LABORATORY EVALUATION OF THETOXICITY OF *Carica papaya* PRODUCTS AGAINST *Callosobruchus maculatus* (F) *(Coleoptera: Bruchidea)* ON COWPEA SEEDS

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Abstract

The insecticidal properties of Carica papaya products (leaf, stem, root and flower powders) were tested Callosobruchus maculatus in cowpea seeds. The experiment was carried out in the laboratory of the Fed College of Agriculture, Ibadan.Actellic dust and four Carica papaya products were tested on cowpea se infested with teneral adults of Callosobruchus maculatus in a simple completely randomized design. The res obtained indicate a significant difference in the mean egg laid, egg hatched and the number of adults emerged at different Carica papaya powder products applied. However the leaves of Carica papaya significa reduced the total developmental period and showed good potential as insecticide for protecting stored cow seeds.

Introduction

The cowpea, *Vigna unguiculata* (L) *Walp* popularly known as beans is a tropical herbaceous annual, belongin the tribe *Phaseoleae* and the order*Leguminosales* (Romain 2002). In tropical Africa, cowpea is consumed mostl the form of dry grain. It is a relatively cheap source of protein and provides an adequate complement to a ce based diet. The bruchid beetle, *Callosobruchus maculatus* (F), is widespread throughout most of the tropical subtropical countries, attacking cowpea and other legumes (Hill, 1983). Attack usually starts in the field where carried to the store, seed damaged have reduced weight, low viability and poor marketability (Ofuya and Bamigl 1991). A female bruchid beetle deposits from 40-80 eggs over a period of 7 days. According to Wesserman (19 about 40% of the total number of eggs are laid in the first day of life. The eggs are ovoid in shape and firmly gl to the testa of the seed. Adenekan 2002 reported that the colour of the eggs is Pinkish when freshly laid but t milky white after eclosion. Several reports on *Callosobruchus maculatus* have been made on cowpea *Vig unguicalata* and other pulses. It has been reported that *Callosobruchus maculatus* could cause 60-80% damag cowpea seeds stored for a period of six months (Hill, 1983). *Carica papaya* belongs to the familyCaricaceae, wl originated from America. It is a latex-producing tree. The latex contains papain, which could be used to protect seeds against insects' infestation. This paper therefore investigates the insecticidal properties of *Carica pap* products for the control of bruchid beetles in cowpea seeds.

Materials and methods

The *Callosobruchus maculatus* used for this study was obtained from already established culture. The study carried out in the laboratory under ambient temperature conditions (temperature 32-34^{0}C) and relative humidity 95%. Untreated Ife Bimpe variety of cowpea seeds used for this study was obtained from the National Seed Serv Ibadan, Oyo State. The seeds were cleaned and carefully sorted out; seeds of similar sizes were selected and kep the laboratory until they were needed for the study. The plant products tested for insecticidal activity were collec from growing stands of *Carica papaya* in Ibadan, Oyo State, a month before the commencement of the study. leaves, stem, root and flowers of the plant were separately collected and sun dried before grinding into powd form. The untreated cowpea seeds were collected and placed in petri dishes. 20 grammes of seeds were placed each petri dish arranged in six groups. There were six treatments replicated four times each. The treatments w powders of the leaf, stem, root and flower of *Carica papaya*,, Actellic dust and untreated cowpea seeds, which se as the standard check and control respectively. The plant products powder and Actellic dust were administered cowpea seeds in each Petri dish at the rate of 0.5g per 20g of seeds.

Three male and female of teneral adults of *Callosobruchus maculatus* were introduced and confined in each petri dish for seven days. The petri dishes were arranged in completely randomized design an each group containing s treatments with the control experiment was carefully arranged in the laboratory and observed for seven days before data collection commenced.

Da were collected on the total number of eggs laid, number hatched and number of adults that emerged from each treatment. The total developmental period in each treatment was also noted, recorded and analyzed using the analysis of variance while the treatment means were separated with the aid of Duncan new multiple range test at 0.0 level of significance.

Results and Discussion

The results of the toxicity of *Carica papaya* products and Actellic dust are presented in Table 1. There were significant differences among cowpea seed treated with different *Carica papaya* products and Actellic dust (P< 0.C) The beetles exposed to seeds treated with leaf powder of *Carica papaya* recorded the lowest mean number of egg laid, hatched and adult emergence and was significantly different from other treatments where powders of flower, stem and roots were applied. However there was no oviposition on cowpea seeds treated with Actellic dust in all the replicates. All the adults introduced died within five days in all the treatments where Actellic dust was applied. The highest mean number of egg laid, ecloded and total number of adult emergence at the control were 84., 81.3 and 75.3 respectively and were significantly reduced when compared with the values obtained when other products of the tested plant powders were applied (Table 1).

Similarly, the highest mean number of dead bruchid beetles of 6.0 and 4.1 were obtained on the treatments where Actellic dust and leaf powder of *Carica papaya* was applied respectively while the lowest mortality rate of 1.4 was obtained on the control experiment where no plant product was applied (Table 1). The leaf powder of *Carica papaya* supported the lowest developmental period of 17days and significantly different when compared with control experiment where no plant part was applied (Table 2). The other three products of the plant supported various developmental periods from egg to adult emergence and were not significantly different from the control experiment. The performance of Actellic dust in this experiment confirms the assertion of Singh (1989) who reported that synthetic insecticides are relied upon mostly for prevention or reduction of storage wastage.

There is increasing emphasis on mammalian toxicity and environmental pollution associated with the continuous use and abuse of synthetic insecticides for storing grains meant for consumption. The results of this study therefore indicates that *Carica papaya* leaves which is available all year round in every part of Nigeria could also be used as seed protectant for grain storage. The toxicity level of the leaves of *Carica papaya* as seed protectant merits further investigation.

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Table 1: Toxicity effect of *Carica papaya* productst and Actillic dust on the Ovipcsition and development of *Callosobruchus maculatus* on cowpea seeds.

Test Product	Mean No. of Egg laid	Mean No. of egg hatch	Mean No. of dead bruchid	Mean No. of adult emergence
Leaf	10.2ad	4.3ae	4.1ab	3.3a
Stem	60.3be	55.7bd	4.9a	43.5b
Flower	67.8bd	60.3bc	3.4b	41.5b
Root	44.3ca	42.4cd	3.0b	43.4b
Actellic dust	0.0da	0.0d	6.0d	0.0c
Control	84.0e	81.3eb	1.4ca	75.3d

Mean followed by the same letter are not significantly different (D<0.05) (DNMRT)

Table 2: Effect of *Carica papaya* products and Acttellic dust on the total developmental period of *Callosobruchus maculatus*

Test product	Mean No. of Adult emergence	Total development period (day)	Percentage Adult emergence (%)
Leaf	3.3	17	30
Stem	43.0	20	71
Flower	42.0	21	60
Root	35.3	22	63
Actellic dust	0.0	0.0	0.0
Control	75.0	25	89
$LSD_{(0.05)}$	12.3	0.8	

BIOMASS YIELD OF COWPEA AS INFLUENCED BY FERTILIZER APPLICATION IN THE GUINEA AND SUDAN SAVANNAH ZONES OF GHANA

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ABSTRACT

An experiment was conducted in the Guinea and Sudan savanna zones of Ghana to evaluate the effect nitrogen, phosphorus and potassium applications on the biomass yield of cowpea in the Guinea and Sudan Savanna zones of Ghana. The treatments were laid out in a randomized complete block design with 4 replications and carried out in the 2012 and 2013 cropping season. Performance of omondaw cowpea variety was evaluated at different combinations of Nitrogen (0, 10, 20 and 30 kg/ha); Phosphorus (0, 15, 30 and 45 kg/ha) and Potassium (0, 10, 20, 30 kg/ha) fertilizers making 10 treatments. Results show that biomass yield was significantly enhanced by application of fertilizer. The highest biomas yield at both locations was recorded by fertilizer application rate of 20 - 30 - 20 NPK kg/ha^{-1} which was over 100% more than control. The promising fertilizer rates selected for optimal cowpea biomass yield at both sites was 20 - 30 - 20 NPK kg/ha^{-1}.

Key words: Cowpea, Biomass, Fertilizer, Nitrogen, Phosphorus, Potassium.

INTRODUCTION

Cowpea (Vigna unguiculata (L.) Walp) is a leguminous plant high in protein and widely cultivated in Ghana especially in the rain fed transition and savanna zones by small holder farmers. This system already faces the challenge of low soil fertility resulting in low crop yields, insufficient domestic production, food insecurity and poverty, all of which constitute major constraints to national development. . Cultivation has been shown to depress soil organic matter (SOM) level up to 500% in savanna soils within a period of 5 years after natural vegetation conversion (Fosu and Tettteh 2008). This has led to the low SOM content in the Guinea and Sudan savanna zones of Ghana with a mean around 1% in cultivated fields (Fosu et al., 2004). Adu 1996 even reported a SOM level of as low as 0.48% for the ferric Luvisol of the savanna region. Since cultivation cannot be stopped, there must be a way of building SOM levels of the soils of the savannah because good crop yields can be obtained in savanna soils only with soil amendment.

Quansah *et al.* (2001) evaluated farmers' perception and management of organic matter in 155 communities covering parts of the savanna zones of Ghana. Their findings revealed that farmers are well aware of organic matter and its important role in soil fertility and increased crop yields. Anane-Sakyi and Dzomeku (1998) in an evaluation of indigenous soil fertility maintenance practices in northern Ghana reported that the major strategies farmers use in maintaining or augmenting SOM apart from manure application includes incorporation of crop residues. Legumes can contribute nutrients particularly N (and organic matter) to the farming system when the biomass is incorporated into the soil. In order to maintain or increase SOM in soils of the Guinea and Sudan savanna regions of Ghana, use of crop residues and farm yard manure needs to be encouraged. Increased use of mineral fertilizer will supplement N supply and contribute to SOM maintenance through increased above and below ground biomass production. Although cowpea is known to obtain most of its nitrogen requirements through symbiotic fixation of the atmospheric nitrogen, through symbiotic fixation of the atmospheric nitrogen, the importance of the externally applied N to its growth and grain yields have reported. Most fertilizer recommendation for cowpea available mainly focuses on grain yield which is considered the economical part of cowpea. It is therefore imperative to develop a fertilizer recommendation for high biomass yield which when incorporated into the soil will argument other soil fertility management practices. The objective of this study was to improve biomass yield of cowpea in the Guinea savanna zone of Ghana using site specific fertilizer recommendation that will help in building up the SOM levels.

MATERIALS AND METHODS

The study was carried on two benchmark soils at Dondori (Sudan Savanna zone) and Nyoli (Guinea Savanna zone) both in the Upper West region of Ghana. Dondori is located in the Lawra district of Upper West region of Ghana and lies geographically between latitudes 10°40▪ and 11°00▪ N and longitude 2°51▪ and 2°45▪ W. Nyoli on the other hand is located in the Wa West District of the Upper West region approximately between longitudes 9° 40▪ and 9° 46▪ N and Latitudes 2° 30▪ and 2° 32▪ W. At Dondori, the study was conducted on Dorimon soil series which is classified as Ferric Lixisol according to IUSS World Reference Base (2006). Nyoli site belongs to Varempere soil series which is classified as Ferric Luvisol. Both sites experience unimodal patten of rainfall annually with annual ranges of 800 – 1100 mm (Dondori) and 840 and 1400 mm (Nyoli). The plot size was 24 m^2 with a planting distance of 60 cm × 20 cm, while seeds were planted at 2 seed per hole. Omondaw cowpea variety was used. The treatments were laid out in a Randomized Complete Block Design with four replications. Fertilizer application was done at planting as spot application using urea, triple superphosphate and muriate of potash.

The treatments were as follows

	$N-P_2O_5-K_2O$ kg ha^{-1}
T1	0 – 0 - 0
T2	0 – 45 – 30
T3	30 – 0 – 30
T4	30 – 45 – 0
T5	10 – 15 – 20
T6	20 – 45 - 30
T7	20 – 30 – 20
T8	20 – 45 – 20
T9	10 – 15 – 10
T10	20 – 30 – 10

To determine the biomass yield, five plants were randomly chosen from the two border rows on each of the treatment plots. The plants were cut to the ground level and then put in large brown envelopes and oven dried at 60 °C for 72 hours for weighing.

All data collected was analysed with Genstat 9th edition (2007) using general linear model (GLM) analysis of variance (ANOVA) with randomized blocks procedure. Analysis of variance was combined over the two locations (years) with replications nested in locations (years). Location (year) therefore became a blocking component. Where the CV was high (>30%), variance component analysis was performed using the method of Residual Maximum Likelihood (REML). Means were separated using the Least square difference (LSD $P \leq 0.05$) of the means.

RESULTS AND DISCUSSION

Biomass yield of cowpea at Nyoli in 2012 and 2013 croppimg

Results of the biomass yield of cowpea on the Ferric Luvisol in 2012 and 2013 cropping seasons are presented in Table 2. The results showed variation in treatment response between the two years with a CV of 31.7.

Table 2. Effect of fertilizer rates on biomass yield of cowpea at Nyoli in 2012 and 2013 cropping season

Year	Fertilizer rates ($N-P_2O_5-K_2O$ kg.ha^{-1})	Biomass yield (tons ha^{-1})	Increase over control (%)
2012	0 - 0 – 0	1.62	-
	0 – 45 – 30	2.34	44.44
	30 – 0 – 30	3.06	88.89
	30 – 45 – 0	2.18	34.57
	10 – 15 – 20	2.23	37.65
	20 – 45 – 30	2.41	48.77
	20 – 30 – 20	2.68	65.43
	20 – 45 – 20	2.24	38.27
	10 – 15 – 10	2.00	23.46
	20 – 30 – 10	2.13	31.48
2013	0 - 0 – 0	2.55	-
	0 – 45 – 30	2.75	7.84
	30 – 0 – 30	4.71	84.71
	30 – 45 – 0	3.61	41.57
	10 – 15 – 20	3.14	23.14
	20 – 45 – 30	3.52	38.04
	20 – 30 – 20	4.14	62.35
	20 – 45 – 20	4.06	59.22
	10 – 15 – 10	3.99	56.47
	20 – 30 – 10	3.64	42.75
		Treatment	
	F.pr	0.09	
	LSD	0.43	
	CV(%)	19.20	
		Year x treatment	
	F.pr	0.19	
	LSD	1.20	
	CV(%)	31.70	

Table 3. Variance component analysis of biomass yield of cowpea at Nyoli in 2012 and 2013.

Random term	Component	S.E	% variance
Year	0.79	1.24	50.64
Residual	0.77	1.14	49.36

The percentage variation among the two years shown in Table 3 indicated that 50.64% of the variance was accounted for by the year indicating differential response to the fertilizer rates between the 2 years. The differences in biomass yield among the two years could be attributed to better rainfall experienced in the second year of production. However in both years, the control gave the lowest biomass yield of 1.62 tons ha^{-1} and 2.55 tons ha^{-1} respectively. Application rate of 30 – 0 – 30 and 20 – 30 – 20 kg $N-P_2O_5-K_2O$ ha^{-1} gave the highest biomass yield of 3.06 and 2.68 tons ha^{-1} in 2012 and 4.71 and 4.14 2013. The yield obtained from both application rates was not significantly different for each year respectively. The highest biomass yield was obtained from 30-0-30 kg N-P_2O_5- K_2O ha^{-1} while the control gave the lowest yield for the 2 years.

Biomass yield of cowpea in 2013 at Lawra and Nyoli

Table Error! No text of specified style in document.. Effect of fertilizer rates on biomass yield of cowpea at Lawra and Nyoli in 2013 cropping season

Soil type	Fertilizer rates (N-P_2O_5- K_2O kg ha^{-1})	Biomass yield (tons ha^{-1})	Increase over control (%)
Ferric Lixisol (Lawra)	0 – 0 – 0	2.86	-
	0 – 45 – 30	2.99	4.55
	30 – 0 – 30	2.96	3.49
	30 – 45 – 0	3.83	33.92
	10 – 15 – 20	3.63	26.92
	20 – 45 – 30	4.05	41.60
	20 – 30 – 20	4.17	45.80
	20 – 45 – 20	4.10	43.36
	10 – 15 – 10	3.78	32.17
	20 – 30 – 10	3.77	31.82
Ferric Luvisol (Nyoli)	0 – 0 – 0	2.55	-
	0 – 45 – 30	2.75	7.84
	30 – 0 – 30	4.71	84.71
	30 – 45 – 0	3.61	41.57
	10 – 15 – 20	3.14	23.14
	20 – 45 – 30	3.52	38.04
	20 – 30 – 20	4.14	62.35
	20 – 45 – 20	4.06	59.22
	10 – 15 – 10	3.99	56.47
	20 – 30 – 10	3.64	42.75
		Treatment	
	F.pr	0.027	
	LSD	1.00	
	CV(%)	17.00	
		Loc x Treatment	
	F.pr	0.94	
	LSD	1.42	
	CV(%)	19.20	

Loc = Location

Biomass yield at Lawra and Nyoli (Table 4) showed that the application of fertilizer increased biomass yield significantly ($P \leq 0.05$). Treatments significantly increased biomass yield at both locations except for treatments 0 – 45 – 30 and 30 – 0 – 30 kg N - P_2O_5 - K_2O ha^{-1} at Lawra and 0 – 45 – 30 kg N - P_2O_5 - K_2O ha^{-1} at Nyoli. For the Ferric Lixisol, biomass yields obtained from all other treatments were not significantly different from each other. The biomass yield on the Ferric Luvisol differed from the observation from the Ferric Lixisol. While the highest biomass yield was obtained from application rate 30 – 0 – 30 kg N - P_2O_5 - K_2O ha^{-1} on the Ferric Luvisol, application rate of 20 – 30 – 20 kg N - P_2O_5 - K_2O ha^{-1} gave the highest on the Ferric Lixisol though not significantly different from the yield obtained from application of 20 – 45 – 20 kg N - P_2O_5 - K_2O ha^{-1}. Across the two locations, the yields obtained from 20 – 30 – 20 and 20 – 45 – 20 kg N-P_2O_5- K_2O ha^{-1} were not significantly different from each other. Fertilizer rates of 10-15-10 and 10-15-20 kg N-P_2O_5- K_2O ha^{-1} also did not differ across the two locations.

DISCUSSION

Result obtained at both locations for the 2 seasons showed that biomass yield was increased by N and P applications. This affirms the report of Bationo *et al.* (2002) that application of fertilizers can triple cowpea biomass production. Abayomi *et al.* (2008) reported significant increase in dry matter of cowpea due to N application. In addition, Azarpour *et al.* (2011) demonstrated the contribution of applied N to cowpea biomass growth even though it has the ability to fix N. Bationo and Ntare (2000) also reported increase in cowpea biomass with N application up to 45 kg ha^{-1}. Application of N fertilizer may be required for increased cowpea biomass production in the 2 locations. The increase in biomass due to increasing P application could be linked to the report of Sinclair and Vadez (2002) which stated that phosphorus deficiency results in stunted shoot and root growth due to reduced cell division and reduced cell enlargement. Magani and Kuchinda (2009) observed significant increase in total dry matter production for cowpea varieties in response to P application while Ahamefula and Chinedu (2014) reported maximum biomass accumulation at 30 kg P ha^{-1}. The observed increase in cowpea biomass with increased P application was not in agreement with the results of Gweyi - Onyango *et al.* (2011) who found that P application did not significantly increase cowpea biomass. Potassium proved to be beneficial in biomass accumulation of cowpea as was observed by Ayodele and Oso (2014) that P fertilizer increased vegetative growth of cowpea when applied with basal N and K_2O than application of P alone. Sangakkara *et al.* (2001) also reported that the application of K_2O in suboptimal moisture conditions increased biomass of cowpea and highlighted the importance of K for cowpea growth especially under water stress. Thus, K applications must not only provide enough K to meet crop needs, but also sustain plant available soil K supplies over the long term. On soils with high indigenous supplies, omitting K would not reduce yields or production; however, continued withdrawal of K through successive crop harvests will eventually deplete indigenous supplies to yield limiting levels.

CONCLUSION

The promising fertilizer rates for high biomass yield was obtained from 30 – 0 – 30 kg N - P_2O_5 - K_2O ha^{-1} on the Ferric Luvisol while application rate of 20 – 30 – 20 kg N - P_2O_5 - K_2O ha^{-1} gave the highest on the Ferric Lixisol. Application rate of 20 – 30 – 20 kg N - P_2O_5 - K_2O ha^{-1} gave a biomass yield of 4.14 which was not significantly different from that obtained from application rate of 30 – 0 – 30 kg N - P_2O_5 - K_2O ha^{-1}. It will be a better rate for application since omitting P in fertilizer application will not be sustainable in the long run. Application rate of 20 – 30 – 20 kg N - P_2O_5 - K_2O ha^{-1}

The promising fertilizer rates selected for optimal cowpea biomass yield at both sites was 20 – 30 – 20 kg N - P_2O_5 - K_2O ha^{-1}.

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