Introduction

White yam (Dioscorea rotundata L. Poir) Family Dioscoreaceae is native to West Africa, but it does not occur in the wild, and is probably developed in cultivation from the wild species - D. praeckensilis Benth. D. rotundata Poir is grown on a greater acreage than any other cultivars in West Africa. Other popular cultivated yam species in Nigeria are D. cayenensis Lam. (yellow yam) and D. alata L. (water yam) (Tchabi et al 2010). There is a very large number of cultivars of D. rotundata that are grown, especially in Nigeria where it originated and is most widely cultivated (Osunde, 2006). The various cultivars can be identified by the tuber characteristics after harvest or by their shoot characteristics while they are growing in the field.

Underground tubers vary in size and shape averaging 1.3 - 3.6 kg, sometimes reaching 27.2 kg or more (IITA, 2007). Besides its importance as food source, yam also plays a significant role in the socio-cultural lives of people in some producing regions like the celebrated New Yam Festival in West Africa (Osunde and Orhehva, 2009) and wedding ceremonies (O'Sullivan, 2008). Yam also provides cash income for a wide range of smallholders, including many women as producers, processors and traders (Adekunle et al., 2012).

Nutritionally, the content of white yam is mainly carbohydrate, but also contain about 1-2% dietary protein, which is high with greater amount than other tropical root crops (Ekfan et al., 1999). However, yam production in West Africa is affected by several threats including effects low soil fertility, pests and diseases. These pests include Scutellonema bradys, a yam nematode, and root-knot nematode, Meloidogyne spp. (Kofoid & White) which are field and post-harvest pest. Root knot nematodes mainly Meloidogyne incognita, M. javanica and M. arenaria are a major cause of yield decline in the production fields. They alter the plant physiology by producing specific enzymes that induce giant cell formation within the root at the feeding site (Karsen et al., 2006). The objective of this study is to investigate allelopathic and nematotoxic effect of Hibiscus sabdariffa on the yield parameters of D. rotundata cultivars.

Materials and Methods

Study sites

The trials were conducted at the teaching and Research Farm, Federal University of Agriculture, Makurdi Benue state, Nigeria. The area is significant for extensive cultivation of D. rotundata and initial parasitic nematode population densities were perceived to be very high.

Experimental design

Land preparation was done manually by clearing weeds with a cutlass and debris was collected. Stumps were removed with a mattock and pick-axe before mounds were raised at a planting distance of 1 x 1 m. There were 20 mounds for each treatment. Trials were mounted on Randomized Complete Block Design (RCBD) with three replications on a total land area of 360 m².

Plant material

Three (3) most popular D. rotundata cultivar among farmers in this area; Hembakwase, Aloshi and Amula which are highly patronized by buyers was selected for the trials. The cultivar was purchased from the open markets in the area. Yam sets averaging 350 g were used for planting. Setts were tested for presence of plant parasitic nematodes prior to planting. The experimental plant Hibiscus sabdariffa was established with the yam cultivars. Five gram tuber peel samples were taken at planting and processed for plant parasitic nematodes. Peel samples were replicated three times. Setts were placed in the hole made with a hoe in the mound and properly covered with soil. Dry straw was placed on top of the mounds for moisture preservation after planting. After sprouting, yam vines were supported with stakes and the experimental trials were each weeded three times before harvest. The trials had three replications and repeated two times during (2016 and 2017) planting seasons.

Soil sampling for nematodes

Initial soil sampling was collected prior to planting to determine plant parasitic nematodes population densities at the site. Stand establishment was taken 3 months after planting. At harvest, soil samples (200 cm/mound) were randomly collected with a 2.5 cm diameter soil
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Results and Discussion

Table 1 shows allelopathic effect of Hibiscus sabdariffa on the yield parameters of some selected cultivars of Dioscorea rotundata on nematode infested soils of Makurdi Benue state. The number of tubers is significantly (P ≤ 0.05) higher in all the treated tubers: Alishi X Hibiscus sabdariffa, (20.67), Amula X Hibiscus sabdariffa, (19.67), Hembakwase X Hibiscus sabdariffa (27.67) respectively and significantly (P ≤ 0.05) lower in untreated yam tubers. There is no significant (P ≤ 0.05) difference in the yield per plot of all the different cultivars and treatments. The untreated control gave a significantly (P ≤ 0.05) higher yield per plot than all other treatments.

Table 2: Allelopathic effect of Hibiscus sabdariffa on the initial, mid and final nematode population of some selected cultivars of Dioscorea rotundata in nematode infested soils is shown on Table 2. There’s no significant difference in the initial nematode population for all the different cultivars and treatments. The untreated control gave a significantly (P ≤ 0.05) higher mid nematode population than all other treatments for the different cultivars. There’s however no significant difference in the mid nematode populations for the treated plants. Similarly, the untreated control plants gave a significantly (P ≤ 0.05) higher final nematode population for all the different cultivars while the treated cultivars gave a significantly lower final nematode population.

Table 3: Allelopathic potential of Hibiscus sabdariffa on the Root knot nematode damage and root gall index on some selected Dioscorea rotundata cultivars in nematode infested soil of Makurdi, Benue state

The means of the two years data (2016 and 2017) was subjected to Analysis of variance (ANOVA). Mean separation was done using Least Significant Difference (LSD) at p = 0.05 using GenStat 8.1 (Lawes Agricultural Trust, VSN International).

Data collection

Data collected include yield parameters such as number of ware tubers per plot, weight of ware tubers per plot, total fresh tuber weight, tuber length, tuber diameter. The roots were washed carefully under a gentle stream of tap water, mopped dry and assessed for galls. Eggs were extracted from the roots and estimated. The numbers per 100g of fresh root weight of tuber following extraction using Baerman extraction method was also be assessed.

Data analysis

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Table 3 shows the allelopathic effect of Hibiscus sabdariffa on the number of galls per 10 g of root, Egg mass per 10 g of root, nematode population per 10 g of root and the root gall index of some selected cultivars of Dioscorea rotundata on nematode infested soils. There’s significant difference in all the result obtained for in the number of galls per 10 g of root. Egg mass per 10 g of root, nematode population per 10 g of root and the root gall index. The untreated control gave a significantly (P ≤ 0.05) higher number of galls than all other treatments for the different cultivars with tubers treated with tubers treated with Hibiscus sabdariffa recording a significantly (P ≤ 0.05) lowest number of galls per 10 g of root. Similar trend is observed in the data obtained for Egg mass per 10 g of root and nematode population per 10 g of root. Also, the untreated control plants gave a significantly (P ≤ 0.05) higher root gall index for all the different cultivars while the treated cultivars gave a significantly lower root gall index. Allelopathy of secondary metabolites is being explored in field crop production for integrated pest and disease management. Production of allelopathic chemicals that function as nematode antagonistic compounds has been demonstrated in many plants such as castor bean, chrysanthemum, velvet bean, sesame, jack bean, crotalaria, sorghum-sudan, indigo, tephrosia, neem, Tamarindus indica, flame of the forest (Chitwood, 2002). These chemicals include saponins, tannins, polyphenyls, glucosiniolates, cyanogenic glucosides, alkaloids, lipids, terpenoids, triterpenoids and phenolics, among others. When grown as allelopathic cover crops, bioactive compounds are exuded during the growing season or released during green manure decomposition (Chitwood, 2002; Ball-Coelho et al., 2003). The result obtained in this experiment is in line with Narwal (2010) where the use of allelochemicals gives higher yields and considerably reduces the density of nematodes. Wood ash increased yield but was ineffective in reducing nematode densities. This suggests that Hibiscus sabdariffa has stimulatory (positive) allelopathic ability on shoot and root growth. This enhanced growth may be linked to the production of more auxin at 100% concentration of the extract. Zhung et al. (2005) gave similar report on the effect of Lantana (Lantana camera L.) on water hyacinths (Eichornia crassipes). Stimulation of growth by plant extracts can be accounted for by the breakdown of functional allelochemicals in the extracts and their subsequent transformation to plant nutrients required for growth. In the opinion of Aladejimokun et al. (2014), stimulation of growth by plant extracts can be accounted for by the breakdown of functional allelochemicals in the extracts and their subsequent transformation to plant nutrients required for growth. This unequal susceptibility to different plants could be due to inherent differences in various biochemicals released by the different plants in the intercrop.

Conclusion and Recommendation

The results obtained in this study showed that the highest number of tubers, tuber weight per plant and tuber yield was obtained from yam cultivars treated with allelopathic plants, most especially Hibiscus sabdariffa in all the cultivars used for this study. There is sufficient evidence in this study to support that Hibiscus sabdariffa had more allelopathic potentials on the growth and yield of white yam cultivars. Also, the stimulatory effect of Hibiscus sabdariffa when properly utilized could lead to increase in growth of white yams. Farmers should be encouraged to plant Hibiscus sabdariffa around their farms because the allelochemicals produced by the plant could enhance growth in the crops. This strategy is durable, compatible and integrable with the prevailing agricultural practices specific to our people.

References


