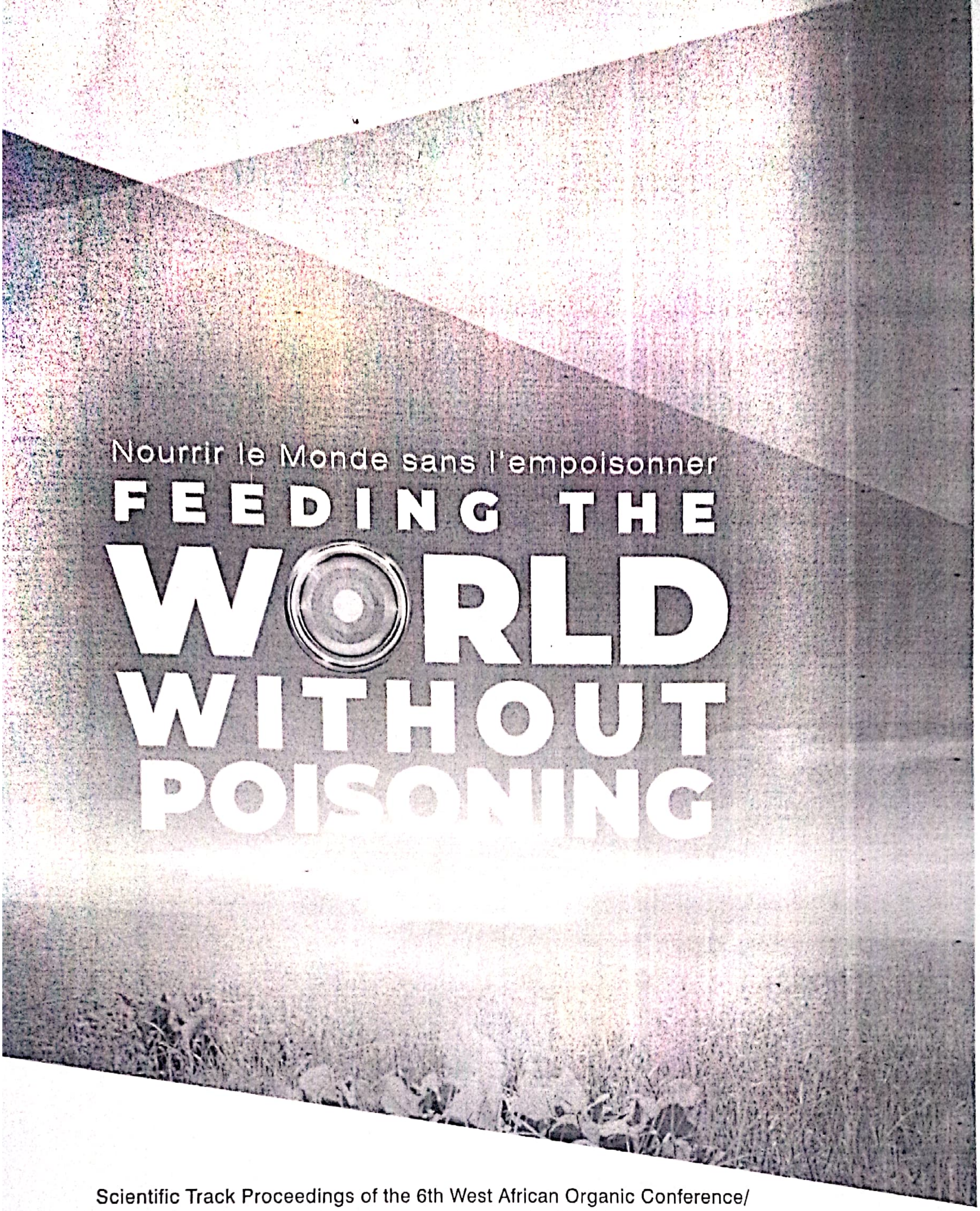

Nourrir le Monde sans l'empoisonner

FEEDING THE WORLD WITHOUT POISONING

Scientific Track Proceedings of the 6th West African Organic Conference/
6ème Conference Ouest Africaine De L'agriculture Biologique
November 23-26, 2021, Royal Beach Hotel,
Ouagadougou, Burkina Faso

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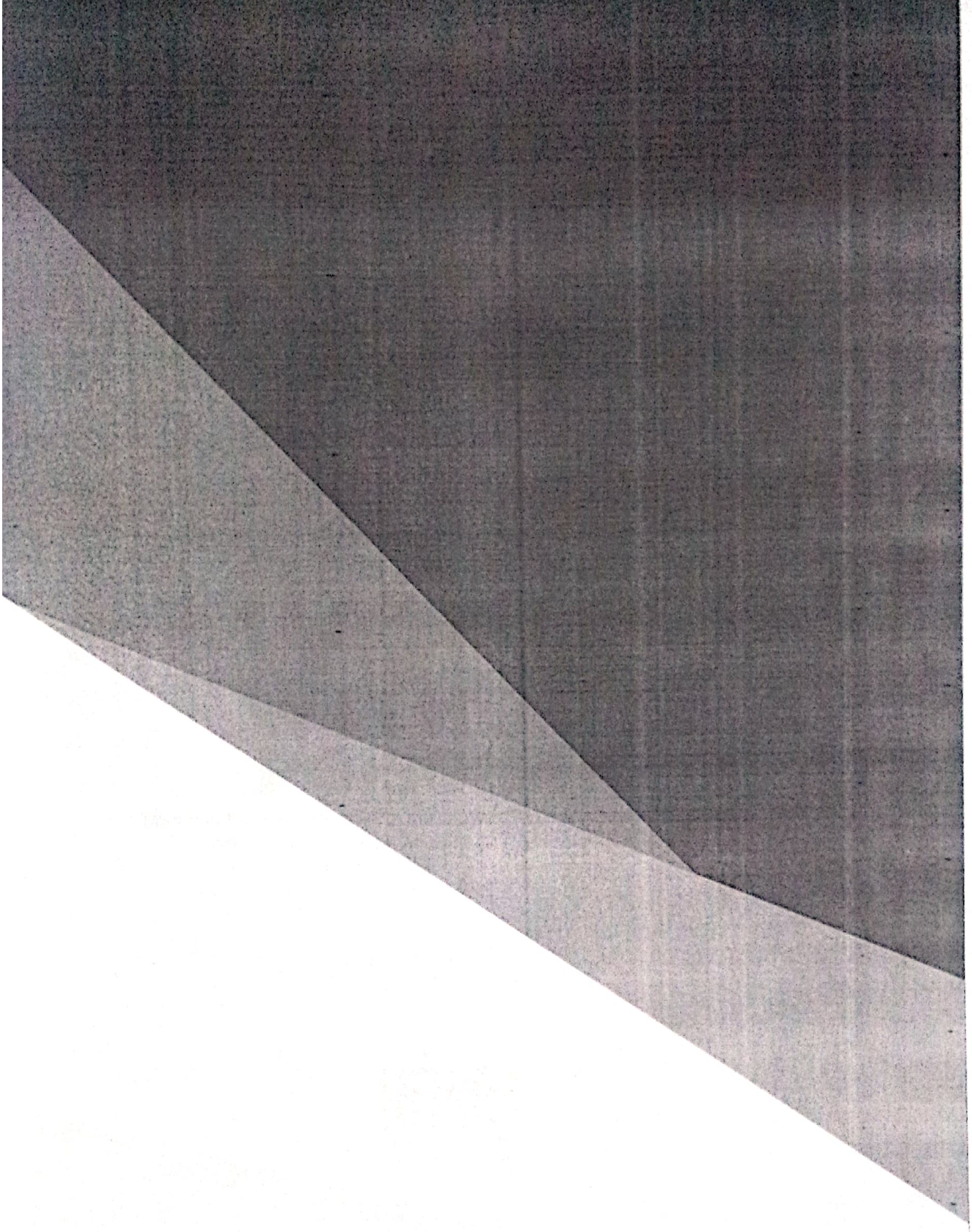

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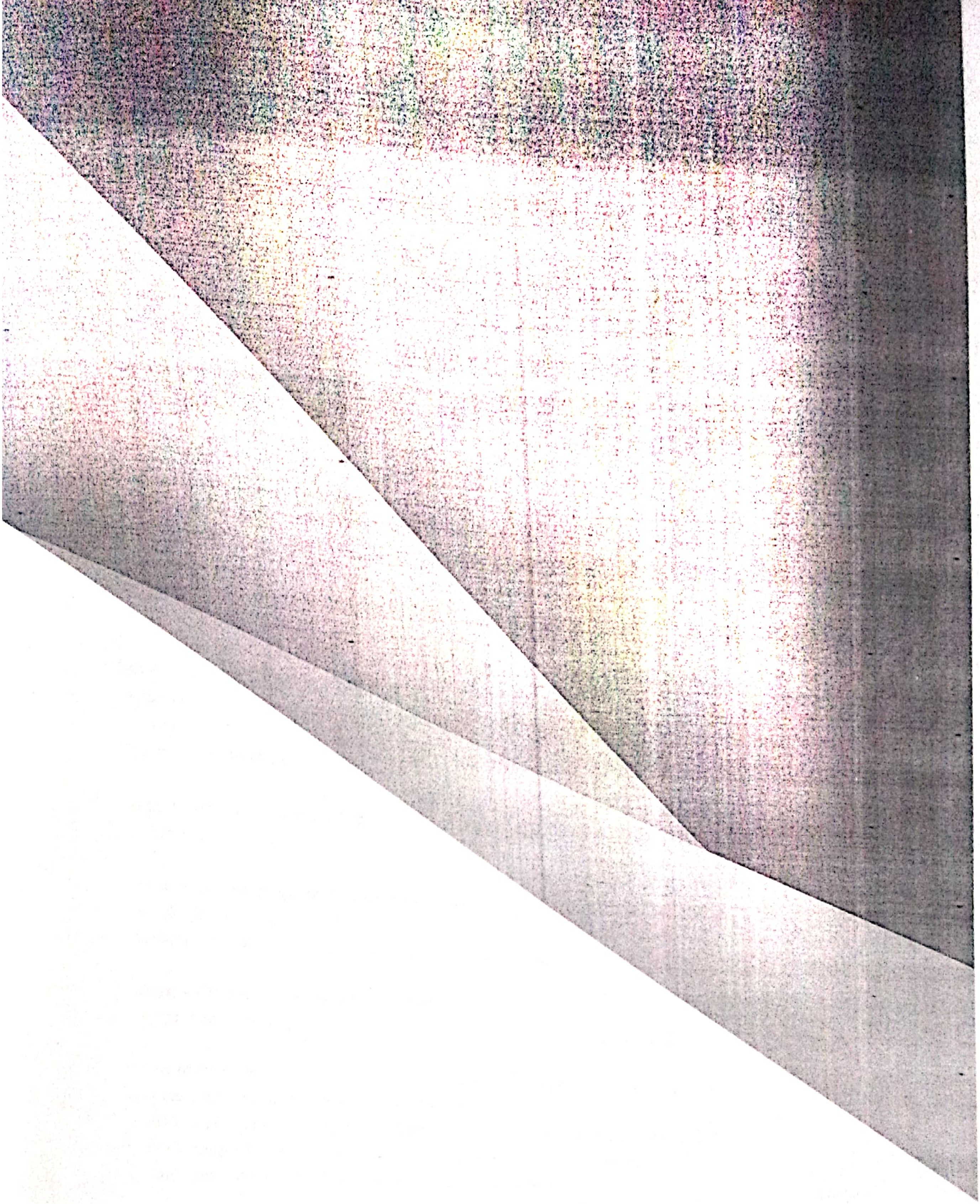

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Table of Contents

AdeOluwa, O.O., Ologundudu, O.M., Oloore, N.O. (Eds) (2021) Scientific Track Proceedings of the 6th West African Organic Conference/ 6ème Conference Ouest Africaine De L'agriculture Biologique. Theme: Feeding the World Without Poisoning/Nourrir le Monde sans l'empoisonnet. November 23-26, 2021, Royal Beach Hotel, Ouâgadougou, Burkina Faso

pp.115-122

Effects of Different Nitrogen Sources on Maize intercropped with Soybean on an Alfisols

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Abstract

A pot experiment was carried out at the screen house of the School of Agriculture and Agricultural Technology, Gidan Kwano campus, Minna in the cropping season of 2020. The experiment aimed to evaluate the growth and nodulation of soybean intercropped with maize. Two seeds of each crop were planted per pot containing 14kg of Gidan Kwano soils. A week after sowing, plants the were thinned to a seedling per crop genotype per pot, before basal application of N, P, K, Mg and micronutrients (B, Mo, Zn). Thereafter, the following cropping system (sole maize, sole soybean, intercropped maize and intercropped soybean) were fertilized as follows: -N as 0 kg N ha^{-1} (control), +inorganic N (urea) as 20 kg N ha^{-1} , +organic N (poultry dropping) as 20 kg N ha^{-1} and the United States Department of Agriculture (USDA) 110 as 5mls per plant of rhizobium inoculant. Subsequently, treatments were then arranged in a Completely Randomized Design with three replicates. Watering of plants was done daily till harvest at 6 weeks. Data collected were subjected to ANOVA. Means were separated using Duncan Multiple Range Test (DMRT). Results showed that averagely, sole maize was better than intercropped maize in plant height, the number of leaves and root weight but was significantly higher than intercropped maize in leaf area and shoot weight. Averagely, with the exception of days to 50% flowering and nodule weight, sole soybean was better than intercropped soybean in all the growth and nodulation characteristics measured. The sole soybean performed better when inoculated with elite strains of rhizobia USDA110 while the intercropped soybean was better when in association with indigenous rhizobium and 0 Kg N ha^{-1}. Organic Nitrogen of poultry source produced the best maize growth traits that was not significantly different as a result of inoculation of soybean with rhizobia.

Effets de différentes sources d'azote sur le maïs intercalé avec le soja sur un alfisols

Résumé

Une expérience en pot a été réalisée à la serre de l'École d'agriculture et de technologie agricole, campus Gidan Kwano, Minna pendant la saison de culture de 2020. L'expérience visait à évaluer la croissance et la nodulation du soja intercalé avec du maïs. Deux graines de chaque culture ont été plantées par pot contenant 14 kg de sols Gidan Kwano. Une semaine après le semis, les plants ont été éclaircis à raison d'un semis par génotype de culture par pot, avant l'application basale de N, P, K, Mg et de micronutriments (B, Mo, Zn). Par la suite,

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precisely Nigeria showed an improved intercropping system of two rows of cereal followed by two rows of the leguminous crop has been observed to be more profitable than the conventional intercropping system. This is due to its efficiency in the use of resources, particularly land, nutrients, light and water. Nevertheless, intercropping of cereal-legume might lead to reduction in the yield of the legume component because of the adverse competitive effects.

Aim and Objectives of Study

This study aims to evaluating the effects of N sources on the growth of maize and soybean in an intercrop system of Minna.

The objectives of this study are to;

i. assess growth, root formation and nodulation of soybean in sole and intercropped system.
ii. assess growth and root formation of maize in sole and intercropped system.

Materials and Methods

Description of Study Area

The pot experiment was carried out in the screen house of the School of Agriculture and Agricultural Technology, Federal University of Technology Gidan Kwano, Minna, Niger State. Minna in the Southern Guinea Savannah Zone of Nigeria. Minna lies between longitudes 9^{0} 35'E and latitudes 6^{0} 33'N at an elevation of about 258.5m above sea level. The temperature rarely falls below 22^{0} C. The peaks are 40^{0}C between February to March and 35^{0}C between November and December.

Soil Sampling and Analysis

Soil samples were collected randomly from Gidan Kwano at ten auger points per plot of five with the aid of a sterilized auger, bulked to form a composite. The composite was thoroughly mixed to form a soil. Thereafter, a larger portion was collected in pots while a smaller portion was reserved in the refrigerator for rhizobium population trials. Another small portion was air- dried in preparation for soil physical and chemical properties determination according to standard methods described by International Soil Reference and Information Centre and Food and Agricultural Organization (ISRIC/FAO, 2002).

Poultry N Content Analysis

The nitrogen content of the poultry droppings used was determined in the laboratory using the Kjeldahl method.

Treatments and Experimental Design

The treatments consist of Control (0 Kg N ha^{-1}), Inorganic Nitrogen of urea source (20 Kg N ha^{-1}), Organic Nitrogen of poultry source (20 Kg N ha^{-1}) and USDA 110 as Rhizobium inoculant at the rate of 5mls per plant. The treatments were replicated three times to give a total of thirty -six (36) pots.

Planting and Crop Management

The polythene pots used were filled with 14 kg of soil. The maize seeds (sammaz 15) and soybean seeds (TSB4810) were sown in polythene pots at the rate of two seeds (of each crop) per pot. Seeds were thinned to one crop per pot a week after planting. Organic nitrogen (poultry dropping) was added to the pots according to experimental design a week before planting. Single Super Phosphate (SSP) fertilizer was added to all the pots at planting. Basal applications of Single super phosphate, Muriate of Potash, Magnesium Sulphate, Zinc sulphate, Molybdate salt, boric acid and urea were supplied after thinning at the following rates; 30 Kg P ha^{-1}, 60 Kg K ha^{-1}, 5 Kg Mg ha^{-1}, 10 Kg Zn ha^{-1}, 0.1 Kg Mo ha^{-1}, 0.1Kg B ha^{-1} and 20 Kg N ha^{-1}. Weeds were hand-picked before and after the basal application of nutrients and when necessary. Plants were watered to field capacity at a day interval till harvest six weeks after planting.

Data Analysis

Data collected were subjected to Analysis of Variance (ANOVA). Mean differences were separated using Duncan Multiple Range Test (DMRT) at a 5 % level of probability.

Results

Table 1: Initial Soil Properties Chemical properties of experimental location

Parameters (g kg)	Values
Sand	859.6
Silt	5.76
Clay	82.8
Textural class	Loamy sand
pH in H_2O (1:2.5)	6.95
Total Nitrogen (g kg^{-1})	1.68
Organic Carbon (g kg^{-1})	4.2
Available P (mg kg^{-1})	7
Poultry dropping (g)	7.83

Table 2: Main effect of N source and cropping system on Growth of maize

	PH (Cm)	LNO $plant^{-1}$	LA (Cm^3)	DSW g $plant^{-1}$	DRW g $plant^{-1}$
N source(N)					
Control	90.50b	8.00b	318.75b	11.53c	2.94b
Organic Nitrogen (PD)	102.00a	9.17a	370.55ab	16.46a	3.73ab
Inorganic Nitrogen(urea)	95.67ab	8.17ab	415.56a	15.81ab	3.34ab
+USDA 110 inoculants	89.83b	8.50ab	366.60ab	13.08bc	4.19a
LSD (0.05)	9.77	1.03	66.92	3.10	1.11
Cropping system(C)					
Sole maize	95.58a	9.17a	345.78a	12.32b	4.23a
Intercropped maize	93.42a	7.75b	389.95a	16.12a	2.87b
LSD (0.05)	6.91	0.73	47.32	2.19	0.78
Interaction N * C	NS	NS	NS	NS	NS

KEY: PH= Plant height; LNO= Leaf number; LA= Leaf area; DSW= Dry shoot weight; DRW= Dry root weight

Table 3: Main effect of N source and cropping system on the growth of soybean

	PH (cm)	NOB plant^{-1}	LNO plant^{-1}	LA cm3	50% flow	NN plant^{-1}	NDW g plant^{-1}	DSW g plant^{-1}	DRW g plant^{-1}
N source(N)									
Control	56.67b	8.0a	26.0b	39.75ab	32.0b	6.0b	0.08a	2.38ab	0.56ab
Organic Nitrogen (PD)	68.08b	8.0a	27.0ab	44.88a	32.0b	3.0c	0.05bc	3.19a	0.79a
Inorganic Nitrogen(urea)	59.67ab	6.0a	20.0c	33.44b	33.0a	3.0c	0.03c	1.78b	0.35b
+USDA 110 inoculant	82.17a	7.0a	31.0a	41.63ab	32.0b	14.0a	0.07ab	3.23a	0.54ab
LSD (0.05)	14.03	1.52	4.91	9.48	0.001	2.32	0.02	1.04	0.32
Cropping system(C)									
Sole soybean	84.29a	9.0a	34.0a	54.19a	30.0b	9.0a	0.05a	3.97a	0.91a
Intercropped soybean	49.00b	6.0b	17.0b	25.66b	34.0a	4.0b	0.06a	1.32b	0.22b
LSD (0.05)	9.92	1.07	3.48	6.70	0.001	1.64	0.02	0.73	0.22
Interaction N * C	**	NS	**	NS	**	**	**	*	NS

KEY: PH = Plant height NOB = Number of branches LNO= Leaf number LA= Leaf area NN= Nodule number NDW= Nodule dry weight DSW= Dry shoot weight DRW= Dry root weight.
Means with different letter(s) indicated on the column are significantly different at P≤0.05.
** = highly significant, NS = Not significant, * = Significant

Table 4: Plant Height (cm) as affected by the interaction between cropping system and N sources

	Sole soybean	Intercropped soybean
N Source (S)		
Control	63.67bc	49.67cd
Organic N	81.50b	54.67cd
Inorganic N	75.0b	44.33c
+USDA 110	117.0a	47.33cd
SE±	6.62	

Table 5: Leaf Number per plant as affected by the interaction between cropping system and N sources

	Sole soybean	Intercropped soybean
N Source (S)		
Control	29.0c	22.0de
Organic N	36.0b	17.0ef
Inorganic N	27.0cd	12.0f
+USDA 110	45.0a	17.0ef
SE±	2.32	

Table 6: Days to 50% flowering as affected by the interaction between cropping system and N sources

	Sole soybean	Intercropped soybean
N Source (S)		
Control	31.0c	32.0d
Organic N	28.0f	36.0a
Inorganic N	31.0c	34.0c
+USDA 110	28.0f	35.0b
SE±	0.001	

Table 7: Nodule number per plant as affected by the interaction between cropping system and N sources

	Sole soybean	Intercropped soybean
N Source (S)		
Control	4.0c	8.0bc
Organic N	2.0c	4.0c
Inorganic N	4.0c	2.0c
+USDA 110	26.0a	2.0c
SE±	1.09	

Table 8: Nodule dry weight per plant as affected by the interaction between cropping system and N sources

	Sole soybean	Intercropped soybean
N Source (S)		
Control	0.06c	0.10a
Organic N	0.03c	0.07ab
Inorganic N	0.03c	0.03c
+USDA 110	0.10a	0.04bc
SE±	0.01	

Table 9: Dry shoot weight per plant as affected by the interaction between cropping system and N sources

	Sole soybean	Intercropped soybean
N Source (S)		
Control	2.83b	1.93bc
Organic N	4.85a	1.52bc
Inorganic N	2.82b	0.75c
+USDA 110	5.38a	1.07c
SE±	0.49	

Discussion

Soil Properties of the Experimental Location

The results obtained from the soil properties of Gidan Kwano soil (Table 1) showed that the soil textural class was loamy sand. Soil reaction was neutral which is the optimum for the growth of most plants as nutrients are most available to plants at the pH range of 5.5 to 7.0 (Miller and Donahue, 1995). The total nitrogen was very low. The organic carbon content of the soil was low which is characteristic of tropical soils resulting from the effect of high annual temperature and rainfall. Soil organic carbon is a potential soil fertility indicator for regulating nitrogen application in tropical farming systems. The soil's available phosphorus content was moderate. The total P concentration in crops generally varies from 0.1 to 0.5 percent, as such, moderate to a high content of phosphorus is required for maximum productivity of both maize and soybeans.

Growth and nodulation characteristics as affected by N sources.

Leaf area and shoot biomass were significantly affected by N sources (Table 2). This is because maize as a cereal crop requires an appreciable amount of nitrogen (90 – 120 Kg N ha^{-1}) to grow (Adesoji *et al.*, 2016). Maize in an intercrop system requires more nitrogen input. Since the association is with soybean, it is expected that the soybean would supply the amount of nitrogen sufficient through its association with effective rhizobia (Osunde *et al.*, 2003)

The best maize height and heaviest shoot weight were attained when 20kg N ha-^{1} was applied as organic N. There were more leaves and root weight was heaviest with the application of USDA 110 which is because the specie is capable of producing plant growth-promoting substances. The most important is indole acetic acid, an auxin resulting in higher root development (Perrig *et al.*, 2007), and thus increasing the area of root system exploration and nutrient absorption (Ferreira *et al.*, 2013).

Leaf area was widest with the application of Urea as an inorganic N source due to the fact that during the N assimilation and remobilization phases, young roots and leaves which are sink organs efficiently absorb and assimilate inorganic N for amino acids and protein synthesis (Hirel *et al.*, 2007).

Inoculation with USDA was beneficial to sole soybeans compared to intercropped soybean with regards to plant height, the number of leaves, days to 50% flowering, nodulation and shoot weights (Table 4). This may be due to the fact that legumes are weak competitors in legume/cereal intercropping systems, compared with cereals (Hauggaard-Nielsen and Jensen, 2001). This is often ascribed to differences in the root distributions of legumes and cereals, and the resulting differences in the ability of these crops to compete for soil N (Fan *et al.*, 2006).

Organic N was more beneficial to maize than the inorganic N when sole than when intercropped (Table 2). Generally, organic nitrogen is not readily available to plants because they are not in the form that can be taken up by plants due to the slow release of the nutrients. However, a plant rooting system and architecture affect the way nutrients are taken up. Maize plant with a prop rooting system are not deep feeders. Hence, sole maize that has no competitors has enough time to biodegrade and assimilate organic inputs than maize intercropped with soybeans. Intercropped soybean preferred natural rhizobial population and basal N than any other input. It has been well reported that N can be transferred from legumes to cereals in intercropping systems by indirect or direct pathways (He *et al.*, 2009; Xiao *et al.*, 2004). Indirect pathways transfer N released from dead and decayed legume tissues, and from legume root exudates to the rhizosphere, where they are taken up from the soil solution by cereal roots or hyphae. Direct N transfer is mediated by Common Mycorrhizal Network (CMN) between coexisting legumes and cereals (Paynel *et al.*, 2008).

Interaction with native rhizobia (control) was also beneficial to intercropped soybean compared to other sources of nitrogen suggesting that the bioavailable nitrogen from the natural rhizobia was preferentially utilized by the legumes while the other forms of N (inorganic and organic N precisely) were utilized by the maize plants. Soybean and maize can be naturally inoculated by indigenous Arbuscular Mycorrhizal fungi and rhizobia in the field. Indigenous rhizobia have low nodulation activities than those of introduced rhizobia (Qin *et al.*, 2012). Therefore, effective rhizobium inoculation combined with indigenous AM fungi not only increases N uptake through symbiotic N fixation but also enhances N transfer by CMNs, which could subsequently contribute to improved intercropping advantages in soybean/maize intercropping system.

Conclusion and Recommendations

Although there were no significant differences between the different nitrogen sources and cropping systems in the growth of maize, the study has shown that soybean was significantly affected by the interaction between N sources and the cropping system. Sole soybean performed better when inoculated with an elite strain of rhizobium USDA 110 while the intercropped soybean performed better when in association with indigenous Rhizobium and 0 Kg N ha^{-1} (control).

It can therefore be recommended that intercropping maize with soybean will help supply a reasonable amount (60-70 %) of nitrogen required for optimum growth of the maize in association with soybean which can later be supplemented with the supply of 20 Kg N ha^{-1}as organic and inorganic sources to raise the crop to maturity. However, soybean in association with maize preferred natural rhizobial population such that inoculation with exotic rhizobia becomes needless and the cost of supply of biological nitrogen avoided or minimized.