The Use of Different Cropping Systems for Pepper (*Capsicum Annum*) Seed Production in Tropical Rain Forest Soils of Nigeria

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ABSTRACT

A cropping system that involved the use of intercropping and planting patterns was used to test the profitability of producing pepper seeds. The triple replicated randomized complete block design experiment was carried out during the wet and dry seasons of 2018 at the Teaching and Research Soils of the Rivers State University Port Harcourt. The planting patterns were: Sole pepper (control), strip rows, double alternate rows and scattered pattern while maize and okra were used as inter crops. During the wet and dry seasons, the control (sole pattern) outperformed the other patterns in fresh pepper fruit yield (6000kg/ha, 5503kg/ha) but not in fruit number and fruit seed yield which were not significantly different from that of strip rows. Also, the strip rows fresh maize cobs yield (9573.3kg/ha, 6133.33kg/ha) and okro pods yield (2453kg/ha, 2470.67kg/ha) in wet and dry seasons respectively were high. With Land equivalent ratio of 2.3 and 1.62 in both seasons, the strip row pattern proved to be more stable, sustainable and profitable. This cropping system (pepper, maize and okra inter crop on strip row pattern) is therefore very profitable since it allows poor resource farmers to harvest different crop produce (maize cobs and okro pods) for use and sale until the maturation, processing and sale/use of the pepper seeds.

Keywords: *Double alternate rows, Land equivalent ratio, Scattered pattern, Sole pattern, Strip rows and tropical rainforest soils.*

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Highlights of this paper

- Intercropping maize, pepper and okra had a land equivalent ratio of between 2.20 -1.37 in both wet and dry seasons, signifying that they were better than sole cropping.
- The use of sole pattern, double alternate rows, strip rows and scattered pattern allowed the intercrops to be grown with minimal inter species shade while harnessing the vast benefits of intercropping.
- The production of pepper seeds for sale or use was sustainable and profitable under this cropping system since it allowed the availability of okra pods and fresh maize cobs over time before the maturation, processing and sale/use of the pepper seeds, especially on the strip rows pattern.

1. INTRODUCTION

A Propagule is any part of the plant body which is used for commercial multiplication of crop while seed proper is the product of fertilized ovule that consists of embryo, seed coat and cotyledon. The use of high quality seed plays a pivotal role in crop production. Seeds for planting can be obtained from certified seed vendors and farmers/community based informal seed producers. Community based informal seed production has recently gained popularity as an alternative to the formal seed sector of disseminating new crop varieties [1]. This is because farmer produced seed is readily available and is more affordable by most farmers than certified seeds [2]. Recent literature indicates that farmer-to-farmer seed marketing has gained importance as a means of seed exchange in Sub-Saharan Africa as economies develop and farmers are increasingly using markets to meet their seed needs [3]. On many Instances even government institutions lack capacity to produce seed in sufficient quantities. It is estimated that by 2050 the world population will be 9 billion people and the main goal of Agriculture is to feed this teeming population [4]. Production of high quality seeds that are readily available and easily affordable is imperative.

Hot pepper (Capsicum annuum L.) is one of the most important vegetable and spice crop grown in different parts of the world [5]. Pepper is primarily grown for its pungency and utilization as spice commodity and for domestic and economic purposes. Pepper has a high concentration of alkaloid, capsoicinoid that makes it an important ingredient used for spice commodity in the world [6]. Sweet peppers are photo-period and humidity-insensitive (day length and relative humidity do not affect flowering or fruit set). Sweet pepper (*Capsicum annuum)* L also forms a good intercrop with Okra. It is hardly attacked by common above ground insect pests and forms a good camouflage for susceptible crops like okra [7].

Okra, *Abelmoshus esculentus* (L) Moench is a widely cultivated erect annual herb of the malvaceae family. The fruit is a beaked pyramidal capsule with *a* high mucilage content and is used as a vegetable when immature either boiled or fried [8]. In African traditional cropping system, okra is a good intercrop with maize Zea *mays* (L) because they share a few insect pests and diseases. They also have different rooting patterns and feeding zones. The main advantage of intercropping is the more efficient utilization of the available resources and the increased productivity compared with each sole crop of the mixture [9]. Increased leaf cover in intercropping systems helps to reduce weed populations once the crops are established. Having a variety of root systems in the soil reduces water loss, increases water uptake and increases transpiration. This is important during times of water stress, as intercropped plants use a larger percentage of available water from the field than mono-cropped plants. Rows of maize in a field with a shorter crop will reduce the wind speed above the shorter crops and thus reduce desiccation. Flexibility, maximization of profit, minimization of risk, soil conservation and soil fertility improvement are some of the principal reasons for smallholder farmers to intercrop their farms/crops [10]. Further to that, they have the potentials to give higher yield than sole crops, greater yield stability and efficient use of nutrients [11]. It is on these facts that this research work examined the profitability and sustainability of using pepper, maize and okra intercrop on strip rows pattern for pepper seed production.

2. MATERIALS AND METHODS

The study was conducted at the Teaching and Research Farm of the Rivers State University of Science and Technology, Port Harcourt during the 2018 early and late planting seasons. Port Harcourt is located at latitude 4.8156°N and longitude 7.0498°E and altitude of 18m above sea level in the humid tropical zone and has a bimodal rainfall pattern. The multiple cropping experiment involved three crop viz maize, pepper and okra. The maize cultivate used was Bende white a local variety, the pepper cultivar is high yielding and early maturing, and was obtained from National Horticultural Research Institute (NIHORT) Ibadan. Likewise, the okra variety NIHORT 47-4 was obtained from NIHORT. The experimental design was Randomized Complete Block Design (RCBD).

Four planting patterns used were: Double alternate rows pattern, strip rows pattern, scattered pattern and sole rows pattern as control. The double alternate rows pattern was made up of two rows of maize followed by two rows of okra, followed by two rows of pepper, and this arrangement repeated three times to give a plot of 9m x 3m. There were a total of 36 stands each of maize, okra and pepper. The strip rows pattern contained six rows of maize followed by six rows of Okro and then followed by six rows of pepper. The scattered pattern was made up of a group containing six stands of each crop and randomly planting at six points on the plot. However, the planting distance and number of stands were the same as in other plots. The sole pattern was made up of pepper crops grown as pure stands and contained a total of 108 stands per plot. All crops were planted at 50cm x 50cm.

2.1. Data Collection and Sampling Techniques

In both seasons, a nursery bed was prepared and pepper seeds planted a month before clearing the main field and were later transplanted Okro, maize seeds and pepper seedlings were planted the same day. Data were subjected to ANOVA test and differences between means were determined at the 5% level of probability using Duncan's multiple range test.

3. RESULTS AND DISCUSSION

3.1. Results

3.1.1. Okra Components

During both seasons there was no significant difference in Okra plant height values Table 1. The same trend was also observed in number of Okro pods. Strip rows pattern Okro pod weight (2453kg/ha,2470kg/ha) was significantly higher than the other patterns in both seasons.Double alternate rows gave the least Okro pod weight in both seasons.

Table-1. Okra components.

	Wet season			Dry season		
Treatments	**Plant height(cm)**	**Number of pods**	**Pod weight(kg/ha)**	**Plant height(cm)**	**Number of pods**	**Pod weight(kg/ha)**
Double alternate rows	24.97 ± 4.25	5.2 ± 0.25	1864 ± 114.b	27.4 ± 3.5	10.4 ± 0.2	2002.67 ± 102c
Strip rows	23 ± 4.31	5.8 ± 0.62	2453 ± 86a	27.99+1.5	10.8 ± 1.4	2470 ± 129a
Scattered rows	24.13 ± 3.65	5.3 ± 0.53	2035 ± 112b	29.84 ± 1.94	11.0 ± 0.6	2390.6 ± 128b
P 0.05	ns	Ns	186.24	ns	Ns	201.53

Within column, figures with different superscriptions vary significantly at P< 0.05 by DMRT.

3.1.2. Maize Components

Maize plant height(cm), plant biomass(t/ha) and fresh cob weight(t/ha) values did not significantly vary despite planting pattern and season Table 2.

Table-2. Maize Components.

	Wet season			Dry season		
Treatments	**Plant height(cm)**	**Plant biomass(t/ha)**	**Fresh cod weight(t/ha)**	**Plant height(cm)**	**Plant biomass(kg)**	**Fresh cod weight(t/ha)**
Double alternate rows	421.17 ± 107	27.2 ± 3362	9.9 ± 1545	315.97 ± 21	16.3 ± 3716	6.5 ± 1285
Strip rows	387.25 ± 57	25.3 ± 3894	9.6 ± 1409	292.7 ± 45	15.3 ± 2309	6.1 ± 231
Scattered rows	392.33 ± 20	29.5 ± 6014	10.9 ± 688	280.33 ± 42	16 ± 3464	7.1 ± 1006
P 0.05	ns	Ns	ns	ns	Ns	Ns

Within column, figures with different superscriptions vary significantly at $P< 0.05$ by DM.

3.1.3. Pepper Components

During the rainy season okra height values in sole pattern and its derivative strip pattern did not vary but were significantly higher than the other patterns. The same trend was also observed in pepper fruit number Table 3. The planting patterns had no significant effect on the pepper fruit size despite season. On pepper fruit seed number, during the rainy season both sole pattern (111.0,75.25) and strip rows pattern (110.3,73.67) were not significantly different but significantly higher than the other two planting patterns. Sole pattern fruit weight(6t/ha,5.5t/ha) was the highest while scattered pattern(0.5t/ha,0.56t/ha) was the least in both season.

3.1.4. Weed Biomass at 6 WAP

The sole pattern (control) had the highest weed biomass of 330.23kg/ha and 310.85kg/ha in both seasons followed by its derivative strip rows pattern Table 4. The double alternate rows pattern rows had the least weed biomass in both seasons (185.2kg/ha and 163.57kg/ha).

Land Equivalent Ratio. During both seasons, strip rows pattern had the highest land equivalent ratio Table 5. All the treatments had land equivalent ratio of more than one.

4. DISCUSSION

During the wet season, the different treatments had no significant effect on maize plant height, yield and biomass, but during the dry season, maize plant height in the double alternate rows pattern was significantly higher than other patterns. This crop arrangement apparently reduced maize intra specie light competition especially during dry season [12]. The intercrops and planting patterns seemed not to exhibit much shade effect on okra since they did not significantly affect its height in both seasons. Pepper plants height on the sole pattern and its derivative strip rows were significantly higher than the other treatments in rainy season while scattered pattern had the least(26.27cm). This was due to inter species shade effect. This agreed with the report of Metwally, et al. [13] that there is always a shade effect when a low growing crop is intercropped with a high growing crop(s).

Table-3. Pepper components.

	Wet season					Dry season				
Treatments	**Plant height(cm)**	**Fruit number**	**Fruit size(cm2)**	**Fruit seed number**	**Fruit weight(t/ha)**	**Plant height(cm)**	**Fruit number**	**Fruit size(cm2)**	**Fruit seed number**	**Fruit weight(t/ha)**
Sole pattern	35.00±3.88a	280±1.0a	53.30	111.0±2.0	6.0±125a	31.22±1.5	180±1.0a	45±2.5	75.25±23	5.5±125a
Double alternate rows	31.28±6.87b	96±2.18b	35.8±52	95±2.0b	2.0±16c	27.5±3.4	67±3.0b	33.33±5.7	44±18.52	1.4±72c
Strip rows	34.22±5.87a	279±1.0a	43.2±6.8	110.3±14.5a	5.9±154b	29.33±2.4	178±2.0a	38.57±9.0	73.67±96	5.0±272b
Scattered rows	26.27±3.38c	37±1.0c	38.27±8.6	86±25b	0.56±131d	26.12±5.7	30±2.0c	33.93±5.35	58.69±5	0.564±249d
LSD	1.2	2.99	ns	17.2	234.32	ns	24.87	Ns	ns	326.97

Within column, figures with different superscriptions vary significantly at $P< 0.05$ by DMRT.

Table-4. Weed Biomass at 6 WAP.

Treatments	Wet season	Dry season
Sole pattern	330.23 ± 16a	310.85 ± 41
Double alternate rows	185.2 ± 19	163.57 ± 14
Strip rows	289.13 ± 1.9	278.39 ± 11
Scattered rows	229.0 ± 5.9	198.52 ± 36
LSD	23.62	53.27

Source: Authors Within column, figures with different superscriptions vary significantly at P< 0.05 by DMRT.

Table-5. Land equivalent ratio.

Treatments	Wet Season	Dry Season
Double slternate rows	1.92	1.37
Strip rows	2-20	1.62
Scattered rows	1.89	1.45

Source: Authors.

The sole pepper pattern out-performed all other treatments in both seasons on pod weight(6t/ha,5.5t/ha) followed by its derivative, the strip rows patterns(5.8t/ha,5t/ha). This supports the report of Seran and Brintha [11] that sole cropping promotes high productivity. This high productivity is due to easier economic operations (planting, weeding and fertilize application), little shade effect and non-competition from more aggressive feeding crops and in some cases, allelopathy [14]. The non-significance of pepper fruit size in all treatments and seasons may be likely that it is genetically controlled [15]. During both seasons, the sole pattern had the highest weed biomass followed by strip pattern. This is in accordance with the report of Seran and Brintha [11] that sole cropping and its derivative strip pattern encourage weed growth and development especially if they are not low growing ones The low weed incidence in the scattered pattern clearly showed the advantage of close covering of soil surface by crops of different leaf shapes and heights [9]. The pepper fruit seed number of sole pattern and strip pattern did not significantly vary but were significantly higher than the other patterns. So for pepper seed production both patterns yields were the same but the strip rows pattern had a comparative advantage of high land equivalent ratio of 2.20 and 1.62 in both seasons.

5. CONCLUSION

This research work has demonstrated that pepper maize and okra intercrop on strip rows pattern can be used for profitable and sustainable production of pepper seeds by poor resource farmers. The okra pods mature early and are harvested and sold over time and later the maize cobs. This provides farmhouse hold with food and money until the maturation, processing and sale/use of the pepper seeds.

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