The Effect of Competition between Pearl Millet (*Pennisetum Typhoides (*Burm. F.) Stapf & C. E. Hubb) and Sorghum (*Sorghum Bicolor (*L.) Moench) at Varying Densities

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Abstract
The competitive effect between Pearl millet (Pennisetum typhoides) and Sorghum (Sorghum bicolor) at varying densities was investigated. Three experiments with two phases each were conducted concurrently. It involved planting mixed stands of both species singly (1 seed) and in varying densities consisting of four replicates and five treatments with a total of twenty observations in each experimental unit. Each experiment had two phases of the experiment. Phase one had sorghum planted before millet seed while phase two had the reverse. The treatments were giving in varying densities as T1: I seed was planted, T2: 2 seeds were planted; T3: 4 seeds were planted. T4: 8 seeds were planted and T5: 16 seeds were planted. The experimental design employed was the completely randomized design (CRD) using one-way ANOVA. Morphological parameters measured included plant height, number of leaves, leaf area, fresh weight and dry weight. The data collected were statistically analyzed using SAS (version 9.1, 2007) statistical package for all treatments tested. The means were separated using least significant difference (LSD) at 5% level of probability. The results of the study showed that for all three experiments, the control (T1) had the best growth for the morphological parameters, fresh weight and dry weight. The morphological parameters were best for experiment three than experiment one, then experiment two with pearl millet being a better competitor than sorghum.

Key word: *Competition, Pearl millet, sorghum, plant densities, botanic garden*

INTRODUCTION

The concept of competition is an important aspect of ecology; competition has different meaning to ecologists and agronomists. Agronomists and Foresters are concerned with the way competition affects crop yield (Harper, 1961). Ecologists are concerned with competition as it affects the relative number and success of various species in communities of various kinds. Competition is the interaction between populations that leads to depressed fitness in both populations (Okiwelu and Anyanwu, 2003). Competition within, between, and among species is one of the most important forces in biology, especially in the field of ecology (Keddy, 2001). According to Kershaw (1998), competition is used to describe the struggle between individuals for some environmental factors such as light or nitrogen and the final effect is not one of complete elimination of the performance of one of the competing members When it occurs between species it is considered as inter-specific and the outcome is to narrow or reduce distributional range of the population, but when it occurs between individuals of the same species, it is considered as intra-specific and the outcome is to expand the range of distribution of the species population. The aim of this study is to determine the inter specific competitive effect of pearl millet (*Pennisetum typhoides*) and sorghum (*Sorghum bicolor*) at varying densities.

MATERIALS AND METHODS

Seeds of *S. bicolor* and *P. typhoides* were obtained from a local market in Port Harcourt metropolis Rivers State, Nigeria and taxonomical reference given in the department of Plant Science and Biotechnology. The soil used was loamy. 120 planting bags with their sides perforated were used for this experiment. The perforation was to ensure proper drainage and good soil aeration. 30 kg of top soil was transferred into 35cm x 35cm planting bags.

The experiment was carried out in the Botanic Garden of the Department of Plant Science and Biotechnology, Faculty of Sciences, University of Port Harcourt. The Geographic Position System of the experimental site is Latitude N 4^{o} $53^{'}$ $50.89^{''}$, Longitude E 6^{o} $55^{'}$ 00.81"

Pre germination tests were carried out separately in the laboratory on both seeds using five (5) Petri dishes each of it containing ten seeds. It was observed that after four (4) days of germination both species Pennisetum *typhoides* and *Sorghum bicolor* had 100% germination.

Soil physico-chemical were conducted and the results obtained were as follows; pH= 5.26 (acidic), Conductivity= 12µs/cm, and Alkalinity = 4.2mg/L

Experimental Layout

Experiment 1: Sorghum seed was constant (1 plant density) while millet varies at different densities of 1, 2, 4, 8 and 16 seeds.

Phase 1: Sorghum seeds were planted first and after 2 weeks millet seeds were planted at different densities of 1, 2, 4, 8 and 16 seeds.

Phase 2: Millet seeds were planted first and after 2 weeks sorghum seeds were planted at different densities of 1, 2, 4, 8 and 16 seeds.

Experiment 2: Millet seeds were constant (1 plant density), sorghum Varies in densities.

Phase 1: Sorghum planted first, after 2 weeks millet seeds were planted at different densities of 1, 2, 4, 8 and 16 seeds.

Phase 2: Millet planted first, after 2 weeks sorghum seeds were planted at different densities of 1, 2, 4, 8 and 16 seeds.

Experiment 3: Both millet and sorghum planted on the same day.

Phase 1: Sorghum constant, millet at different densities of 1, 2, 4, 8 and 16 seeds.

Phase 2: Millet seeds were constant (1 plant density), Sorghum at different densities of 1, 2, 4, 8 and 16 seeds.

Treatments

Each experiment had five treatments (T1-T5) that were replicated four times with a total observation of 20 each in each phase;

T_1 = 1 seed of the test plant (control, no competition)
T_2 = 2 seeds of the varying species
T_3 = 4 seeds of the varying species
T_4 = 8 seeds of the varying species
T_5 = 16 seeds of the varying species

Experimental Design

A Completely Randomized Design (CRD) was employed for this experiment. Three experiments were conducted concurrently.

Parameters Taken

The morphological parameters taken include;

% germination count, plant height, number of leaves, leaf area, fresh weight and dry weight at harvest of both plants.

Data Analysis

The data collected were statistically analyzed using SAS (2007, Version 9.1) statistical package for all treatments tested.

RESULTS

The tables and graphs below show the morphological data collected at 4^{th}, 6^{th} and 12^{th} weeks after planting for the three experiments. The morphological data were all subjected to statistical analysis.

Four Weeks after Planting

In all the three experiments, the mean plant height for 1 seed treatment and 16 seeds treatments were significantly $P \leq 0.05$ higher than other treatments. For number of leaves and leaf area, 1seed treatment and 16 seeds treatment were also significantly $P \leq 0.05$ higher than other treatments.

Table 1: Mean plant height, number of leaves and leaf area at 4 weeks after planting for experiment 1 phase1 [1st sorghum].

Treatment	Mean plant height (cm)	Mean number of leaves	Mean Leaf area (cm^3)
TI: 1seed	44.75^{a}	7.25^{a}	151.25^{a}
T2: 2 seeds	33.00^{b}	5.75^{b}	140.00^{b}
T3: 4 seeds	26.50^{bc}	4.75^{bc}	131.00^{b}
T4: 8 seeds	20.93^{C}	4.00^{c}	119.00^{c}
T5: 16 seeds	47.01^{a}	7.00^{a}	155.25^{a}
LSD	9.2837	1.2016	11.228

The values above are means of 4 replicates. Means with the same letter are not significantly different at $P \leq 0.05$.

Table 2: Mean plant height, number of leaves and leaf area at 4 weeks after planting for experiment 1 phase 2 [1st millet].

Treatment	Mean plant height (cm)	Mean number of leaves	Mean leaf area (cm^3)
TI: 1seed	35.00^{a}	6.00^{a}	141.75^{a}
T2: 2 seeds	25.00^{b}	4.75^{b}	129.00^{b}
T3: 4 seeds	22.25^{c}	4.00^{c}	126.00^{c}
T4: 8 seeds	17.75^{d}	3.75^{c}	115.50^{d}
T5: 16 seeds	13.15^{e}	3.00^{d}	109.00^{e}
LSD	0.8702	0.4219	2.7271

The values above are means of 4 replicates. Means with the same letter are not significantly different at $P \leq 0.05$.

Table 3: Mean plant height, number of leaves and leaf area at 4 weeks after planting for experiment 2 phase1 [1st sorghum]

Treatment	Mean plant height (cm)	Mean number of leaves	Mean leaf area (cm^3)
TI: 1seed	25.25^{a}	4.50^{a}	127.50^{a}
T2: 2 seeds	23.00^{b}	4.00^{b}	122.75^{b}

T3: 4 seeds	20.25^{c}	4.00^{b}	120.25^{c}
T4: 8 seeds	17.00^{d}	3.75^{b}	114.50^{d}
T5: 16 seeds	13.00^{e}	3.00^{c}	108.50^{e}
LSD	0.9005	0.4872	1.5342

The values above are means of 4 replicates. Means with the same letter are not significantly different at $P \leq 0.05$.

Table 4: Mean plant height, number of leaves and leaf area at 4 weeks after planting for experiment 2 phase2 [1st millet]

Treatment	Mean plant height (cm)	Mean number of leaves	Mean leaf area (cm^3)
TI: 1seed	31.25^{a}	5.75^{a}	140.00^{a}
T2: 2 seeds	27.00^{b}	5.00^{b}	132.75^{b}
T3: 4 seeds	23.25^{c}	4.00^{c}	128.00^{c}
T4: 8 seeds	21.00^{d}	4.00^{c}	121.00^{d}
T5: 16 seeds	17.25^{e}	3.75^{c}	116.75^{e}
LSD	0.7032	0.4219	1.974

The values above are means of 4 replicates. Means with the same letter are not significantly different at $P \leq 0.05$.

Table 5: Mean plant height, number of leaves and leaf area at 4 weeks after planting for experiment 3 phase1 [1st sorghum].

Treatment	Mean plant height (cm)	Mean number of leaves	Mean leaf area (cm^3)
TI: 1seed	61.63^{a}	8.00^{a}	173.00^{a}
T2: 2 seeds	56.25^{b}	7.00^{b}	166.50^{b}
T3: 4 seeds	50.13^{c}	6.75^{b}	160.25^{c}
T4: 8 seeds	43.13^{d}	6.00^{c}	152.00^{d}
T5:16 seeds	37.38^{e}	5.00^{d}	146.00^{e}
LSD	1.043	0.3445	0.7442

The values above are means of 4 replicates. Means with the same letter are not significantly different at $P \leq 0.05$.

Table 6: Mean plant height, number of leaves and leaf area at 4 weeks after planting for experiment 3 phase 2 [1st millet].

Treatment	Mean plant height (cm)	Mean number of leaves	Mean leaf area (cm^3)
TI: 1seed	51.25^{a}	8.75^{a}	$1.58.25^{a}$
T2: 2 seeds	45.63^{b}	8.00^{b}	153.50^{b}
T3: 4 seeds	41.13^{c}	6.75^{c}	147.00^{c}
T4: 8 seeds	39.00^{d}	6.00^{d}	138.50^{d}
T5:16 seeds	33.00^{e}	5.50^{d}	131.50^{e}
LSD	1.2037	0.5071	1.4343

The values above are means of 4 replicates. Means with the same letter are not significantly different at $P \leq 0.05$.

SIX WEEKS AFTER PLANTING

In all the three experiments, plant height, number of leaves and leaf area for treatment 1(control) was higher than other treatments (Fig. 1).

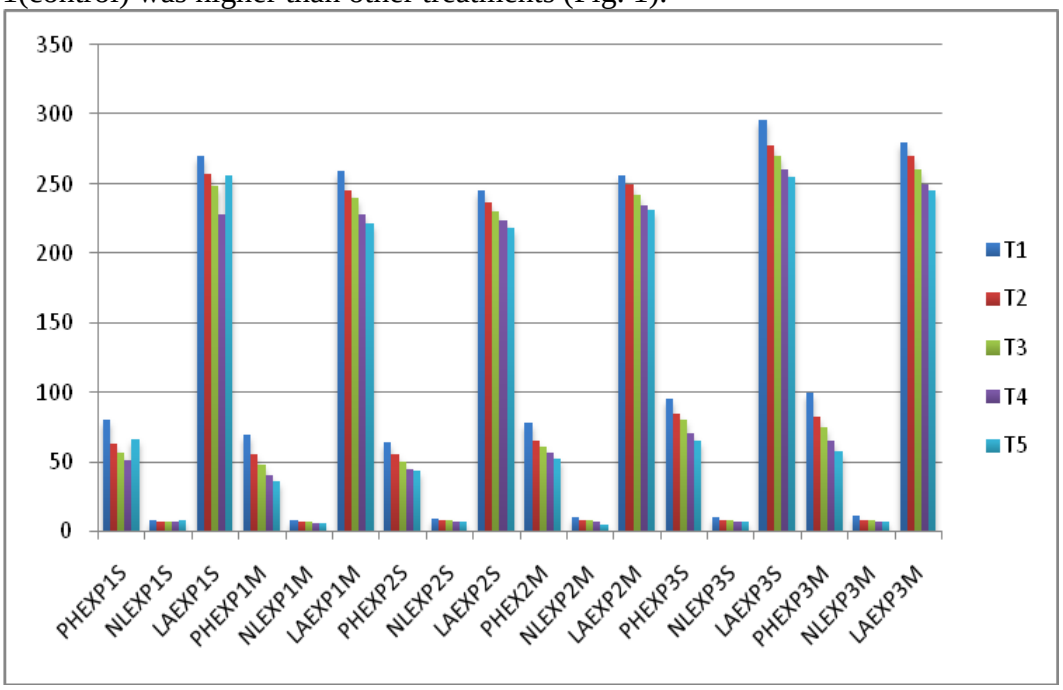

Fig. 1: Showing plant height, number of leaves and leaf area at six weeks after planting for the three experiments

Where T = Treatment
PH = Plant height
NL = Number of leaves
LA = Leaf area
EXP = Experiment
M = Millet seed planted first
S = Sorghum seeds planted first

TWELVE WEEKS AFTER PLANTING

In all the three experiments, mean plant height, leaf area, fresh weight and dry weight for 1 seed treatment (control) was higher than other treatments while for number of leaves there was no difference for treatments 1-4 but these treatments were higher than treatment 5 (Figures. 2 and 3).

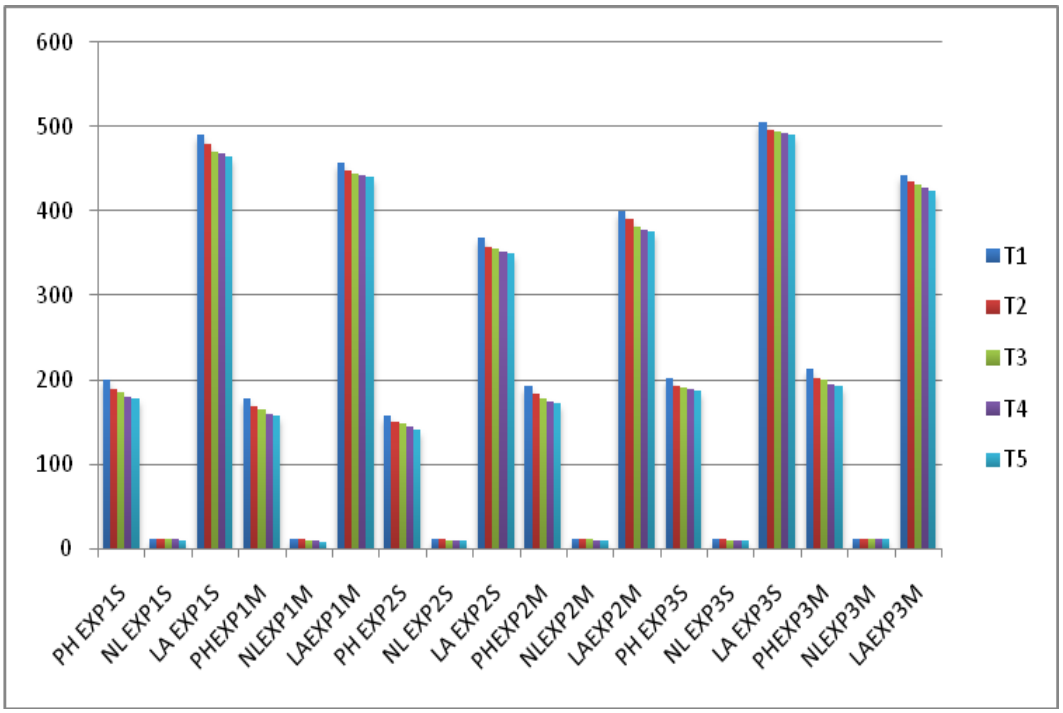

Fig. 2: Showing plant height, number of leaves and leaf area at twelve weeks after planting for the three experiments

Where T = Treatment
PH = Plant height
NL = Number of leaves
LA = Leaf area
EXP = Experiment
M = 1st Millet planted first
S = 1st Sorghum first

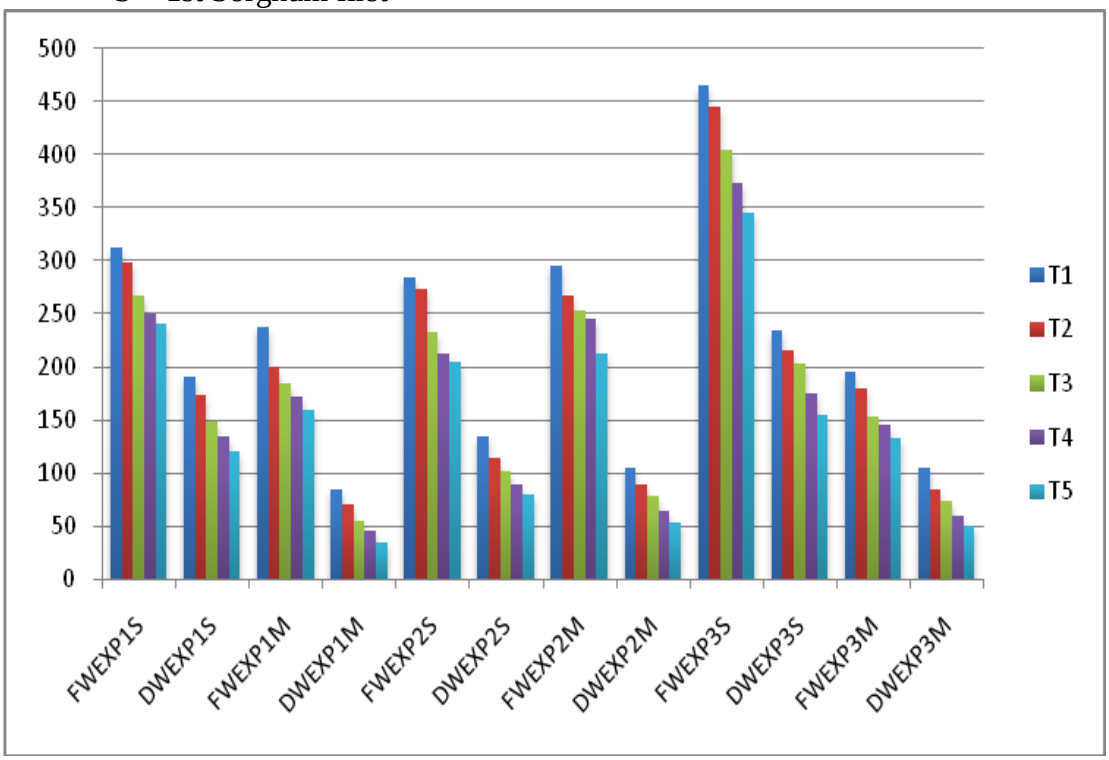

Fig. 3: Showing fresh weight and dry weight at harvest for the three experiments

Where

FW = Fresh weight
DW = Dry weight
EXP = Experiment
S = Sorghum
M = Millet
T = Treatments

DISCUSSION

The competition between pearl millet and sorghum were observed. Morphological parameters decreased with increase in density of the treatments. This may be due to inter-specific and intra-specific competitions; as a result of overcrowding because the biomass yield of components is strictly proportional to the environmental resources it can acquire (de wit, 1960). Kirk Patrick (1993) in studying the effect of competition between jimsonweed and soybean pointed out that increasing the density of jimsonweed resulted in reduced soybean yield (Wright, *et al*., 1994).

From the results, it was observed that the competitive ability of *S. bicolor* in experiment 1 phase1 for all treatments was more than that of *P. typhiodes* with dec*rease* in plant height, number of leaves, leaf area and biomass as competition in plant density increases. This is because sorghum was planted earlier before pearl millet in this phase and has established itself to exploit more resources before pearl millet. In experiment 2 phase 2 the same incidence occurred where pearl millet showed a greater competitive advantage than sorghum in all treatments except in leaf area and biomass. This may be as a result that the plants is still in its vegetative phase for growth and that pearl millet was planted earlier than sorghum and in phase 1 leading to a decrease in growth and biomass due to late planting time.

In experiment 3 where both species were planted on the same day, pearl millet showed greater competitive ability in plant height and number of leaves than sorghum. Competitive ability, therefore, is a function of the area, the activity and the distribution in space and time of the plant surfaces through which resources are intercepted and at such depends upon a combination of plant characteristics (Grime, 2001).

Therefore, based on the data obtained from the study, it has been determined that density of crop stands affects the intensity of competition between crops in a directly proportional fashion. Furthermore, it has been established that early planting confers an initial advantage to the crops that were first established, thus giving an edge in competition over those planted later. The plants resources (water, food, nutrient, space and light) competed for also determined the performance of the plants.

CONCLUSION

The results of this work emphasizes that both plant densities determine the intensity of competition. If *P. typhoides* and *S. bicolor* vary in their requirement for resources, then they can exist in concordance with each other. Although, the experiment was an in vitro experiment, but in natural environment (i.e. in vivo), the outcome of competition between these two crops may be different. Therefore, it is recommended that both species should not be intercropped because yield in both plants will be seriously reduced even though *Pennisetum typhoides* is a better competitor.

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