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Effect of maize sweet potato intercrop over sole cropping system on weed infestation.

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Abstract. A field experiment was conducted at the Teaching and Research Farm of Landmark University, Omu-Aran, Kwara State, during the 2018 cropping season. located at latitude 8^0 9' 0 N and longitude 5^0 6' 0 E of the southern Guinea savannah zone of Nigeria. The experiment was laid as a randomized complete block design with a split-plot arrangement and 3 replications. The main plots were 2 trial sites (Site A and B), sub-plots consisted of intercropping pattern : T_1: 2 seeds of maize + 1 vine of sweet potato, T_2: 2 seeds of maize / 2 vines of Sweet potato, T_3: 2 seeds of maize + 3 vines of sweet potato; T_4: sole maize and T_5: Sole Sweet Potato. Data collected on weed were estimated using a quadrat (25cm x 25cm) placed randomly at 5 positions within each sub plot at 3, 6, 9 and 12 WAP. All data collected were analyzed with analysis of variance (ANOVA) at $P<0.05$. Results showed that there was better grain yield of 1.89 t/ha intercrop of maize – sweet potato at ratio 2 : 2 of seeds / hill to vines / stand with better weed suppression and optimum tuber yield of 1.72 t/ha. Actual yield loss in the study was very high in the cropping system 2 seed of maize + 3 vine of sweet potato with -0.85 and in maize weed suppression percentage (%), 2 seed of maize +1 vine of sweet potato highly suppressed weed with 98.2% at 6 weeks after planting (WAP) and it showed 48% weed suppression in 2 seed of maize + 3 vine of sweet potato at 9 weeks after planting (WAP). Sweet potato weed suppression showed highest weed suppression of 37.2% at 3 weeks after planting (WAP) in 2 seed of maize + 2 vines of sweet potato. The highest competitive ratio occur in the cropping system 2 seed of maize + 1vine of sweet potato with 4.06 value. Maize showed the highest lnd equivalent value of 0.79 better than sweet potato and both maize and sweet potato combined had the highest land coverage in 2 seed of maize and 2 vines of sweet potato with 1.19 value. It is concluded from the study that the cropping system of 2 seed of maize + 1 vine of sweet potato gave the high response to weed suppression.

1. Introduction

Maize is the staple food in Nigeria. However, it is sensitive to water deficit hence is prone to crop failure and low yields, if rains are not timely and regular during the cropping season. Intercropping is an important tool for getting higher productivity per unit area of land and it improves the food security [1]. Intercropping system becomes productive and economical only when it is done properly by selecting compatible crops [2],

Cropping system characteristics can fundamentally alter the abiotic and biotic features of an agroecosystem and could modify the life cycle of pests such as weeds [3]. [4] Added that cropping system that reduces weed population may provide a weed suppressive foundation upon which cultural weed control could be laid. [5] In addition stated that the use of intercropping by smallholder and peasant farmers is a common practice [6]: That dates back to ancient civilization in the tropics [7] and rain-fed areas of the world [8]. The advantages of intercropping include soil conservation, lodging resistance, yield increment [9] and weed control [3] over the monocropping. [10] Stated that the individual crops that constitute an intercrop can differ in their use of resources spatially, temporally, or in form, resulting in overall more complementary and efficient use of resources than when they are grown in sole cropping; thus decreasing the amount available for weeds. [11] Added that intercropping increase light interception by the weakly competitive component and can, therefore, shorten the critical period for weed control and reduce growth and fecundity of late-emerging weeds. [12] In added stated that the apparent increased competitiveness of intercropping systems makes them potentially useful for adoption into low in-put farming systems in which options for chemical weed control are reduced or non-existent. [13] Reported that when two crops are planted together, intra and/or inter specific competition or facilitation between plants may occur. Studies showed that mixtures of cereals and legumes produce higher grain yields than either crop grown alone [14 and 15]. [16] Reported that the yield increase is not only due to improved nitrogen nutrition of the cereal component, but also to other unknown causes. The objectives of this research work is to assess the effect of cropping systems and planting patterns on weed suppression and crop yield.

2. Materials and Methods

2.1 Site Description
The trial was carried out at the Teaching and Research Farm of Landmark University, Omu-Aran, Kwara State, during the 2018 cropping season. The farm is located at latitude 8^0 $9^'$ 0 N and longitude 5^0 $6^'$ 0 E of the southern Guinea savannah zone of Nigeria. The minimum temperature ranges from 22^0C -28^0C during the period of the experimental. The humidity of the area was 43-47% except in January. Average rainfall ranges between 600-1500 mm, most of which is received in the months of April-September. The Total rainfall received during the cropping season was 1,043.72 mm.

2.2 Experimental Design and Field Layout
The experiment was laid as a randomized complete block design with a split split-plot arrangement and 3 replications. The main plots were 2 trial sites (Site A and B), sub-plots comprised of sub sub-plots consisted of intercropping pattern and these were: T_1: 2 seeds of maize + 1 vine of sweet potato, T_2: 2 seeds of maize / 2 vines of Sweet potato, T_3: 2 seeds of maize + 3 vines of sweet potato; T_4: sole maize and T_5: sole sweet potato.

2.3 Field Establishment
The land was ploughed, harrowed and ridged using tractor. The size of the plot was 6 m x 3 m (18 m^2) with 1m alley way. Maize (*Oba super* 6) was sown at a spacing of 0.25 m x 0.75 m at 2 seed per hill to give an approximate population of 53,333plants per hectare and followed by sweet potato planted between the maize stand and the vine cuttings was planted 1,2, and 3 vine per placement. The crops were planted simultaneously on the same day.
A pre emergence application of Premextra at 2.5 kg ai/ha was applied immediately after planting and supplementary at 5-6 WAP. Application of fertilizer was done in two splits. The first application was done 3weeks after planting (WAP) and second application was done at 6-7 WAP concurrently on both maize and sweet potato as 200kg/ha (4bags) of NPK 15:15:15 for the first application and the second application as 150 kg N/ha.

2.4 Data Collection

2.4.1 Crop Data
Growth data collected on maize were stand count at 4 and 7 WAP; plant height and number of leaves at 4,7 and 9WAP; and stem girth at 5,7, and 9 WAP while sweet potato data were stand count at 4 and 7 WAP;

vine length at 5,7, and 9WAP; and number of leaves at 6, 8, and 12 WAP. The plant height was taken by the use of meter rule, leave count/ stand count was manually done and stem girth was taken with a Vanier caliper.

At harvest, grain row per cob, number of grains per row, number of grains per cob and the grain yield per plot were estimated on maize while tuber length, tuber girth and yield of tuber per plot were taken on sweet potato.

2.4.2 Weed Data

The weed parameters were estimated using a quadrat (25 cm x 25 cm) placed randomly at 5 positions within each sub plot at 3, 6, 9, and 12 WAP. However, at each assessment period, weeds were counted, pulled out and identified into species level using procedure as described by Akobundu et. al. [17]. The harvested weeds were oven dried to a constant weight.

2.5 Data Analysis

All the data collected were subjected to analysis of variance (ANOVA) using Genstat statistical package and significant were separated using LSD $P<0.05$.

3. Result

3.1 Weed Species Composition

Twenty-five (25) weed species within 24 genera belonging to 14 families were encountered in the study sites. The weed spectrum comprised of 76% broadleaves, 20% grasses and 4% sedges. Annual weed species made up of 68%, perennials were 24% while 8% were annual to perennials.

On site A, the emerged weed species encountered in the intercropping systems: 2M1S, 2M2S, 2M3S, SMZ and SSP were 20, 19, 22, 23 and 16 respectively. The following 12 weed species (*Ageratum conyzoides, Bidens pilosa, Digitaria horizontalis, Euphorbia heterophylla, Lindernia crustacean, Ludwigia hyssopifolia, Melochia corchorifolia, Oldenlandia corymbosa, Paspalium scrobiculatum, Rottboellia cochinchinensis, Spilanthes costata, Stachytapheta jamaicensis*) were found to be more prevalent.

Table 1. Importance Value Index of weed species encountered across intercropping systems at study site A

Weed species	2M1S	2M2S	2M3S	SMZ	SSP
Ageratum conyzoides	11.31	13.22	2.93	24.01	0.0
Aspillia Africana	6.83	4.75	6.24	8.2	0.0
Bidens pilosa	0.0	0.0	0.0	24.39	0.0
Boerhavia erecta	0.0	0.0	3.67	13.37	0.0
Brachiaria deflexa	3.84	4.13	15.37	4.32	4.9
Cynodon dactylon	0.0	0.0	2.94	7.55	0.0
Cyperus rotundus	1.96	0.0	12.85	20.03	3.9
Digitaria horizontalis	9.27	29.14	9.23	25.46	11.6
Euphorbia heterophylla	0.0	2.86	2.63	24.37	0.0
Euphorbia hirta	0.0	3.54	0.07	10.23	2.2

Hyptis suaveolens	1.25	9.51	0.08	7.62	2.4
Indigofera hirsute	0.0	2.22	2.99	5.41	8.8
Ipomoea involucrate	2.37	2.26	0.08	6.48	6.9
Lindernia crustacean	39.04	14.78	51.77	2.26	71.5
Ludwigia hyssopifolia	15.63	6.19	11.03	8.34	47.1
Melochia corchorifolia	20.92	34.95	24.92	7.33	21.5
Mitracarpus villosus	1.97	0.0	0.0	0.0	0.0
Oldenlandia corymbosa	25.48	28.53	23.14	3.82	27.5
Paspalium scrobiculatum	6.28	0.0	24.06	4.23	5.5
Rottboellia cochinchinensis	14.43	20.05	16.05	47.14	20.2
Spigelia anthelmia	14.92	15.86	8.53	1.85	16.2
Spilanthes costata	22.94	51.93	21.51	13.08	22.6
Stachytapheta jamaicensis	24.65	49.56	57.84	17.89	27.3
Tephrosia linearis	1.41	1.92	0.0	0.0	0.0
Vicoa leptoclada	1.25	5.47	2.91	12.91	0.0

2M1S=maize@2seeds/hill + vine/stand, 2M2S=maize@2seeds/hill + 2vines/stand, 2M3S=maize@2seeds/hill + 3vines/stand, SMZ=sole maize, SSP=sole sweet potato

On site B, the emerged weed species encountered were 12, 15, 16, 24 and 17 in SM1S, 2M2S, 2M3S, SMZ and SSP, respectively. *Ageratum conyzoides*, *Boerhavia erecta*, *Digitaria horizontalis*, *Euphorbia heterophylla*, *Euphorbia hirta*, *Lindernia crustacean*, *Ludwigia hyssopifolia*, *Melochia corchorifolia*, *Rottboellia cochinchinensis*, *Paspalium scrobiculatum*, *Spilanthes costata*, *Stachytapheta jamaicensis*, *Tephrosia linearis* and *Tithonia diversifolia* were the prevalent 14 species with higher importance value index. *Rottboellia cochinchinensis* (61.86) and *Lindernia crustacean* (53.03) recorded the highest importance value index in 2M1S and 2M2S respectively, while *Stachytapheta jamaicensis*maintained the second highest index of 53.03 and 54.08 in 2M1S and 2M2S respectively. *Tithonia diversifolia*(66.02) and *Ludwigia hyssopifolia* (34.17) recorded the highest index value in 2M3S. However, in the SMZ, *Rottboellia cochinchinensis* (34.58) and *Euphorbia heterophylla* (25.78) had the highest while *Ageratum conyzoides* (38.26) and *Stachytapheta jamaicensis* (37.46) recorded the highest importance value index in SSP (Table 2).

Table 2. Importance Value Index of weed species encountered across intercropping systems at study site B

Weed Species	2M1S	2M2S	2M3S	SMZ	SSP
Ageratum conyzoides	6.43	5.65	3.08	17.47	38.26
Aspilliaa Africana	0.0	0.0	0.0	13.26	12.55
Boerhavia erecta	0.0	0.0	0.0	11.04	31.05

Brachiaria deflexa	5.04	4.04	9.26	8.56	6.84
Cynodon dactylon	0.0	0.0	0.0	2.95	0.0
Cyperus rotundus	5.07	0.0	0.0	8.53	3.67
Digitaria horizontalis	34.05	21.23	16.54	8.42	26.23
Euphorbia heterophylla	0.0	0.0	0.0	25.78	8.98
Euphorbia hirta	0.0	4.07	0.0	22.17	0.0
Hyptis suaveolens	0.0	0.0	0.0	7.09	4.43
Indigofera hirsute	0.0	0.0	5.63	11.46	3.61
Ipomoea involucrata	0.0	0.0	0.0	12.04	11.72
Lindernia crustacean	41.44	73.36	10.55	10.83	3.63
Ludwigia hyssopifolia	0.0	9.54	34.17	8.26	0.0
Melochia corchorifolia	36.26	12.98	20.79	12.04	33.84
Mitracarpus villosus	0.0	13.01	6.68	7.05	0.0
Oldenlandia corymbosa	21.28	19.74	20.15	9.77	23.46
Rottboellia cochinchinensis	61.86	6.23	0.0	34.58	0.0
Paspalium scrobiculatum	0.0	21.35	10.29	6.17	22.13
Spigelia anthelmia	7.87	12.46	3.64	14.62	14.95
Spilanthes costata	23.35	18.07	32.25	10.83	17.78
Stachytapheta jamaicensis	53.03	54.08	29.67	12.64	37.46
Tephrosia linearis	5.06	0.0	21.13	0.0	0.0
Tithonia diversifolia	0.0	25.19	66.02	16.93	0.0
Vicoa leptoclada	0.0	0.0	11.28	8.56	0.0

2M1S=maize@2seeds/hill + vine/stand, 2M2S=maize@2seeds/hill + 2vines/stand, 2M3S=maize@2seeds/hill + 3vines/stand, SMZ=sole maize, SSP=sole sweet potato

3.2 Effect of cropping system on weed density and biomass

Weed density was significantly influenced by cropping system in all period of assessment except at 12 WAP where the cropping system 2 seed of maize 2 vine of sweet potato had high value of 20.3 g/m^2 which is comparable with the Sole Maize with 30.0 g/m^2 value higher, study site significantly affected weed density at 3WAP (Table 3). Sole maize plot had significantly higher emerged weed seedlings in all sampling periods followed by plots where maize was sowed at 2 seeds / hill + 1 vine / stand. The sole sweet potato plots had significantly higher weed density though similar to plots with maize and 2 or 3 vines / stand.

3.3 Effect of cropping system on sweet potato growth parameters

Study site did not significantly influence stand count, vine length and number of leaves of sweet potato (Table 4). Stand count per 88 plants / plot in 4 and 7 WAP, respectively while vine length ranged between 94.1 – 270.4 cm and the higher number of leaves per plant was 48 leaves in site B. Cropping systems did

not significantly affect stand count, vine length except number of leaves at 6 WAP where high number of leaves (40 leaves/plant) was obtained in sole sweet potato plots.
Study site did not significantly affect yield and yield components of sweet potato (Table 7). Cropping system did not significantly influence yield parameters except tuber yield where sole sweet potato plots had significantly higher tuber yield 3.13 ton/ha compared to other plots that yield ranged between 1.23 – 1.72 ton/ha

Table 3. Effect of cropping system on weed density and biomass

	Weed density (Seedling/m^2)				Weed Biomass (g/m^2)			
SITE (S)	3WAP	6WAP	9WAP	12WAP	3WAP	6WAP	9WAP	12WAP
A	24	36	24	36	0.65	12.9	16.0	25.4
B	12	28	32	32	0.06	4.0	8.9	12.9
Sed	0.5*	1.66	1.66	1.11	0.04*	3.11	4.41	4.91
Cropping System (C)								
2M1S	20	32	36	44	0.33	5.5	11.8	15.1
2M2S	16	32	32	32	0.27	5.3	8.6	20.3
2M3S	16	32	40	24	0.32	10.0	11.9	14.0
SMZ	24	40	48	48	0.43	16.4	22.9	30.0
SSP	16	28	32	24	0.43	4.9	7.2	16.5
Sed	1.49*	1.30*	2.03*	1.38*	0.10	3.25*	4.11*	8.29
Interaction								
S x C	NS	*	NS	NS	NS	*	NS	NS

2M1S=maize@2seeds/hill + vine/stand, 2M2S=maize@2seeds/hill + 2vines/stand,
2M3S=maize@2seeds/hill + 3vines/stand, SMZ=sole maize, SSP=sole sweet potato

Table 4. Effect of cropping system on sweet potato growth parameters

SITE (S)	**Stand count**		**Vine Length**			**Number of Leaves**		
	4WAP	7WAP	5WAP	7WAP	9WAP	3WAP	6WAP	9WAP
A	90.69	87.53	94.1	159.0	270.4	25	31	46
B	92.42	87.61	94.1	159.0	270.4	25	36	48
Sed	0.12*	0.17	0.00	0.00	0.00	0.00	1.56	1.21
Cropping System (C)								
2M1S	91.67	87.06	96.1	149.0	287.8	25	35	48
2M2S	90.83	87.00	101.4	135.3	300.2	24	29	47

2M3S	92.17	89.11	89.8	173.8	254.1	22	30	46
SMZ	-	-	-	-	-	-	-	-
SSP	91.56	87.11	88.9	178.0	239.6	29	40	47
Sed	1.62	1.52	12.68	25.73	27.82	4.07	2.77*	3.49
Interaction								
S x C	NS	NS	NS	NS	NS	NS	NS	NS

2M1S=maize@2seeds/hill + vine/stand, 2M2S=maize@2seeds/hill + 2vines/stand, 2M3S=maize@2seeds/hill + 3vines/stand, SMZ=sole maize, SSP=sole sweet potato

3.4 Cropping system on the yield of Sweet potato
From table 4, the site for the trial did not show any significant difference where site A had 2.79 tons/ha tuber yield and site B had 2.68 tons/ha tuber yield while the cropping system showed that 2 seed of maize + 2 vine of sweet potato had higher yield of 1.72 tons/ha followed by 1.45 tons/ha of 2 seed of maize + 3 vine of sweet potato. The sole cropping of sweet potato had highest yield of 3.13tons/ha.

3.5 Cropping System on Maize Growth Parameters
From table 5, trial site did not significantly influenced growth parameters of maize except plant height at 7 WAP where site B had significantly higher plant height of 136.7 cm compared to 112.1 cm obtained in site A. Cropping system significantly influenced stand count and stem girth. The sole maize plots had high stand count and significantly higher stem girth than other intercropped plots.

3.6 Cropping System on the Yield of Maize
From table 6, trial site did not significantly affect maize yield. Cropping system did not significantly influence yield and yield components of maize except grain yield. The cropping system 2 seed of maize + 1 vine of sweet potato showed higher yield of 1.89 tons/ha than other inter cropping system. However, maize sole cropping had a higher yield of 2.40 tons/ha

Table 5. Effect of cropping system on yield and yield components of sweet potato

SITE (S)	Tuber length	Weight of Tubers	Tuber Yield (ton/ha)
A	15.81	499	2.79
B	15.81	314	2.68
Sed	0.00	58.8	0.27
Cropping System (C)			
2M1S	16.67	354	1.23
2M2S	14.89	478	1.72
2M3S	15.56	414	1.45
SMZ	-	-	-
SSP	16.11	381	3.13
Sed	1.30	84.9	0.25

Interaction			
S x C	NS	NS	NS

2M1S=maize@2seeds/hill + vine/stand, 2M2S=maize@2seeds/hill + 2vines/stand, 2M3S=maize@2seeds/hill + 3vines/stand, SMZ=sole maize, SSP=sole sweet potato

Table 6. Effect of cropping system on maize growth

	Maize Stand Count (Stands/plot		**Maize Plant height (cm)**			**Maize Stem Girth (cm)**		
SITE (S)	4WAP	7WAP	5WAP	7WAP	9WAP	6WAP	8WAP	12WAP
A	93.47	87.56	70.4	112.1	169.4	1.18	1.76	2.03
B	93.69	87.28	66.7	136.7	169.8	1.16	1.76	1.95
Sed	0.41	1.33	8.64	1.95*	1.69	0.02	0.05	0.05
Cropping System (C)								
2M1S	90.50	81.89	72.3	130.1	163.0	1.35	1.81	2.06
2M2S	94.89	88.67	72.9	125.7	170.8	1.43	1.75	1.98
2M3S	93.33	87.72	57.9	108.8	158.5	0.78	1.57	1.83
SMZ	95.61	91.39	70.9	132.9	185.9	1.13	1.88	2.08
SSP	-	-	-	-	-	-	-	-
Sed	1.68*	1.88**	8.09	9.49	10.30	0.17*	0.10*	0.10
Interaction								
S x C	NS	NS	NS	NS	NS	NS	NS	NS

2M1S=maize@2seeds/hill + vine/stand, 2M2S=maize@2seeds/hill + 2vines/stand, 2M3S=maize@2seeds/hill + 3vines/stand, SMZ=sole maize, SSP=sole sweet potato

Table 7. Effect of cropping system on yield of maize

SITE (S)	**Row per Cob**	**Seeds per Row**	**Seeds per Cob**	**1000 Seed Weight (g)**	**Grain Yield (ton/ha)**
A	13.89	30.67	436	191.1	2.33
B	14.17	25.56	362	200.8	1.31
Sed	0.06*	2.27	31.2	10.34	0.59
Cropping System (C)					
2M1S	14.44	27.39	413	192.8	1.89
2M2S	13.56	28.39	385	187.2	1.53

2M3S	13.78	28.78	399	192.8	1.45
SMZ	14.33	27.89	399	207.9	2.40
SSP	-	-	-	-	-
Sed	0.44	1.65	29.3	7.58	0.48
Interaction					
S x C	NS	NS	NS	NS	NS

2M1S=maize@2seeds/hill + vine/stand, 2M2S= maize@2seeds/hill + 2vines/stand, 2M3S= maize@2seeds/hill + 3vines/stand, SMZ=sole maize, SSP=sole sweet potato

4. Discussion

The general reduction in weed density and dry matter in intercropped plots compared with the sole crop plots was in line with the results obtained by other workers [18, 19, 20 and 21]**.** This research showed that, an increase in the plant population of sweet potato-maize intercrop resulted to a higher tuber yield of 1.72 t / ha at 2 vines per stand whereas a slight reduction of 15 % in the yield was recorded when the plant population was increased to 3 vines per stand as compared to 28 % yield reduction in maize plots intercropped with 1 vine per stand. the increase in the plant population of sweet potato intercropped with maize led to a reduction in the grain yield whereby the highest grain yield in the sweet potato-maize intercrop was recorded in 2M1S with 1.89 t / ha as compared with 2M2S and 2M3S with yield reduction of 19 % and 23 %, however, [22] reported a yield loss of 2 - 42 % in the East Mediterranean region. [20] added that the reduction was not only due to the high plant population in the intercropped plots than the sole cropped plots but also the different planting pattern that in turn led to better ground cover which inhibited weed seed germination and subsequent growth thus the slight differences in weed emergence between the intercropping systems. [11] suggested that intercropping helps to improve weed suppression relative to monoculture, whose open canopy structure permits weeds to proliferate.

5. Conclusion

This study concludes that intercropping system may be eco-friendly approach for reducing weed problems through non-chemical methods. Intercropping maize and sweet potato in different patterns may affect grain yield due to competition between the 2 crops compared to sole cropping; that Intercropping of maize – sweet potato at ratio 2 : 2 of seeds / hill to vines / stand had better weed suppression and optimum tuber yield of 1.72 t/ha. However, maize – sweet potato intercrop at 2:1 had the highest grain yield of 1.89 t/ha. In maize weed suppression percentage (%), 2 seed of maize +1 vine of sweet potato highly suppressed weed with 98.2% at 6 weeks after planting (WAP) and it showed 48% weed suppression in 2 seed of maize + 3 vine of sweet potato at 9 weeks after planting (WAP). Sweet potato weed suppression showed highest weed suppression of 37.2% at 3 weeks after planting (WAP) in 2 seed of maize + 2 vines of sweet potato.

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