Esxon Publishers

International Journal of Applied Research and Technology
ISSN 2277-0585

Publication details, including instructions for authors and subscription information:
http://www.esxpublishers.com

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Aliyu, K. T.[1], Mohammed, I. B.[1] and Zakari, S. A.[2]

[1]International Institute of Tropical Agriculture (IITA), Kano, Nigeria.
[2]Audu Bako College of Agriculture, Danbatta, Kano, Nigeria.

Available online: June 30, 2016.

To cite this article:

Aliyu, K. T., Mohammed, I. B. and Zakari, S. A. (2016). Assessment of Millet-Groundnut Intercropping Systems Efficiency in Jigawa and Kano States. *International Journal of Applied Research and Technology*. *5(6)*: 44 – 50.

International Journal of Applied Research and Technology
Vol. 5, No. 6, June 2016. 44 – 50.

Assessment of Millet-Groundnut Intercropping Systems Efficiency in Jigawa and Kano States.

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(Received: 23 June 2016 / Accepted: 27 June 2016 / Published: 30 June 2016).

Abstract

In this study, an intercropping experiment consisting of millet and groundnut was established at Dutse (Jigawa) and Minjibir (Kano) to compare the efficiencies of intercropping systems. Two intercropping systems (2:2 and 2:4; millet to groundnut ratio) were studied in terms of aggressivity, competitive ratio, actual yield loss and intercropping advantage. The treatments were studied under split-split plot design that was replicated four times. The results shows that aggressivity was determined by crop arrangement not by component crop and that the rate of increase in millet aggressivity was proportional to rate at which groundnut aggressivity was reduced. Intercropping advantage was higher and positive under 2:4 system at both trial locations; this implies that the system have a better economic feasibility. Under the same system at Dutse, competitive ratio was higher (1.18); indicating that the crops have a fairly comparative ability for resources competition, in contrast, the reverse was the case at Dutse 2:2 with higher competitive ration difference value of 1.05 compared to 0.69 at 2:4.

Keywords: Competitive Ratio, Actual Yield Loss, Intercropping Advantage, Jigawa and Kano States

For corresponding author:
E-mail: *info@esxpublishers.com*
Subject: *0616-0221.*

Introduction

The mixture of two or more crops in the same field during their life is referred to as intercropping. Intercrops are arranged base on farmers' preference and choice of main crop, the way the crops are arranged with respect to distance between strips, number of crop combinations, life cycle and type of crop is usually referred to as intercropping system. Intercropping results to both intra and inter-specific competitions (Spitters, 1983). These competitions are intensified when poorly or uneven planting configuration/pattern existed; and this leads to unjustified plant competition for resources. Competition may be too intense among some plants and less among others. The productivity of intercropping system depends to a large extent on the nature and magnitude of plant competition and distance between intercrops (Harper, 1977). High competition between the crops manifests in growth, total dry matter production and yield performance of the competing crops. This is best addressed through spatial manipulations of the intercrops and this of course increases the overall system efficiency (Awal *et al*., 2006; Zhang *et al*., 2008).

Millet-groundnut intercropping is the very common practice among the small scale farmers around Kano and Jigawa providing staple and income respectively. The yield was found to be sub optimal owing to faulty crops arrangement; it was against this background this studies was conducted and aimed at assessing and identifying intercropping system that is argonomically and economically feasible.

Materials and Methods

This experiment was conducted at the experimental field of Institute of Agricultural Research (IAR), Minjibir and the second at Rahama town at Dutse. The treatment combinations were two varieties of millet, four varieties of groundnut planted in two intercropping systems. The total plot size was 5.0m x 4.5m from which 15m^2 was demarcated to measure yield of intercrops; this was laid out in split-split plot design with 4 replications. Using different formulae proposed by many researchers, Intercropping efficiencies and economic evaluation were deduced from measured yield and analyzed using Genstat 17th edition. Means of treatments were separated using Tukey HSD test.

Intercropping indices

Aggressivity as proposed by Gilchrist (1965) and competitive ratio by Willey and Rao (1980) were two indices used to determine the intercrops competition.

Aggressivity

$$\text{Aggressivity of millet (Am)} = \frac{Yim}{Ysm\ x\ Zm} - \frac{Yig}{Ysg\ x\ Zg}$$

$$\text{Aggressivity of groundnut (Ag)} = \frac{Yig}{Ysg\ x\ Zg} - \frac{Yim}{Ysm\ x\ Zm}$$

Competitive ratio

$$\text{Competitive ratio of wheat (CRm):} \left(\frac{\frac{Yim}{Ysg}}{\frac{Yim}{Ysg}}\right) x\, \frac{Zg}{Zm}$$

$$\text{Competitive ratio of lentil (CRg):} \left(\frac{\frac{Yig}{Ysm}}{\frac{Yig}{Ysm}}\right) x\, \frac{Zm}{Zg}$$

Where:
Ysm = Yield of sole millet
Yim = Yield of intercrop millet
Ysg = Yield of sole groundnut
Yig = Yield of intercrop groundnut
Zm = Proportion of millet in intercrop
Zg = Proportion of groundnut in intercrop

Actual yield loss

Actual yield loss (AYL) is the proportion of yield loss or gain in intercrops in comparison to the respective sole crop, i.e. it takes into account the actual proportion of the component crops with its pure stand. Actual yield loss (AYL) was calculated by the following formula proposed by Banik (1997).

$$AYL = AYLm + AYLg$$

$$AYLm = \left(\frac{\frac{Ymg}{Zmg}}{\frac{Ym}{Zm}}\right) - 1$$

$$AYLg = \left(\frac{\frac{Ygm}{Zgm}}{\frac{Yg}{Zg}}\right) - 1$$

Where:
Y = Yield per unit area.
Z = Sown proportion,
Subscripts m and g refers to pure stand (sole crops) of millet and groundnut, and mg and gm refers to intercrops respectively.

AYLm and AYLg are the partial yield losses; they represent the proportionate yield loss or gain of the millet and groundnut species respectively when grown as intercrops, relative to their yield in pure stands. AYL is therefore the sum of the two partials. $AYLm$ and $AYLg$.

Intercropping advantage

Intercropping advantage (IA) was calculated using the following formula:

$$IA = (Pm\ X\ AYLm) + (Pg\ X\ AYLg)$$

Where:
IA= Intercropping advantage
Pm = Unit price of millet.
Pg = Unit price of groundnut.

Results and Discussion

Table 1 shows the results of differences between the intercrops in terms of ability to compete for growth resources, this is quantified by aggressivity and competitive ratio. From the result, competitive ability (aggressivity) was determined by crop arrangement not by component crop. At Dutse, millet was more competitive at 2:4 system; contrast to Minjibir where 2:2 system gave millet higher ability to compete. As millet exerts its competitive pressure, groundnut aggressivity is reduced at the same magnitude. Higher numerical values of aggressivity denote greater difference in competitive ability as well as larger difference between actual and expected yield in both crops (Billore *et al*., 1992). At Dutse, groundnut aggressivity was significantly lowered at 2:4 system while at same arrangement at Minjibir, groundnut was more competitive and aggressivity was significantly low (-0.19) at 2:2 system. This is confirmed by Ghosh (2004) in a groundnut–cereal intercropping systems (maize, sorghum, and pearl millet) that the cereals were the dominant species in most cases.

The assessment of economic feasibility of intercropping systems was done by employing the concept of Intercropping Advantage (IA). IA as an indicator of the economic feasibility of intercropping systems, specified that the values of IA were higher and positive under 2:4 system at both trial locations (Table 1); this implies that the system is more economically feasible, whereas the other mixture, which had negative value, showed an economic disadvantage. Also, the advantage of 2:4 intercropping system found in this study can be attributed to the better utilization of growth resources which resulted from better competitive ratio and agrgressivity. Dhima *et al.* (2007) and Caballero and Goicoechea (1986) discovered that great competitive ability of wheat to exploit resources in association with common vetch led to increase the overall system advantages.

Competitive ratio (CR) indicates the ability of competition of one component crop over another under intercropped condition. The CR value over unity indicates the component as a good competitor while less than unity as a poor competitor when grown in association (Jedel *et al*., 1998). The CR varied significantly with the variation in crop combination and planting configuration. The result indicated that at Dutse, among the millet varieties, Supersosat have higher value of CR; meaning it is more competitive that Dankaranjo when grown in association with groundnut. Also the CR difference values for the two systems suggested that at 2:2 the competitive ability of one crop was far higher than the other, and this decreased the CR value (to -0.29). Under 2:4 system, competition is relatively milder and thus CR value was higher (1.18); indicating that the crops have a fairly comparative ability for resources competition. Meanwhile, at Minjibir (Table 2), both crops were indicated to be good in terms of competition when grown in association. When the crops were associated at 2:2 system, CR difference value was higher (1.05) and decreased (to 0.69) as the spatial variability was increased at 2:4. In most cereal-legume intercrops, the cereal species are shown to be the dominant in the system and have significant advantage over the legumes when it comes to resources competition. Das *et al*. (2012) in a cereal-common vetch experiment discovered that values of CR for cereals were greater than for common vetch indicating the dominance of cereals under these crop mixtures. The CR of cereals can only be decreased by increasing the proportion of the common vetch in the mixtures and it will increase the CR difference which will practically give the crops similar chances for competition.

The concept of actual yield loss determines the advantage or disadvantage of the individual crop and the intercropping system. A positive AYL value indicates the efficiency while negative one denotes non-system efficiency. According to Banik *et al*. (2000), the AYL index gives more precise information than the other indices on inter and intra-specific competition of the component crops and the behavior of each specie involved in the intercropping system. The AYL is the summation of partial AYLs of millet and groundnut. Among the millets at Dutse, partial AYL was shown to be significantly higher when Supersosat was used for intercropping. Yield advantage of intercrops is mostly dependent on the partial AYL of the cereal component; Banik (1996) and Banik *et al*. (2000) indicated that a yield advantage for common vetch was probably because of the positive effect of cereals on common vetch when grown in association, it was also revealed that in the experiment that cereal crop was the dominant one because the partial AYL of cereal was greater than that of common vetch. In this experiment 2:2 system was also negative indicating the disadvantage of the system which resulted in significant yield loss than 2:4. This agrees with the findings by Das *et al.* (2012) that among intercropping treatments wheat-lentil at 3:1 and wheat-chickpea 3:1 row ratio scored negative values indicating the disadvantage of the crop combination and planting configuration.

Conclusion and Recommendations

Intercropping efficiencies varies significantly with the variation in planting system and component crop. The experiment revealed that intercrop advantage was higher at 2:4 intercropping system at both location, and this is a sign that the system is more efficient in reducing inter and intra-specific completion.

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Tables

Table 1: Aggressivity, and intercropping advantage as affected by system and component crop

	Millet aggressivity		Groundnut aggressivity		Intercrop advantage	
Treatment	Dutse	Minjibir	Dutse	Minjibir	Dutse	Minjibir
Millet (M)						
Dankaranjo	0.32	0.44	-0.32	-0.44	41	32
Supersosat	0.39	0.53	-0.39	-0.53	40	37
SE±	0.081	0.143	0.081	0.143	5.39	6.12
System (S)						
2:2	0.18b	0.79a	-0.18b	-0.79a	38b	-4.0b
2:4	0.53a	0.19b	-0.53a	-0.19b	44a	17.3a
SE±	0.077	0.143	0.077	0.143	2.95	6.12
Groundnut (G)						
SAMNUT 21	0.25	0.38	-0.25	-0.38	38	14
SAMNUT 22	0.45	0.69	-0.45	-0.69	46	11
|SAMNUT 23	0.34	0.37	-0.34	-0.37	43	30
SAMNUT 24	0.38	0.50	-0.38	-0.50	37	60
SE ±	0.126	0.203	0.093	0.203	8.28	86.5
Interactions						
M*S	NS	NS	NS	NS	NS	NS
M*G	NS	NS	NS	NS	NS	NS
S*G	NS	NS	NS	NS	NS	NS
M*S*G	NS	NS	NS	NS	NS	NS

Means followed by the same letter within treatment are not significantly different at 5% using Tukey HSD Test.

Table 2: Competitive ratio as affected by system and component crop

Treatment	Millet Competitive Ratio Dutse			Groundnut Competitive Ratio Minjibir		
	Millet	Groundnut	Difference	Millet	Groundnut	Difference
Millet (M)						
Dankaranjo	1.14b	1.18a	-0.04b	1.46	0.93	0.53
Supersosat	1.80a	0.85b	0.95a	2.07	0.83	1.24
SE±	0.196	0.18	0.016	0.199	1.137	0.027
System (S)						
2:2	1.07b	1.36a	-0.29b	1.86a	0.81	1.05a
2:4	1.86a	0.68b	1.18a	1.66b	0.97	0.69b
SE±	0.196	0.189	0.023	0.270	0.236	0.031
Groundnut (G)						
SAMNUT 21	1.75	0.74c	1.10	1.66	1.03	0.63
SAMNUT 22	1.45	1.02a	0.43	2.38	0.74	1.64
SAMNUT 23	1.19	0.96b	0.23	1.48	0.94	0.54
SAMNUT 24	1.48	1.35a	0.13	1.53	0.90	0.63
SE ±	0.277	0.268	0.090	0.484	0.223	0.262
Interactions						
M*S	NS	NS	NS	NS	NS	NS
M*G	NS	NS	NS	NS	NS	NS
S*G	NS	NS	NS	NS	NS	NS
M*S*G	NS	NS	NS	NS	NS	NS

Means followed by the same letter within treatment are not significantly different at 5% using Tukey HSD Test.

Actual yield loss (AYL)

Table 3: Actual yield loss as affected by system and component crop

Treatment	Millet Actual Yield loss		Groundnut Actual Yield loss		Actual Yield loss	
	Dutse	Minjibir	Dutse	Minjibir	Dutse	Minjibir
Millet (M)						
Dankaranjo	0.36	0.36b	0.67	0.88	0.16b	1.03
Supersosat	0.08	0.08a	0.78	1.06	0.85a	0.86
SE±	0.118	0.099	0.178	0.365	0.312	0.273
System (S)						
2:2	0.15	0.15	0.67	0.86	-0.05b	0.82
2:4	0.29	0.29	1.08	1.08	1.05a	1.08
SE±	0.154	0.099	0.231	0.365	0.312	0.300
Groundnut (G)						
SAMNUT 21	0.14	0.26	0.63	0.65	0.89	0.76
SAMNUT 22	0.23	0.33	0.86	0.86	0.63	1.10
SAMNUT 23	0.17	0.18	0.66	0.66	020	0.84
SAMNUT 24	0.34	0.25	0.75	0.75	0.30	1.09
SE ±	0.093	0.203	0.252	0.516	0.441	0.265
Interactions						
M*S	NS	NS	NS	NS	NS	NS
M*G	NS	NS	NS	NS	NS	NS
S*G	NS	NS	NS	NS	NS	NS
M*S*G	NS	NS	NS	NS	NS	NS

Means followed by the same letter within treatment are not significantly different at 5% using Tukey HSD Test.