Agronomic performance of soybeans (*Glycine max* (L.) Merrill) in an organic crop rotation system

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Abstract

Soybean was sown after sunflower, sesame and maize between 2008 and 2012 to assess its agronomic performance under continuous, rotational and conventional cropping systems. The experiment was laid out in a randomized complete block design and replicated four times. Soybean grown under rotational cropping system produced significantly ($p<0.05$) higher number of branches, seeds and pods per plant than the soybean under continuous and conventional cropping systems in 2012. Similar trend was recorded in 2011 and 2012 for grain yield. On average, grain yield performance of soybean under rotational cropping system (2,445.0 – 2758.3 kg.ha^{-1}) was superior to the yield of soybean under continuous and conventional cropping systems (1343.8 – 2556.3 kg.ha^{-1}) as the rotation scheme became stable from 2010 to 2012. Inclusion of soybean in crop rotation scheme is hereby recommended for sustainable organic crop production systems in the humid tropics.

Introduction

Soybean (*Glycine max* (L.) Merrill) is a grain legume crop grown mainly for its high quality seeds (Weiss 2000). The inclusion of soybean in a crop rotation system is very crucial because it provides the soil with nitrogen through nitrogen fixation, reduces soil erosion, improves soil structure and increases soil organic mater content apart from the economic yield (seeds) it provides for the farmer (Peel 2010). Unfortunately, crop rotation is seldom practiced by most farmers in tropical Africa because it requires special management or additional planning skills to effectively plan and execute. Therefore, there is the need to generate scientific information that can assist in developing appropriate recommendation package for crops such as soybean, sunflower, sesame and maize that have economic importance in an organic crop rotation system. This study evaluated the agronomic performance of soybean under rotational, continuous and conventional cropping systems.

Material and methods

The field trials were carried out between 2008 and 2012 on the organic agriculture research plots of the Organic Agriculture Project in Tertiary Institutions in Nigeria (OAPTIN) located on the Teaching and Research Farm of the Federal University of Agriculture, Abeokuta (9^o 15´ N, 3^o 25´ E, altitude 140 m.a.s.l). The component crops in the experiment were soybean, sunflower, sesame and maize (Table 1). The crops were grown in the late cropping season (July – November) each year. The soil of the experimental field was oxic Paleudulf (Adetunji 1991). The test variety of soybean grown was TGx 1448-2E, an improved late maturing variety resistant to pod shattering (Asofo-Adejei and Adekunle 2001). The experimental design was randomized complete block design (RCBD) with four replicates and the treatments evaluated were continuous, rotational and conventional cropping systems. The conventional plots were located at about 15 m away from the organic plots in order to avoid any commingling. The row spacing adopted was 60 x 5 cm (266,000 plants ha^{-1}). The conventional soybean plots received pre-emergence herbicide (galex + gramoxone), inorganic fertilizer (30 kg N ha^{-1}, 56 kg P_2O_5 ha^{-1} and 100 kg K_2O ha^{-1}) application. The organic fertilizer (Aleshinloye Fertilizer - 1.2%N, 76 ppm P, 13.75 cmol K, 10.28 cmol Na) equivalent to 30 kg N ha^{-1} of the inorganic fertilizer was applied at the rate of 25 tonnes ha^{-1} to the continuous and rotational cropping systems plots in 2010 – 2012. No herbicides and inorganic fertilizers were applied to the continuous and rotational plots during the experiment. All the experimental plots were weeded twice at 4 and 8 weeks after sowing, WAS each year. Data were collected on some yield attributes: number of branches, pods and seeds per plant, weight of pods and seeds per plant, and grain yield on yearly basis. All data collected were

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subjected to analysis of variance and where cropping systems effects were significant, means were separated using the least significant difference method.

Results

Data on grain yield (2008 – 2012) and some yield attributes of soybean (2012) are presented in Table 2. Rainfall data taken on daily basis showed a distribution that varied markedly during the period of experimentation (328.0, 479.5, 791.2, 934.0 and 451.7 mm in 2008, 2009, 2010, 2011 and 2012, respectively). At the commencement of the study in 2008, cropping system had no significant effect on grain yield. However, cropping system significantly (*$p<0.05$, F-test*) affected grain yield in subsequent years, except in 2010 even though the rotational cropping system produced grain yield 7.3 and 51.2% higher than the conventional and continuous cropping systems. Cropping system significantly (*$p<0.05$; F-test*) affected number of branches, seeds and pods per plant in 2012. Soybean plants grown under rotational cropping system recorded significantly *($p<0.05$)* higher number of branches, seeds and pods per plant than those under continuous and conventional cropping systems.

Table 1: Rotation scheme involving sesame, sunflower, soybean and maize

2008	2009	2010	2011	2012
Sunflower	Sesame	Maize	**Soybean**	**Sunflower**
Sesame	**Soybean**	Sunflower	Maize	**Sesame**
Maize	Sunflower	**Soybean**	Sesame	**Maize**
Soybean	**Maize**	**Sesame**	**Sunflower**	**Soybean**

Table 2: Grain yield (2008 – 2012) and some yield attributes of soybeans (2012) under three cropping systems

Cropping System	Number per plant			Weight per plant (g)		Grain yield (kg.ha^{-1})					
	bran-ches	seeds	pods	seeds	pods	mean	2008	2009	2010	2011	2012
Continuous	2.9	156.8	78.5	21.3	11.8	1822.4	623.0	1343.8	1269.3	1893.3	**1390.4**
Rotational	4.9	317.3	132.8	34.0	19.5	1822.4	1029.0	2758.3	2445.0	2711.7	**2153.3**
Conventional	3.2	163.9	75.7	25.0	13.8	2004.0	1771.5	2556.3	1733.0	1913.2	**1995.6**
Lsd 0.05	**0.59**	**74.03**	**22.16**	**ns**	**ns**	**ns**	**481.1**	**ns**	**415.6**	**556.12**	**511.79**

ns: not significant

Discussion

The grain yield of soybeans under the conventional and rotational cropping systems were at par and superior to the yield from continuous cropping system between 2008 and 2012. In 2012, the significantly higher grain yield recorded under rotational cropping system could be attributed to significantly higher number of branches, seeds and pods per plant relative to the soybeans under continuous and conventional cropping systems.This trend corroborated earlier findings that yields from organic plots are usually higher than yields from conventional plots especially in drought years because of better water holding capacity of soils under organic system than the conventional soils (Posner et al. 2008). This confirmed the potential of crop rotation in soil fertlity management under organic production systems in the tropics because the grain yield values (1029.0 – 2758.3 kg ha^{-1}) recorded compared favorably with the African (729 kg ha^{-1}) and world (2,250 kg ha^{-1}) averages (FAO, 2004).

Suggestions to tackle the future challenges of organic soybean production

Organic soybean production has been confirmed to be a profitable venture. Resource poor farmers in the tropics that produce over 70 percent of food consumed cannot afford to purchase synthetic fertilizers to boost production. Inclusion of soybean in crop rotation system coupled with the application of organic fertilizer will definitely enhance the fertility status of tropical soils and thereby increase crop productivity.

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