Yield of Selected Food Crops under Alley-cropping with Some Hedgerow Species in Humid Tropical Southeastern Nigeria

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Abstract A study was conducted at the Teaching and Research Farm of the University of Calabar, Nigeria to evaluate the effect of three hedgerow species (Enterolobium cyclocarpum, Dialium guianense and Sesbania macrantha) on the growth and yield of plantain (Musa spp.), cowpea (Vigna unguiculata) and maize (Zea mays) in an alley-cropping system. The growth rate and biomass yields of the hedgerow species as well as the growth and yield of the associated food crops were determined. The highly branched, bushy species, E. cyclocarpum gave the highest biomass yield of 17.3 t/ha, while the fast-growing leguminous species, S. macrantha and the slow-growing D. guianense gave biomass yields of 11.9 and 7.4 t/ha, respectively. Compared with the other hedgerow species, alley-cropping with E. cyclocarpum generally enhanced the growth and bunch yield of plantain, while alley-cropping with S. macrantha decreased the bunch yield of plantain by 9%. The grain yield of cowpea was higher under alley-cropping with the hedgerow species, whereas that of maize was depressed. The overall results indicated the beneficial effect of alley-cropping on plantain and cowpea with the hedgerow species at the early stages of establishment.

Key words alley cropping, cowpea, hedgerow species, maize, plantain

Introduction

Small holder cropping systems in the humid tropics often combine food and tree crops in various mixtures. This production system has long been adopted in West Africa where resource-poor farmers also deliberately grow plantains and other crops in orchards without systematic arrangement. The compound farm in which plantain features prominently constitutes a very complex agro-ecosystem in which man attempts to have available within reach, all the food crops which are required during certain seasons of the year. An observation of the plant inventory of the compound farms in the rainforest belt of Nigeria has revealed the presence of more than 60 species of crops, some arising from volunteer crops and some others purposely planted, but all intermingled in less than 0.5 ha of land. Thus small farm size resulting from land fragmentation is a typical feature in the humid tropics. The ever-increasing population on the available limited farm land makes the reduction in farm size even more acute. As a result, mixed cropping to maximize the use of available land is a common practice in the tropics.

The various advantages derived from growing crops in mixtures have been reported by many authors. KASSAM and STOCKINGER showed that higher component yields can be
achieved when there is a competition gap between the time that component crops make maximum demand on the micro-environmental growth resources. Thus various modifications of polycultural production systems for several crops have evolved over time. The emphasis of the farmer on the intercrop component such as productivity, cropping period and relative importance of crops determines the choice of any intercropping arrangement.

Several intercropping systems with plantain and grain crops have evolved over the years in the humid tropical areas. In this context, the principle is to effectively utilize the interrow spacing, time and other resources, before, during and after canopy closure to satisfy the requirements of minor crop biotypes. The crops may be introduced at different plantain growth phases or cycles. The intercropping of plantain and grain crops with hedgerow species (mostly leguminous shrubs) under an alley cropping arrangement has been subjected to only few scientific investigations in tropical Africa. Furthermore, research and development of alley cropping in the humid tropics have largely been restricted to Leucaena leucocephala, Gliricidia sepium and Gmelina arborea.

The need to extend such investigations to other species was the objective of the present study.

Materials and Methods

The trial was conducted at the Teaching and Research Farm of the University of Calabar, Nigeria. The top soil at the experimental site has a sandy loam texture with the following chemical properties: pH, 5.5; organic C content, 1.9g/100g; total N content, 0.15g/100g; available P content, 1.8 mg/kg and exchangeable K content, 0.14 cmol/kg. The total annual rainfall in Calabar is about 2000mm, while temperatures range from 23 to 33°C. The relative humidity is about 86%.

Three hedgerow species, Enterolobium cyclocarpum, Sesbania macrantha and Dialium guianense were used for this trial. E. cyclocarpum is native to the dry forests of Mexico and central America (latitudes 23°N - 7°N). However, it has been widely introduced throughout the tropics and occurs in different forest types from tropical dry deciduous forest to tropical moist forest. Sesbania species are considered to be native to the tropical Southeast Asian countries where they are widely distributed and cultivated. They are also widely distributed in Africa. D. guianense is well adapted and widely distributed in the humid zone of West Africa, but extends to drier areas of the sub-region such as Senegal.

The three hedgerow species and a "no tree control" were used in the treatments which were replicated 5 times, and arranged into a randomized complete block design. The spacing of hedgerow species was 3 m between and 0.5 m within rows. Plantain suckers were then planted into the alleys at the rate of 1,666 plants/ha. Cowpea (variety IT 820D-719) was also introduced between the hedgerows and plantain stands at a population rate of 55,555 plants/ha. The hedgerow species, plantain and cowpea were planted in the last week of September, 1995. Cowpea was harvested on 15 December, 1995, while plantain fruits were harvested in November, 1996. Following the harvest of cowpea, maize was planted in April of the following year at a population rate of 20,000 plants/ha. Maize was harvested on August 10, 1996. The control plots consisted of a mixture of plantain, cowpea and later, of maize without the hedgerow species.

Observations were taken on the growth and biomass yield of the hedgerow species, based on the plant height, number of branches and dry matter yield. The dry matter yield was calculated from the sum of the dry weight of hedgerow prunings just before and after maize was introduced and harvested. For plantain, the growth parameters as well as bunch yield were determined, while the grain yields of cowpea and maize were also measured at harvest time. The grains were oven-dried (60°C) for 24 hours to determine the dry weight. All the data generated were subjected to an analysis of variance, and means that differed significantly were further separated using the Duncan's multiple range test.

Results

Growth of hedgerow species

The growth and dry matter yield of the hedgerow species are presented in Table 1. Enterolobium cyclocarpum showed the shortest period of dormancy as its seeds took the lowest number of days (8) to attain 50% emergence. Dialium guianense and S. macrantha took about two weeks to attain a similar level of emergence. However, once emerged, the seedlings of S. macrantha were the fastest growing, followed
by those of *E. cyclocarpum* which showed roughly half the growth rate of *S. macrantha*. *Dialium guianense* exhibited a slow growth rate and the lowest value of plant height. After 3 and half months of establishment, plant height was in the order: *S. macrantha* (95 cm) > *E. cyclocarpum* (52 cm) > *D. guianense* (27 cm).

The number of branches was in the order: *E. cyclocarpum* > *S. macrantha* > *D. guianense* (Table 1). The relatively fast growth rate of *S. macrantha* was not reflected in superior biomass yield probably because of the presence of few branches and scanty, small leaves. In contrast, the bushy and highly branched *E. cyclocarpum* produced the highest plant biomass. The biomass yield of *E. cyclocarpum* (17.3 t/ha) significantly exceeded that of *S. macrantha* and *D. guianense* by 46 and 135%, respectively (Table 1).

**Yield of the food crops**

The data on the growth and yield of plantain, cowpea and maize are shown in Table 2. Alley-cropping with *E. cyclocarpum* significantly increased the number of hands per bunch and bunch yield of plantain. However, alley-cropping with any of the species did not significantly increase plantain height, stem girth, number of suckers and number of fingers per bunch. Under *S. macrantha*, the bunch yield was actually depressed, though slightly by 9%.

The grain yield of cowpea was generally higher (though not significantly) in all the hedgerow plots than in the control plot, but the yield was highest under *D. guianense*. In contrast, maize yield in the hedgerow plots decreased by between 7.6% under *S. macrantha* and 68% under *D. guianense* (Table 2).

**Discussion**

The different hedgerow species evaluated showed large differences in growth characteristics and dry matter yield. Reasonably fast growth rates were observed for *S. macrantha* and *E. cyclocarpum* while *D. guianense* exhibited poor growth. Kang *et al.* also recorded poor growth for *S. macrantha* and *D. guianense*. Clearly, *E. cyclocarpum* was the most vigorous species with the most favorable influence on plantain bunch yield. This species also regenerated faster after pruning. The data for the bunch yield of plantain indicate the benefit of intercropping of plantain with this species.

Although the seed yield of cowpea was not statistically different among the treatments, the highest grain yield of cowpea was obtained under *D. guianense* which showed the poorest growth and the least shading effect. Cowpea is a sun-loving crop which performs best under little

<table>
<thead>
<tr>
<th>Hedgerow species</th>
<th>Days to 50% seedling emergence</th>
<th>Plant ht. (cm)</th>
<th>No. of branches (cm)</th>
<th>Dry biomass yield (t/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>E. cyclocarpum</em></td>
<td>8b</td>
<td>52.3b</td>
<td>8.0a</td>
<td>17.3a</td>
</tr>
<tr>
<td><em>D. guianense</em></td>
<td>13a</td>
<td>26.9c</td>
<td>3.0c</td>
<td>7.4c</td>
</tr>
<tr>
<td><em>S. macrantha</em></td>
<td>15a</td>
<td>94.6a</td>
<td>5.0b</td>
<td>11.9b</td>
</tr>
</tbody>
</table>

Means followed by different letters are significantly different at p = 0.05.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Plantain</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Height (m)</td>
</tr>
<tr>
<td><em>E. cyclocarpum</em></td>
<td>3.8</td>
</tr>
<tr>
<td><em>D. guianense</em></td>
<td>3.8</td>
</tr>
<tr>
<td><em>S. macrantha</em></td>
<td>3.8</td>
</tr>
<tr>
<td>Control</td>
<td>3.7</td>
</tr>
</tbody>
</table>

Means followed by different letters are significantly different at p = 0.05.
or no shading. The absence of shading may have also prevented pathogens thriving and attacking cowpea, hence the higher yield. In contrast, maize yield was comparatively higher in the control plots than in the hedgerow plots. This may be due to the late introduction of maize and intense competition from the hedgerow plots during the establishment stage. The effects of this type of competition have been frequently reported by several workers\(^1\).\(^4\),\(^7\). Maize was introduced after cowpea was harvested. Among the hedgerow species, \textit{S. macrantha} enhanced maize yield more than other species. This is possibly due to nodulation and N fixation or production of a high biomass from prunings of this species which may have supplied some nutrients after decomposition from which maize benefited. All the prunings were returned to the respective plots after sub-sampling for dry matter determination.

References


