The effect of cropping patterns on the number of pods/plant and grain yield of soybean and LER

Sole soybean (0:1) produced the highest number of pods, which was comparable with the other treatments except the 1:1 ratio of maize to soybean which produced a significantly lower number of pods/plant in 2015. The number of pods/plant was not significantly affected in 2016 nor was the mean (Table 6). Sole soybean produced grain yield that was significantly higher than the grain yield of

other treatments, but was comparable to the 1:2 ratio of maize to soybean cropping pattern in both years and to the means. The cropping pattern of the 2:1 ratio of maize to soybean, the 2:2 ratio of maize to soybean and the 1:1 ratio of maize to soybean, produced significantly less soybean grain yield at the mean. The 2:1 ratio of maize to soybean cropping system had the highest land equivalent ratio followed by the 1:1 ratio of maize to soybean in both years (Table 7). The higher population of soybean in the sole crop and in the 1:2 ratio of maize to soybean cropping system could have resulted in significantly higher soybean grain yield in both years and in the means.

Table 6. Effect of cropping patterns on the number of pods.

Treatment	2015	2016	Mean
1:1	68.2 ^b	60.1 ^{a1}	64.1 ^a
1:2	89.3 ^a	61.7 ^a	75.5 ^a
2:1	86.8 ^a	57.1 ^a	72.0 ^a
2:2	84.7 ^{ab}	53.3 ^a	68.0 ^a
0:1	96.1 ^a	60.0 ^a	78.0 ^a
1:0	-	-	-

1. Means within the same column with the same letter (s) are not significantly different at the 5% level of probability using the LSD test.

Table 7. Effect of cropping patterns on grain yield of soybean and land equivalent ratio (LER).

Treatment	Grain yield (Kg/ha)			Land equivalent ratio	
	2015	2016	Mean	2015	2016
1:1	1,097.4 ^{a1}	732.5 ^a	860.1 ^b	1.3	1.1
1:2	1,636.9 ^a	1,353.8 ^a	1,413.4 ^{ab}	1.3	0.6
2:1	773.8 ^a	496.1 ^a	596.2 ^b	1.3	1.5
2:2	877.7 ^a	911.8 ^a	850.9 ^b	1.0	0.9
0:1	1,610.9 ^a	3,681.3 ^a	2,565.6 ^a	-	-
1:0	-	-	-	-	-

1. Means within the same column with the same letter (s) are not significantly different at the 5% level of probability using the LSD test.

Also, sole soybean was exposed to the greater amount of solar radiation which is an essential factor for photosynthesis and higher yield. This is in line with the findings of Tunku and Ishaya (2012) who reported that the highest grain yield of soybean could be attributed to the higher population of soybean and the lack of inter-specific competition as a result of the absence of maize. The lower yield of

soybean in the intercrop plots with regards to the 1:1 ratio of maize to soybean, the 2:1 ratio of maize to soybean and the 2:2 ratio of maize to soybean could be due to the shade cast on them by the maize crop depriving them of enough sunlight for photosynthesis, dry matter production and good yield.

Economic assessment of cropping patterns

Table 8 presents the economic assessment of cropping patterns in the production of a maize/soybean intercrop. The 2:2 ratio of maize to soybean cropping pattern resulted in the higher combined yield (3,284.5 kg/ha) than the rest of the treatments followed by the sole maize cropping pattern (2,959.4 kg/ha), while the cropping pattern with the lowest yield was combined 2:2 ratio of maize to soybean cropping pattern (2,374.8 kg/ha). The least expensive cropping pattern was sole soybean (N 69,000.00 /ha) while the most expensive was the 2:2 ratio of maize to soybean cropping pattern (N132,500.00). Sole soybean was the most economical cropping system compared to the other treatments. This could be due to the low amount of NPK fertilizer used for its production which brought down the cost of production, while the most expensive cropping system was the 2:2 ratio of maize to soybean. The cropping pattern which generated the highest revenue/income (N549,368.00) was the 2:1 ratio of maize to soybean cropping pattern, followed by sole maize (N 513,120.00), while the lowest revenue generating cropping pattern (N473,504.00) was the 2:2 ratio of maize to soybean. The cropping pattern that gave the highest profit was sole soybean (N 444,120.00/ha) followed by the 2:1 ratio of maize to soybean cropping pattern (N419,701.04/ha), while the 2:2 maize soybean cropping pattern had the lowest profit/ha (N281,504) (Table 8). The highest income generated by the 2:1 ratio of maize to soybean cropping pattern could have resulted from the combined income generated from maize and soybean. Soybean has higher price value than maize in the Ilorin market. Despite this advantage, sole soybean was more profitable than the 2:1 ratio of maize to soybean cropping system. This is a result of the lower cost of producing sole soybean. In the production of maize, sole maize had the lowest cost:benefit ratio (1:0.270) followed by the 2:1 ratio of maize to soybean cropping pattern (1:0.277). To produce only soybean, the cropping pattern with the highest cost:benefit ratio (1:0.663) was the 2:1 ratio of maize to soybean while sole soybean had the lowest cost:benefit ratio (1:0.134). The cost:benefit ratio of the combined yield of maize and soybean was the lowest with the 2:1 ratio of maize to soybean cropping system (1:0.236). Although this was less beneficial than the sole soybean cropping system, the highest cost:benefit ratio was incurred by the cropping pattern in the 2:2 ratio of maize to soybean. The 2:1 ratio of maize to soybean had lower combined cost:benefit ratio than sole maize and other treatments except for sole soybean which had the lowest cost:benefit ratio. This is

an indication that these cropping systems are more cost-effective and financially beneficial than sole maize. Similarly, the 2:1 cropping pattern had the highest land equivalent ratio (LER) of 1.30 and 1.50 in 2015 and 2016 respectively. This indicates that the 2:1 stand proportion in the intercrop had greater yield advantage of 30 and 50% than sole cropping. A higher LER in intercropping than in monocropping has been reported in maize/pigeon pea (Patra et al., 1990), maize/soybean (Kalia et al., 1992), and maize/groundnut (Madimba, 1995).

Table 8. Economic assessment of cropping patterns in the production of a maize/soybean intercrop.

Cropping pattern						
Crop yield (kg/ha)	1	2	3	4	5	6
Maize	1,871.9	1,118.9	2,688.3	1,523.9	2,959.4	-
Soybean	860.1	1,413.4	596.2	850.9	-	-
Combined	2,732	2,532.3	3,284.5	2,374.8	2,959.4	2,565.6
Cost of production (₦)						
Maize	118,750	118,750	119,166.6	122,000.00	128,000	-
Soybean	10,500	11,333.3	10,500.00	10,500.00	-	69,000
Combined	129,250	130,083.3	129,666.6	132,500.00	128,000	69,000
Total revenue (₦)						
Maize	299,504	179,024	430,128	243,824	473,504	-
Soybean	172,020	282,680	119,240	170,180	-	513,120
Combined	471,524	461,704	549,368	414,004	473,504	513,120
Profit/gross margin	342,274	331,620.7	419,701.4	281,504	345,504	444,120
Cost:benefit ratio						
Maize	1:0.396	1:0.663	1:0.277	1:0.500	1:0.270	-
Soybean	1:0.061	1:0.040	1:0.088	1:0.061	-	1:0.134
Combined	1:0.214	1:0.281	1:0.236	1:0.320	-	-

Average market prices in Ilorin, 2016/2017, for maize = ₦160/kg, soybean = ₦200/kg; 1 = 1:1; 2 = 1:2; 3 = 2:1; 4 = 2:2; 5 = 1:0; 6 = 0:1.

Conclusion

In conclusion, the type of a cropping system to recommend to the farmers depends on the objectives of the farmer. If his/her objective is to diversity food supply as well as to generate revenue and minimize weed infestation, the 2:1 ratio of maize to soybean cropping system will be more suitable. However, if the objective is to minimize weed infestation, especially in an intensively cultivated field where other crops will follow soybean production in the crop rotation and for profitability, sole soybean could be adopted.

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ZAKOROVljenOST I PRODUKTIVNOST ZDRUŽENOG USEVA
KUKURUZA I SOJE U ZAVISNOSTI OD RASPOREDA
BILJAKA U SAVANI JUŽNE GVINEJE U NIGERIJ

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R e z i m e

Poljski ogledi su sprovedni tokom 2015. i 2016. godine na nastavno-istraživačkom gazinstvu Poljoprivrednog koledža, Univerziteta u Kvari, Malete, kako bi se odredio uticaj prostornog rasporeda biljaka na zakorovljenost, rast i prinos združenog useva kukuruza i soje u savani južne Gvineje u Nigeriji. Ogledi su se sastojali od sledećih šest tretmana: jedan red kukuruza naizmenično sa jednim redom soje (1:1), jedan red kukuruza naizmenično sa dva reda soje (1:2), dva reda kukuruza naizmenično sa jednim redom soje (2:1), dva reda kukuruza naizmenično sa dva reda soje (2:2), čist usev kukuruza (1:0) i čist usev soje (0:1). Tretmani su bili postavljeni u potpunom slučajnom blok sistemu u tri ponavljanja. Prikupljeni podaci su obrađeni analizom varijanse i srednje vrednosti su poređene korišćenjem testa najmanje značajnih razlika (LSD) pri 5% nivou verovatnoće. Rezultati su pokazali da čist usev soje dosledno potiskuje korove što vodi ka većem prinosu. Pored toga, odnos 2:1 kukuruza prema soji nije samo smanjio gustinu korova, već je značajno povećao prinos kukuruza i smanjio prinos soje. Isti tretman je pokazao višu efikasnost korišćenja zemljišta i ekonomski prinos, a pratio ga je čist usev kukuruza.

Ključne reči: zdrženi usev, prinos useva/visina useva, ekonomski prinosi, efikasnost korišćenja zemljišta, Nigerija, gustina korova.

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