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RESEARCH ARTICLE

INHIBITION OF GERMINATION AND GROWTH BEHAVIOR OF SESAME UNDER SELECTED AGROFORESTRY TREE SPECIES IN THE TROPICAL RAINFOREST AREA OF NIGERIA

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ABSTRACT

A field experiment was carried out to investigate germination and early development of sesame (Sesamum indicum L.) as inhibited by selected common tree species (Azardiracta indica, Parkia biglobosa and Vitellaria paradoxa) over a period of 10 weeks. The experiment was laid out in Randomized Complete Block Design (RCBD) with three (3) replicates. Two seeds of studied arable crops were planted on beds 3m by 3m dimension at 90cm by 30cm under each tree species while the open space was used as control. Data were collected on germination, plant height, stem diameter, number of leaves, number of branches, root length, the above grand biomass and the below grand biomass and were subjected to statistical analysis using Analysis of Variance (ANOVA) while the significant mean were separated using Duncan's Multiple Range Test (DMRT) at 5% possibility level. Neem tree (Azardiracta indica), Locust tree (Parkia biglobosa), and shear butter tree (Vitellaria paradoxa) inhibited the germination and physiological development of sesame. The statistical germination value (56.67) observed in TNS and TLS was significantly ($p < 0.05$) lower than 60.00 (TSS) and 100 observed in the control. Since tropical farming system is commonly characterized by an agroforestry, where certain common tree species are unavoidably co-exist with certain arable crops, the significant of the present finding is that famers are to avoid planting of the studied crop on any farm land with these agro-forestry trees.

INTRODUCTION

Despite the increasing global per capita food production, there has been an alarming declining in food production in the African continent over the past years (Bationo *et. al.*, 2003). This has resulted to widespread malnutrition, a recurrent need for emergency food supply and an increasing dependence on food importation. This malnutrition can be attributed to the relatively low growth rate for arable crop yield as compared to the annual population growth rate With large areas of forests, wetlands, river valley bottoms and grassland savanna being put under food crops, the food gap (requirements minus production) keeps widening (Bationo *et. al.* ,2003). One of the approaches which have been sought by researchers to increase food production is the testing of the different cropping systems and the most suitable cropping systems is growing several crops in association as mixtures (Bationo *et. al.*,2006). Mixed and alley cropping agro-forestry system have greater potential than other systems to increase the production and to control erosion on sloppy lands under tropical conditions (Khalid, *et. al.*, 2012). Numerous crops had been investigated more or less thoroughly for allelopathic activities towards weeds or other cultivated crops (Barnes & Putnam 1986; Zoheir, 2009). A suppressive effect on weed, possibly medicated by the release of allelochemicals has been reported for a wide range of temperate and tropic crops (Zoheir, 2009). The allelopathic activity of rye has mainly been investigated in relation to the weed suppressive ability when used as green manure or as cover crop (Narwal, 1994). The release of allelochemicals via root exudates has also been documented (e.g. Barnes & Putnam 1986; 1987; Creamer, *et. al*., 1996; Hoffman *et al*., 1996). A number of authors, such as Rice (1984), Rasmussen and Rice (1971) and Nelson (1996) had documented the interference effects of some plants on other crops, prominent of which is the inhibition of germination (Williamson *et. al.,* 1992, Patil, (1992), Djurdjevic *et. al.,* 2004), reduction in the growth lengths of plumule and radicle (Tobe and Omasa 2000), retardation of seedling growth (Bhatt and Todoria 1990) and poor seedling survival (Smitt 1990). Previous assertions had suggested that allelochemicals inhibit seed germination by blocking of nutrient reserve and cell division thereby caused significant reduction in the growth of plumule and radicle of

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many crops (Ogbe *et al.*, 1994, Tobe and Omasa (2000). Neem (*Azadirachta indica*) belongs to the Kingdom plantae, Division magnoliophyta, Order sapindales, Family Meliaceae, Genus Azardiracta, Species indica. It is a native to South Asia and Southeast Asia, which grows well in the hot river valley areas. Neem is regarded as "The Wonder Tree" and "Nature's Drug Store", because its extract has a vast pharmacological activity and is used as raw materials for pesticide, medicine and other commodities. Neem is considered to be "one of the most promising of all plants and the fact that it may eventually benefit every person on this planet". Probably no other plant yields as many strange and varied neem-products or as many exploitable byproducts.

Parkia biglobosa is native to Africa and is an important multipurpose tree of West African savannah land, and one of the most common species of the packland agroforestry system. The fruit or seedpod is the most widely used and economically important part of the tree. The pods when young are green, fleshy, and pliable, and are sometimes eaten by humans after roasting the pods over embers. Throughout West Africa, *Parkia biglobosa* pods are favored foods of chimpanzees, baboons, and other primates (Hopkins, 1983). *Vitellaria paradoxa* is a member of the Sapotaceae family, and is divided into two subspecies: *nilotica* and *paradoxa*. The difference between the two subspecies occurs primarily in the consistency of the fat content found within its nut (Boffa, 1999). The *paradoxa* subspecies has a fat that is higher in stearin and lower in olien, thus producing a substance that has the consistency of butter, while the *nilotica* subspecies produces a liquid. However, both are still referred to as shea butter (Boffa, 1999). Sesame (*Sesamum indicum* L.) is one of the oldest cultivated oil-rich plants in the world (Langham and Wiermeers, 2006). It was a highly priced oil crop of Babylon and Assyria at least 4,000 years ago (Olaoye, 2007). The precise natural origin of species is unknown but numerous wild relatives are occurring mostly in Africa and a smaller number found in India (Ashri, 1998). It is believed to have originated from the tropical Africa where the greatest genetic diversity exists but was believed to have been introduced to India at a very early date, where a secondary center of diversity is well developed (Alegbejo *et al.,* 2003; Olaoye, 2007). It is widely naturalized in the tropical region around the world and cultivated primarily for its tiny edible protein and oil-rich seeds (Weiss, 2000; Sharma, 2005).

MATERIALS AND METHODS

The experiment was sited at the Teaching and Research Farms of Ladoke Akintola University of Technology, Ogbomoso, Oyo State, Nigeria, which falls within the Southern Guinea Savannah agro-ecological zone of Nigeria. Ogbomoso lies between Longitude 4^0 10'E and Latitude 8^0 10N. This location is found to be cold and dry from November to March and then warm and moist from April to October. It is characterized by bimodal rainfall distribution whereby the early rainy season starts in late March and ends in late July/early August, followed by a short dry spell in August and finally the late rainy season from August to November. The annual mean rainfall is between 1150 mm and 1250 (Olaniyi, *et al.*, 2006)**.** Sesame seeds, variety E8 (an early maturing type) were obtained from the National Cereal Research Institute (NCRI), Badeggi, Niger State, Nigeria. Three (3) tree species; neem, (*Azardirachta indica*), locust bean (*Parkia biglobosa*) and shear butter (*Vitellaria paradoxa*) used were found as volunteers plants. Three beds each 3 m by 3 m dimension were prepared at spacing of 90cm × 30cm under each of the trees respectively. . Weeding was manually done using hoe as at 2, 4, 6, and 8 weeks after sowing. There were three replicates thus making a total of twenty seven (27) beds. Seeds cowpea was planted on each of the beds.

The treatment combinations were replicated four (4) times and the trial was laid out in a Randomized Complete Block Design (RCBD). Control experiment was also set up along the treatments outside the canopy of the trees which were also replicated three times. The control was laid out in a Completely Randomized Design (CRD). Data were collected on seedling emergence at 4, 6, 8, and 10 days after sowing (DAS) and later converted to percentage emergence. Seedling growth parameters measured included plant height using measuring tape, stem girth with venier calipers which gave the diameter value and was later converted to circumference using a fomular of πD (i.e. 3.142) multiplied by the obtained diameter (D) value, number of branches determined by direct counting of all well-developed branches per plant and number of leaves. These were measured at 2, 4, 6, 8 and 10 weeks after sowing (WAS). Seedlings root lengths were measured at harvest using measuring tape. The results obtained from the plants under these tree species were compared statistically to those obtained from the control experiments following the procedure of analysis of variance (ANOVA) where differences were observed, Duncan's Multiple Range Test (DMRT), at 5% level of probability, was used to compare differences between the treatment means.

RESULTS

Several authors had documented the interference effects of some plants on other crops, prominent of which is the inhibition of germination (Williamson *et. al.*,1992, Patil, (1992), Djurdjevic *et. al.*,2004), reduction in the growth lengths of plumule and radicle (Tobe and Omasa, 2000), retardation of seedling growth (Bhatt and Todoria 1990) and poor seedling survival (Smitt, 1990). Results of the present study showed that the studied tropical tree species inhibited the germination of the sesame seeds. The degree of inhibition was not significantly ($p<0.05$) different in the treated seeds. Previous assertions had suggested that allelochemicals inhibits seed germination by blocking of nutrient reserve and cell division thereby caused significant reduction in the growth of plumule and radicle of many crops (Ogbe *et. al.*,1994, Tobe and Omasa, 2000).

Sesame Germination

Figure 1 shows the allelopathic effects of selected tree species on germination of sesame. Faster and higher germination were observed (100% and 100%) in the control than the treated plots across the number of days the experiment was monitored. However Locust less detrimental to sesame germination at 6 DAS and Shear butter less detrimental to sesame at 10 DAS in the pot experiment. There were no significant ($p < 0.05$) difference in both the rate and total germination of sesame treated with the tree species in the two experiments but significantly ($p<0.05$) different compared with control.

Growth and Development of sesame under the selected tropical trees species

As with the germination, the tree species affected sesame plant height, stem diameter, number of leaves number of branches and root length in experiment. The control treatment was superior to the treated plants in plant height, stem diameter and number of leaves (50.60, 0.51, 13.67 and 62.67, 0.50, 32.33) in the two experiments. Sesame response to the treatments was similar over the period of monitoring where significant ($p < 0.05$) different was observed in the two experiments in the pot experiment but T_L (Locust) was superior to other treatments with respect to number of branches.

The above and below ground biomass of sesame as it is influenced by selected tropical tree species

The above and below ground biomass production of sesame was similar in trend to those of germination and growth parameters (Fig. 6 and Fig 7). Meanwhile, TSS (Shea butter) was less detrimental (10.90) to below ground biomass among the treatments in experiment. The control treatment was superior at $p<0.05$ (44.83, 16.40 and 42.57, 16.97) to the treated plants across the two experiments.

DISCUSSION

In the intensive cropping systems in the tropics, series of methods have been adopted to focus problem of low soil nutrients which is prominent and it is even considered inevitable in order to achieve optimum crop yields. However, the major concerns for sustainable crop production in the tropics are the recently reported challenges imposed by availability of farm land for arable crops as a result of human activities such as construction which led to the use land where agro-forestry trees are growing. Therefore, farming activities should be designed towards improving crop productivity and avoid or guide against any other thing that may militate against achieving this.

Conclusion

In the tropics, tree stands on the farm or the cropping plots is a common occurrence for variety of reasons. However, this experiment had confirmed that Neem tree (*Azardiracter indica*), Locust tree (*Parkia biglobosa*), and shear butter tree (*Vitellaria paradoxa*) have inhibitory characteristics on both the germination and growth of sesame. It is not unlikely that the tree species will have similar effects on other crops. Thus, in spite of other reasons for which trees are kept, farmers should also note these detrimental effects and therefore, if unavoidable ensure that the trees are widely spaced. Since the tree species understudied in this experiment are seldomly grown by farmers (they are volunteers) it is advised that wherever they grow in clusters, the stands should be reduced if cropping will be carried out on such plots.

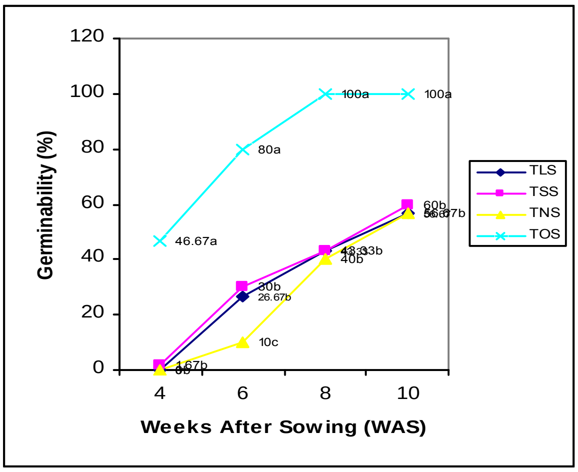

Figure 1. Effect of selected tree species on germination day of sesame seed planted underneath

TLS = soil under *Parkia biglobosa*, TSS = soil under *Vitellaria paradoxa*, TNS = soil under *Azardiracta indica* and TOS = soil from open space.

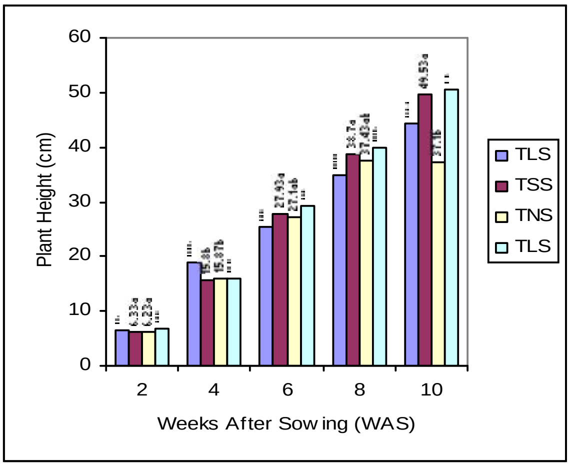

Figure 2. Effect of selected tree species on plant height of sesame planted underneath on the field

TLS = soil under *Parkia biglobosa*, TSS = soil under *Vitellaria paradoxa*, TNS = soil under *Azardiracta indica* and TOS = soil from open space.

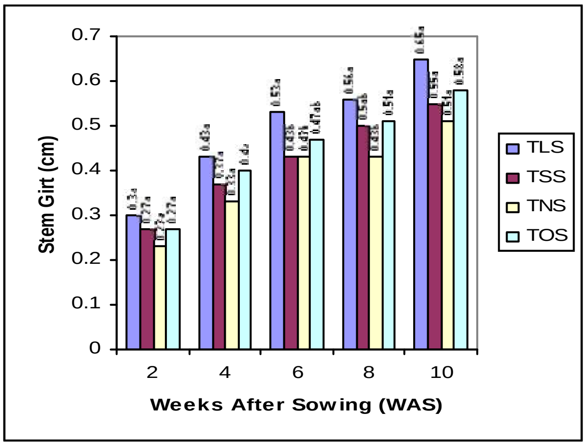

Figure 3. Effect of selected tree species on stem circumference of sesame planted underneath on the field

TLS = soil under *Parkia biglobosa*, TSS = soil under *Vitellaria paradoxa*, TNS = soil under *Azardiracta indica* and TOS = soil from open space.

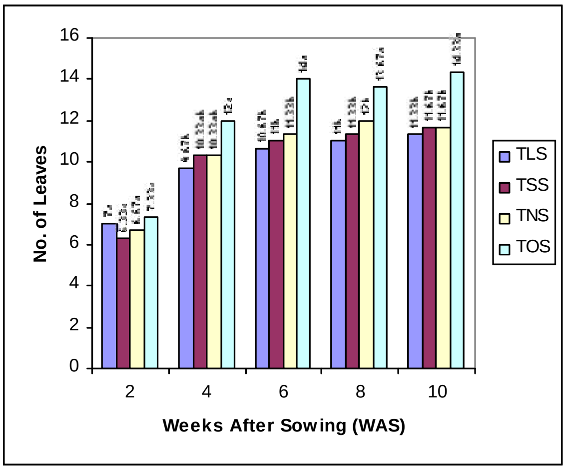

Figure 4. Effect of selected tree species on number of leaves of sesame planted underneath on the field

TLS = soil under *Parkia biglobosa*, TSS = soil under *Vitellaria paradoxa*, TNS = soil under *Azardiracta indica* and TOS = soil from open space.

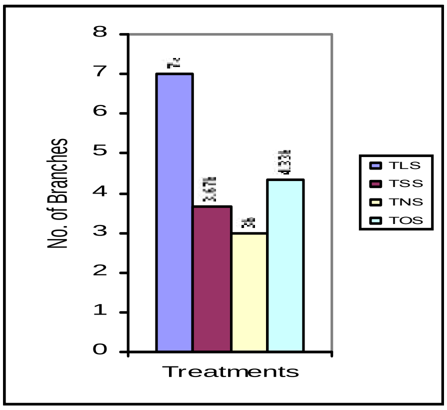

Figure 5. Effect of selected tree species on number of branches sesame planted underneath on the field

TLS = soil under *Parkia biglobosa*, TSS = soil under *Vitellaria paradoxa*, TNS = soil under *Azardiracta indica* and TOS = soil from open space.

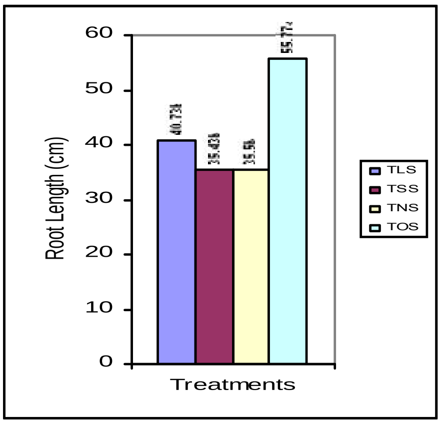

Figure 6. Effect of soil collected from under the selected tree species on root length of sesame in the pot

TLS = soil under *Parkia biglobosa*, TSS = soil under *Vitellaria paradoxa*, TNS = soil under *Azardiracta indica* and TOS = soil from open space.

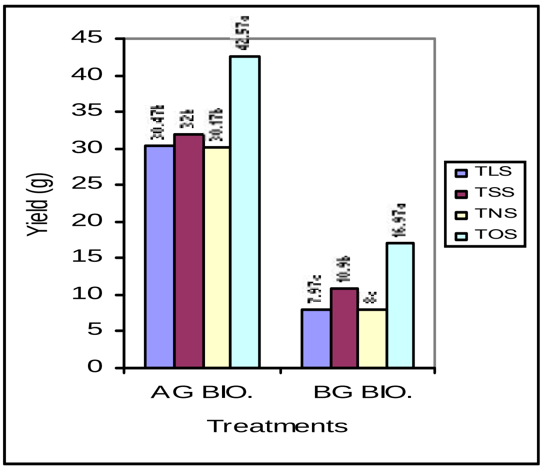

Figure 7. Effect of selected tree species on above grand and below grand biomass sesame planted underneath on the field

TLS = soil under *Parkia biglobosa*, TSS = soil under *Vitellaria paradoxa*, TNS = soil under *Azardiracta indica* and TOS = soil from open space.

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