Futo Journal Series (FUTOJNLS)
e-ISSN : 2476-8456 p-ISSN : 2467-8325
Volume-4, Issue-2, pp- 1 - 9
www.futojnls.org

Research Paper December 2018

Pineapple Forage Legume Intercropping Systems for Sustainable Pineapple Production in the Tropical Rainforest of Southeastern Nigeria.

*Emma-Okafor L.C., Obiefuna, J.C., Alagba, R.A., Okoli, N.A., Nnebue O.M., Keyagha, E.R. and Ibeawuchi, I.I.
Department of Crop Science and Technology, Federal University of Technology, Owerri, Imo State, Nigeria.
**Corresponding Author E-mail: lilianokafor35@yahoo.com*

Abstract

Weeding and soil impoverishment are the major constraints in pineapple production in the high rainforest agroecology of Southeastern Nigeria. The study exploited the biological aspects of four perennial legumes mucuna, puero, calapo and centro laid out in three populations: 20,000, 10,000 and 5,000 respectively. The control was mulched with wood shavings (5 cm depth). The 4 x 3 factorial experiment was laid in a randomized complete block design replicated thrice. The experimental plot were 4.0 x 4.0 m with pineapple suckers planted in 50.0 x 50.0 cm double row system with 100cm alleys. Pre and post experimental soil samples were analyzed for soil macro biological populations (bio-index) and physico-chemical properties. Most mucuna seeds (80-89 %) emerged very early (5- 6 DAP) while calapo, puero and centro emerged late (42-60 DAP) with low (62-68%) establishment. Mucuna legume population of 20,000 plant/ha was very aggressive and suppressed both weed and pineapple despite regular mucuna training. The same populations of the other three forage legumes were efficient weed suppressors and yield enhancers. Except for centro which remain alive, the other forage legumes died back during the dry season but regenerated vegetatively and by selfseeding during the rains. Nodulation was high in centro populations. Pineapple intercropped with 20,000 mucuna matured early 508 days after planting and produced the highest individual fruit yield (3.8 kg) followed by those with), mucuna (10,000) centro (20000) and calpo (10,000) plants respectively. The soil physico-chemical properties and biological indicator significantly ($p \leq 0.05$) increased by 36.0 and 85.0 % respectively over the control. Intercropping pineapple with 10000-20000 mucuna, and centro populations is recommended. Further research on cutting back frequency for high mucuna population, breaking seed dormancy and slow growth rate improvement in centro is advocated.

Keyword: Pineapple intercropping, Mucuna, puero, calapo and centro population.

1. Introduction

Pineapple (*Anaxas comosus (L) Marr)* is a rationing perennial fruit crop and a prominent feature in most rural and urban farming systems of Southeastern Nigeria. The crop is traditionally cherished for its nutritional and medicinal value and fresh fruit consumption by human and animals. Pineapple drives an economically processing value chain addition for national and international markets. However, commercial pineapple production in Nigeria lacks organized production system for various reasons: long gestation, rapid yield decline, poor quality propagules, soil fertility reduction, high weeding hazard etc. The multi-benefit of pineapple notwithstanding, research on pineapple production is neglected and alienated in scarce input resource allocation as agro-based raw material for processing and livestock feed, (Obiefuna, Majumda & Ucheagwu, 1987). Most perennial forage legumes are totally absent in the traditional farming systems as farmers consider them *obnoxious weeds*. Harnessing the biological aspects of forage legume/pineapple intercropping shall positively accelerate the adoption by the small/commercial scale pineapple growers in Nigeria.

Pineapple is a slow growing crop. The pineapple production systems encourage continual weed competition, yield reduction or crop failure. Management of weed interference accounts for over 40% of the total pineapple production cost (Bose & Mitra, 1990). In Southeastern Nigeria, the issue is willingness rather than the cost of manual weeding. Chemical herbicide is expensive, environmentally disastrous and instantly discarded by growers (Sison, 2000). Biological weed control promises an affordable and acceptable alternative to address the challenges of sustainable soil fertility and increased pineapple production.

Most arable crops (tuber, plantain, cereal) and tree crop/food legumes (cowpea, groundnut and soybean) are commonly advocated for sustainable multiple cropping systems, (Ibeawuchi, Dialoke, Ogbedeh, Ihejirika, Nwokeji & Chibundu, 2007).

Small scale poor farmers of arable crops and pineapple often reject/resist adoption of intercrops without direct socio-economic value despite indirect multi-benefits of such intercrops e.g. plantain-gliricidia alley cropping system rejection (Kang, Wilson & Spikens, 1984). However, the challenges of problematic pineapple production systems, soil impoverishment and weeding difficulties may attract interest in the exploitation and adoption of biological weed control, soil fertility improvement and bio-conservation enhancement aspects in pineapple forage legume intercropping systems.

Integration of leguminious cover crops into the prevalent pineapple cropping systems holds a promise to overcome the challenge. Legumes have the potential to improve soil fertility and enhance pineapple yields. The increasing cost of inorganic fertilizers demands alternative sources (Carsky & Iwuafor, 1994). The legumes improve the systems productivity indices (Tarawali, Mahammed-Seloem & Von Kanifuam, 1987, Skerman, Carneron & Rivers, 1988 and Claudius-Cole, Anadu & Fawole, 2001). In low farm-input agricultural systems, need arises to identify the neglected relevant legume species for integration into the pineapple farming systems. Forage legumes stand out among myriad legume species of Southeastern Nigeria agroecology.

2. Material and Methods

The experiment was conducted at the Teaching and Research Farm, Federal University of Technology, Owerri, $5^{0}27^{1}$N and $07^{0}2^{1}$E. Owerri is characterized by two distinctive rainy (March-October) and dry (November –March) seasons. The soil is ultisol, acidic and low in mineral nutrients (Onweremadu, Eshett, Osuji, Unamba-Opara, Obiefuna & Onwuliri, 2007). The five year fallow experimental site was cleared manually. Pineapple suckers (250$\pm$10 g) were established on 4.0x4.0 m experimental plots in 50.0 x 50.0 cm double row system in 100.0 cm alleys between adjacent twin row systems.

The treatments were four forage perennial legumes mucuna (*Mucuna prusiens white),* puero (*Pueraria pubescens)* calapo (*Calap ogonium phaseoloides)* and Centro *(Centrosima purscurium)* populations established at 5,000, 10,000 and 20,000 plants per hectare. The control was mulched 5.0 cm depth wood shavings. Poultry manure (10 t ha^{-1}) was broadest in two splits annually. Pre and post experimental core soil samples (0-30 cm depth) and the forage legume leaf samples were analyzed . Soil biological life was monitored using monolith technique. The quadrat weed samples at 3, 6, and 9 months after planting were analyzed for weed dry weight. Growth and yield data of forage legumes and pineapples were statistically analyzed using Genstat Release 7.2 DE (2007) . Mean separation was by Fishers Least Significant Difference (FLSD) at 5% probability.

3. Results and Discussion

The tropical ultisol is infertile and low in mineral nutrients (Table 1) while the forage legumes are rich in macronutrients NPK Ca and Mg which are crucial in crop production. The macronutrients in all the pineapple forage mixtures soils increased remarkably. The nutrient contributions in pineapple/centro mixture exceeded others from other forage legumes. Such increases were contributed by the degraded biomass and nitrogen fixation through nodulation (Table 1).

Most of the mucuna seeds emerged (98.0%) within 5days and rapidly attained 50% vegetal cover within 30days (Table 2). Seeds of puero, calapo and centro emerged very late 35-45DAP and had low emergence (62-78%) and grew slowly to attain 50% vegetal cover in 32-68 days after planting. The highest forage legume population (20,000) attained the fastest vegetal cover for each legume while centro populations were slowest to attain vegetal cover. The vegetative pineapple growth at flowering (D-leaf) was similar in all the pineapple forage legume mixtures.

The impact of forage legume populations on weed dry weight was remarkable (Table 3). The dry weight significantly ($P \geq 0.05$) decreased overtime (3-9MAP) between and among forage populations and species. The least weed dry weight was recorded in mucuna population of 20,000 plants per hectare at 3, 6 and 9MAP respectively. The heaviest weed weight was recorded in the lowest centro population (5000 plants per hectare). The weed growth significantly ($P \geq 0.05$) increased over time (3-9) in the control.

However, the highest biological index (assessed by the number of different species per plot) and the nodulation count were highest in centro populations. Mucuna populations had the least. Pineapples intercropped with mucuna populations matured early while those in pineapple/centro mixtures matured late (Table 4).

The fruit yield of pineapple plant crop was high in pineapple mucuna (3.69kg/plant) and centro (3.24kg/plant) mixtures and the control (3.22kg/plant) while the yield was moderate (>2.0kg) in pineapple / puero or /calapo mixtures. The ratoon pineapple fruit yield declined significantly ($P \geq 0.05$) than those of the plant crop pineapples. The ratoon pineapple fruit yield reduction was highest in mucuna and puero pineapple intercrops. The number of suckers developed per pineapple followed similar pattern as the fruit yield.

Table 1: Forage leaves, Pre and Post Soil Physio-Chemical Analysis

Pre-planting soil	Percentage						Available P	Cmolkg^{-1}					
	Sand	Silt	Clay	OM	N	BS	(ppm)	K	Mg	Ca	Na	CEC	pH
Pre-planting soil	77.86	13.28	8.86	1.29	0.23	63.35	11.76	0.10	1.10	1.10	0.32	4.73	5.20
Mucuna	NA	NA	NA	NA	0.79	NA	0.06	0.08	0.24	3.18	NA	NA	504
Puero	NA	NA	NA	NA	0.61	NA	0.49	0.11	0.48	3.72	NA	NA	5.08
Calapo	NA	NA	NA	NA	0.64	NA	0.52	0.16	0.20	10.52	NA	NA	5.22
Centro	NA	NA	NA	NA	1.62	NA	0.22	0.18	0.91	2.21	NA	NA	5.18
Post harvest soil analysis													
Forage legume	**Mucuna population**												
Mucuna	5,000			2.02	2.43	0.89	9.05	0.14	2.08	0.64	0.64	NA	5.80
	10,000			2.03	2.53	1.48	19.50	0.52	3.00	0.87	0.45	NA	6.88
	20,000			2.04	2.90	1.70	21.40	0.15	7.03	0.67	0.56	NA	6.30
Puero	5,000			1.02	2.46	0.92	18.20	0.18	2.60	0.28	0.86	NA	6.07
	10,000			1.64	2.86	1.66	25.22	0.15	2.44	0.50	0.86	NA	5.90
	20,000			1.53	2.48	1.46	21.22	0.18	3.62	0.83	0.76	NA	6.28
Calapo	5,000			1.08	2.37	1.42	18.80	0.21	3.02	1.17	0.66	NA	6.59
	10,000			1.08	2.10	1.22	20.68	0.06	2.18	1.86	0.18	NA	5.67
	20,000			1.22	2.47	0.93	18.24	0.23	3.65	0.55	0.66	NA	6.76
Centro	5,000			2.03	2.24	1.66	16.62	0.44	4.50	0.85	0.65	NA	6.78
	10,000			2.03	2.26	1.44	18.60	0.03	5.48	0.83	0.67	NA	6.73
	20,000			2.02	2.28	1.28	18.90	0.44	5.76	1.00	1.76	NA	5.72
Control				0.02	0.01	0.02	0.06	0.01	0.02	0.00	0.02	NA	0.04

Table 2: Forage Legume Seed Emergence, Establishment and Vegetal Cover and D Leaf Length (cm) in Pineapple Forage Legume Population Mixture

Forage legume	Population (ha^{-1})	Days to 50% seed emergence	Percentage emergence (%)	Days to 50% vegetal cover	Length of D. leaf at 50% flowering (cm)
Mucuna	5,000	5.04	98.84	32.64	80.78
	10,000	5.02	98.78	25.64	84.82
	20,000	5.02	98.86	15.56	88.48
	$\bar{x}$	**5.03**	**98.83**	**24.61**	**84.69**
Puero	5,000	45.62	68.69	61.52	76.52
	10,000	46.07	67.88	52.40	78.68
	20,000	45.58	78.95	58.06	78.80
	$\bar{x}$	**46.58**	**71.84**	**57.32**	**78.00**
Calapo	5,000	38.68	63.68	56.18	74.58
	10,000	38.56	64.08	42.08	76.82
	20,000	38.50	63.68	32.06	78.54
	$\bar{x}$	38.58	63.81	43.44	76.65
Centro	5,000	45.62	62.56	68.92	90.56
	10,000	45.60	68.56	54.08	76.08
	20,000	45.58	68.42	46.82	88.64
	$\bar{x}$	**45.60**	**66.57**	**56.61**	**85.07**
Control		0.00	0.00	0.00	76.82
$LSD_{0.05}$ forage		**12.44**	**8.56**	**5.68**	**NS**
$LSD_{0.05}$ population		**5.06**	**40.02**	**6.44**	**NS**
$LSD_{0.05}$ forage x population		**3.48**	**3.24**	**5.82**	**NS**

Table 3: Weed Dry Weight a t 3, 6 and 9 Months after Planting in Pineapple Forage Legume Populations Mixture

Forage legume	Population	Weed dry weight (g/plot)				
		3	6	9	Bio-index	Nodules/plant (₦)
Mucuna	5,000	21.54	15.42	5.32	3.62	10.06
	10,000	20.44	5.16	0.00	3.24	11.04
	20,000	15.62	2.04	0.00	3.04	10.40
	$\bar{x}$	**19.20**	**9.87**	**1.77**	**3.30**	**10.50**
Puero	5,000	36.84	158.56	18.04	4.14	76.04
	10,000	35.42	110.44	12.68	4.08	70.56
	20,000	25.05	96.64	15.50	4.02	68.82
	$\bar{x}$	**32.44**	**121.88**	**15.41**	**4.08**	**71.81**
Calapo	5,000	38.60	128.82	15.08	5.12	58.68
	10,000	34.52	108.64	12.84	5.09	56.08
	20,000	22.58	96.28	10.08	5.05	58.00
	$\bar{x}$	**39.93**	**11.17**	**12.67**	**5.08**	**57.59**
Centro	5,000	65.62	168.62	22.08	6.14	288.54
	10,000	64.08	124.80	15.50	6.08	281.57
	20,000	41.50	104.52	10.02	6.42	268.05
	$\bar{x}$	**57.07**	**132.65**	**15.87**	**6.21**	**279.39**
Control		10.68	12.42	12.06	1.42	NA
$LSD_{0.05}$ forage		**26.42**	**12.56**	**2.08**	**1.04**	**16.82**
$LSD_{0.05}$ population		**15.16**	**18.48**	**1.50**	**0.62**	**9.00**
$LSD_{0.05}$ forage x population		**8.26**	**6.04**	**1.08**	**0.84**	**4.54**

Table 4: Fruit Yield in Pineapple as Influenced by Forage Legume Populations

Forage legume	Population	Days to 50% fruit harvest		Fruit yields (kg)/plant			Number of suckers/plant	
		Plant	Ratoon	Plant	Ratoon	Total	Plant	Ratoon
Mucuna	5,000	520.82	1068.48	3.46	2.80	6.26	3.42	1.86
	10,000	510.52	1060.84	3.80	2.80	6.60	3.40	1.80
	20,000	508.62	1054.02	3.80	2.83	6.63	3.58	2.04
	$\bar{x}$	**513.32**	**1061.23**	**3.69**	**2.81**	**6.50**	**3.47**	**1.90**
Puero	5,000	684.04	1382.68	2.52	1.26	3.78	3.04	0.82
	10,000	736.58	1388.76	28.4	1.42	4.26	3.12	0.96
	20,000	760.52	1268.06	2.86	1.62	4.48	3.12	0.86
	$\bar{x}$	**727.45**	**1346.50**	**2.74**	**1.43**	**4.17**	**3.05**	**0.87**
Calapo	5,000	696.50	1378.62	2.60	1.06	3.88	3.06	1.05
	10,000	750.28	1384.72	2.58	1.28	3.56	3.20	0.96
	20,000	758.08	1398.58	2.65	1.24	3.69	3.16	1.08
	$\bar{x}$	**734.95**	**1387.31**	**2.61**	**1.19**	**3.78**	**3.14**	**1.03**
Centro	5,000	538.40	1079.05	3.76	2.18	5.94	4.26	1.66
	10,000	530.18	1082.56	3.78	2.28	6.06	4.38	1.20
	20,000	525.66	1148.62	3.68	2.46	6.14	3.32	2.04
	$\bar{x}$	**531.29**	**1105.43**	**3.24**	**2.41**	**6.03**	**4.32**	**1.63**
Control		556.28	1148.67	3.22	2.48	5.70	3.32	2.04
$LSD_{0.05}$ forage		**18.52**	**32.40**	**0.54**	**0.20**	**1.08**	**0.20**	**0.62**
$LSD_{0.05}$ population		**8.06**	**12.06**	**0.28**	**1.16**	**0.82**	**0.12**	**0.08**
$LSD_{0.05}$ forage x population		**2.44**	**8.35**	**0.12**	**1.08**	**0.56**	**0.84**	**0.06**

The forage legume generally reduced weed in the pineapple forage intercrop. However, weed was drastically reduced in pineapple mucuna at10000 and 20000 density/ha. This could be attributed to early vegetal cover by mucuna population as observed in the experiment which resulted in smothering of the weeds thereby preventing competition on moisture and soil nutrient .This agreed with Lamerle, Verbeck, Cousea and Coumles, (1996) who reported that crop shading ability may improve weed control without extra cost and negative environmental impacts.

Large biomass from mucuna and other forage legume on decay added more nutrient in addition to nitrogen fixation which the pineapple utilized to produce high yield. The low fruit pineapple yields in puero and calapo mixtures may have resulted from underground root competition between pineapple and puero and calapo root in similar foraging zone.

Biological life was also improved from pineapple forage legume mixture when compared to the control. centro at 20000/ha had the highest bio index(6.42) and nodulation count(260). The biological life improvement in pineapple forage maintained moisture and moderated soil temperature in the intercrop system (Lal, 1985). This in effect improve soil fertility, soil aeration, water percolation as well as improve the system productivity (Tarawali *et al*,1987, Skemah *et al*,1988 and Claudius-Cole *et al*,2001)

Though cetro had more nodulation count and higher bio index but the higher biomass in mucuna compensated for its lower nodulation by increasing the soil nutrient for the benefit of the pineapple as observe from the yield of pineapple in this experiment. The improved soil fertility in postharvest soil analysis of pineapple forage mixtures resulted from forage biodegradation and nitrogen fixation especially in centro, mucuna,puero and calapo mixtures..

4. Conclusion

Pineapple forage legume intercropping is a productive pineapple production. Although mucuna developed massive biomass and accumulated heavy foliage which early in the life of pineapple minimized weed interferences through smoothing. The growth was so vigorous and aggressive that six months after planting, weed growth was virtually non-existent implicating allopathy. .

Intercropping pineapple with 10,000 mucuna or 20,000 centro plants per hectare are recommended for weed suppression, bio-conservation, sustainable soil fertility and heavy pineapple fruit yields. The system is adoptable by grower for pineapple sustainable fruit yield, livestock feed and soil fertility improvement. Further work is required on promising centro and mucuna forage legumes. Areas of immediate work include mucuna vine training or cutting frequency and breaking seed dormancy in centro using priming and scarification techniques

Acknowledgements

The authors are grateful to the Vice-Chancellor Federal University of Technology, Owerri Prof. F.C. Eze, Dean, School of Agriculture and Agricultural Technology, Prof. B.O. Esonu, Ag. Head, Department of Crop Science and technology for the research facilities used and the farm staff for technical assistance rendered.

References

Bose, T.K. & Mitra, S. K. (1990). *Fruits: Tropical and subtropical Nyare Protash Bidhen Sargni.* Calcula India, 838.

Carsky, R. J. & Iwuafor, E.N.O. (1999). Contribution of soil fertility research and maintenance to improved mass production and productivity in soil Saharan Africa. *Proceedings of Regional Maize Workshop IITA, 3 - 20.*

Clanduis-Cole, O.A., Anadu, R. & Fawole, B. (2001). Cultural control of weeds on edible yam. *Book of abstract, eight symposium of the international society for tropical root crops, African Brand 12-11 November 2001. IITA Ibadan Nigeria, 37.*

Ibeawuchi, I.I., Dialoke, S.A., Ogbedeh, K. Ihejirika, G.O., Nwokeji, E.M. & Chibundu, I.N. (2007). Influence of yam-cassava based intercropping systems with legumes in weed suppression and disease pest incidence reduction. *Journal of American science, 3(1), 49-59.*

Kang, B.T., Wilson, G.F. & Spikens, R. (1984). *Croppingmaize (Zea mays l.*) and leucaera (*beucanal leucraphalla)* in Southeastern Nigeria. *Plant and soil*, 63, 165-179.

Lemerle, D. Verbeck, B. Couseas, R.D & Coumles, N.E (1996). *The potential for selecting wheat varieties strongly competitive against weed/weedresearch, 36, 505 - 513.*

Norman, J.C. (1982). Regulation of fruit growth in pineapple (*Ananan comosius.l.). proceedings of XXI international horticultural conference.* Hansbury, Germany, 318-329.

Obiefuna, J.C., Majumda, P.K. & Ucheagwu, A.C. (1987). Fertilizer rates for increased pineapple production in the tropical feralletic soils of South-Eastern Nigeria. *Fertilizer research,* 99-165.

Onweremadu, E.U., Eshett, E.T., Osuji, G.E., Unamba-Opara, I., Obiefuna, J.C. & Onwuliri, C.O.E. (2007). Anisotropy of edaphic properties on suppressions of a university farm in Owerri, South-Eastern Nigeria. *Journal of American Science, 394, 52-61.*

Sison, C.H.ESE (2000). *Sulfertazone for pre-plant weed* control in pineapples. *Acta Horticulturae, 529, 303-308.*

Skerman, P.J., Carneron, D.J. & Rivers, F. (1988). *Tropical forage legumes, FAO Plant Protection and Production Series 2. FAO, Rome.*

Tarawali, G., Mohammed-Saloem, M.A. & Von Kanifuam, R. (1987). Comparison of labour requirements for cropping maize in land previously used for styosanthes fodder bank in an adjacent fallow in the sub-humid zone of Nigeria. *ILCA Bulletin 26, 36-39*