Effects of application rates of some plant materials on the control of red flour beetle, *Tribolium castaneum* Herbst (Coleoptera: Tenebrionidae) on stored millet (*Pennisetum glaucum* (L.) R. Br.)

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ABSTRACT

Laboratory experiment was conducted to evaluate the effectiveness of leaf powders of six plants (Spider plant, Basil, Hyptis, Sugar apple, Desert date and Negro coffee) and a synthetic insecticide Pirimiphos-methyl (Actellic Dust) in controlling *Tribolium castaneum* Herbst in stored millet grain (Variety-Sosat). The leaf powders of each plant and the pirimiphos-methyl were tested at 2.5g, 5.0g and 7.5g/25g of sound millet grain. The experiment was laid in a completely randomized design and each treatment was replicated three times. Although both the plant product and synthetic treatments were significantly higher than control, Pirimiphos-methyl at all the tested concentrations caused significantly higher adult mortality of 3.17 at 22 hours after treatment (HAT) and 1.83 at 72 hours after treatment (HAT) than all the plant materials, with complete suppression of larval development and adult emergence at 15 and 45 days after treatment (DAT), respectively. Among the other treatment, desert date and sugar apple caused adult mortality of 1.00 and 1.29 at 22 and 72 HAT, respectively. This resulted into significant reduction in larval development, adult emergence and grain weight loss at 15, 45 and 63 DAT, respectively. Basil was next to sugar apple and desert date in terms of effectiveness, with grain weight loss of 1.98% and grain damage of 22.2%. Although, 5.0g and 7.5g concentration of plant powders were equally effective in reducing larval development and adult emergence, however, maximum grain protection was obtained with Sugar apple in 7.5g concentration/ 25g millet grain at 63 DAT, i.e. adult mortality was highest (1.29), while grain weight loss (2.82) and grain damage (10.6) were lowest at this concentration. Therefore, use of Sugar apple at the concentration of 7.5g/25g (i.e. 30% w/w) is recommended for the maximum protection of millet grain against damage by *T. castaneum* in storage.

Key words : Application rates, plant products, red flour beetle *(T. castaneum)*, millet.

INTRODUCTION

Energy levels than maize and sorghum grown under the same condition (Ruskin, 1996). However, one of the most important limiting factors to millet production is insect infestation, which is not only restricted to field, but also continues even while in storage.

Cornes (1973) listed a total of 25 insect pests and parasites found on stored millet grains, most of which are Coleopterans with few belonging to the order Lepidoptera. Similarly, Lale and Yusuf (2000) reported that five species of storage insect pests are found to be associated with millet in the North Eastern zone of Nigeria, among which, *Tribolium castenuem* was found to be the most abundant species in stored millet. Synthetic pesticides have been used for many years to control agricultural insect pests in storage. However, chemical pesticides have numerous short-comings which include pollution of environment, development of pest resistance, increased production cost and reduced viability of seeds (Dialoke *et al*. 2004), the search for a cheaper and relatively non-toxic grain protectant of plant origin has become a matter of great importance (Nukenine, 2010). In literature, impact of plant products on *Tribolium castenuem* was available in plenty (eg: Sahayaraj and Paulraj, 2000; Sahayaraj and Ravi, 2003; Sahayaraj *et al.*, 2008; Adarkwah *et al.*, 2010). Therefore, this paper reports the findings from a laboratory evaluation of six plant leave powders and their concentration for insecticidal control of *Tribolium castaneum.*

MATERIALS AND METHODS

The experiment was carried out at the Crop Protection Laboratory of Adamawa State University, Mubi.

The experiment was carried out by treating sound millet grains with fine powders of the plant leaves materials, alongside a synthetic insecticide (Primiphos methyl) used as a standard treatment as T1 - spider plant (*Gyanandropsis penthaphylla*) (Lamiaceae), T2 - basil (*Ocimum bacilicum*) (Lamiaceae), T3 - hyptis (*Hyptis spicigera*) (Lamiaceae), T4 - sugar apple (*Annona squamosa*) (Annonaceae), T5 - desert date (*Balanites aegyptica*) (Zygophyllaceae), T6 - negro coffee (*Cassia occidentalis*) (Compositae), T7 - actellic dust (Pirimphos - methyl) and T8 - control.

About 25g of the fresh and un-infested sound millet grain was measured and transferred in to translucent plastic containers. Thereafter, 2.5, 5.0 and 7.5 gram (i.e. representing 10%, 20%, and 30% weight of the millet grain) of each of the dried, fine powdered of the six plant materials and P-methyl were measured separately and admixed with 25g fresh and un-infested sound millet grain.

Mixtures of the grain and individual plant products including the P-methyl were shaken thoroughly to ensure adequate mixing. Thereafter, three pairs of adults laboratory reared *T. castameum* (8 - 15 days old) were introduced into the treated and untreated, sound millet grains already placed in the individual plastic containers. The open end of each of the containers was covered with a fine muslin cloth and tied firmly with a rubber band. Ambient temperature and relative humidity was maintained through out the period of the experiment (Dialoke *et al*., 2004).

A total of five parameters were assessed during the experiment. The parameters assessed were adult mortality measured by counting the number of dead adult at 22 and 72 hours after exposure to treatments (HAT), larval development measured by counting the number of larvae that emerge at 15 days after treatment (DAT), using a hair of camel brush, percent grain damage was assessed by randomly selecting 20 seeds and counting numbers of holes or attacked embryo of both treated and untreated grain at 63 days after treatment and express as percentage, adult emergence measured by counting the number of adult that emerge at 42 and 63 days after treatment and loss in grain weight was measured at 63 days after treatment when the entire second generation of the adult beetle and the plant material were removed from the treated grain then the millet grain was weighed and the percentage weight loss was computed.

All data in percentages were transformed into arc sine percentage square root as described by Little (1978), while numerical data with low counts or zero were transformed to n + 1 square root. The transformed data's were subjected to analysis of variance using 2008 version 5.0 of genstat statistical package and their means were compared for significant difference using Students Newman Keul test (SNK).

RESULTS

The result presented in Table 1 shows that plant powders and concentration had a significant effect on the mortality of adult T. castaneum at 22 and 72 hours after treatment. Pirimphos-methyl (PM) caused significantly higher adult mortality of 3.17 and 1.83 at 22 and 72 hours after treatment, respectively, than all other plant powders. At 22 hours after treatment the mortality caused by desert date was higher but not significantly different from that caused by basil, negro coffee. The later two plants also had higher mortality, but were not significantly different from those of hyptis and sugar apple treatments. The least mortality of 0.00 adult was recorded in both spider plant and the control. At 72 hours after treatment, p-methyl caused higher mortality but not significantly different from that caused by sugar apple treatment. Next to these two treatments, basil caused higher mortality of 0.56 adult, but not significantly different from those caused by spider plant, hyptis, desert date, and Negro coffee. However, mortality caused by spider plant and hyptis at 72 hours after treatment were comparable with that caused by the untreated control. With regard to the effect of concentration, highest mortality of 0.93 adults was recorded in 7.5g/ 25g grain that was statistically same with that of 5.0g concentration. However, these two concentrations differed significantly from the 2.5g concentration which caused the least mortality.

Table 1. Effect of plant powders and concentration on adult mortalit after treatment

	HAT	
Plant Materials	At 22 HAT	At 72 HAT
Spider Plant	0.00 (0.71)^{d}	0.44 (0.91)^{bc}
Basil	0.78 (1.08)^{bc}	0.56 (0.97)^{b}
Hyptis	0.28 (0.84)^{cd}	0.17 (0.79)^{bc}
Sugar apple	0.33 (0.87)^{cd}	1.29 (1.28)^{a}
Desert date	1.00 (1.13)^{b}	0.50 (0.96)^{b}
Negro coffee	0.72 (1.03)^{bc}	0.44 (0.93)^{b}
Pirimphos-methyl	3.17 (1.89)^{a}	1.83 (1.44)^{a}
Control	0.00 (0.71)^{d}	0.00 (0.71)^{c}
L. SF – Value	** 40.38	** 13.19
Concentration (g / 25g grain)		
2.5	0.54 (0.12)^{b}	0.52 (0.95)
5.0	0.88 (0.18)^{a}	0.65 (1.01)
7.5	0.93 (0.93)^{a}	0.80 (1.05)
L. S	**	Ns
F - Value	4.60	1.76

Table 2 reveals that, there was significant effect of plant powders and concentration on larval development and adult emergence respectively at 15 and 45 days after treatment. Pirimphos-methyl suppresses larval and adult emergence completely. Sugar apple and desert date recorded significantly lower larval count than negro coffee and spider plant, however, larval count in the later two plant are statistically same with those recorded in hyptis, basil and the control. Like wise at 42 days after treatment, sugar apple and desert date suppresses adult emergence significantly higher than the remaining plant powders, however, suppression caused by basil and hyptis treatment were comparable to that of the untreated control. On the effect of concentration on larval count and adult emergence, the highest suppression was caused by 7.5g plant powders / 25g millet grain, which was not significantly different from that, caused by 5.0g concentration. However, these two concentrations differed significantly from the lowest concentration of 2.5g in suppressing larval and adult emergence.

Table 2. Effect of plant powders and concentration on larval count and adult

	Emergence after treatment	
Plant Material	Larval count at 15 DAT	Adult Emergence at 42 DAT
Spider plant	21.7 (3.57)^{a}	57.9 (6.45)^{a}
Basil	10.7 (2.56)^{ab}	26.3 (4.63)^{c}
Hyptis	20.8 (3.32)^{a}	28.3 (4.79)^{c}
Sugar apple	5.1 (1.64)^{bc}	12.8 (2.95)^{d}
Desert date	5.9 (1.56)^{bc}	13.5 (2.76)^{d}
Negro coffee	24.9 (3.74)^{a}	69.2 (7.94)^{a}
Pirimphos-methyl	0.00 (0.71)^{c}	0.00 (0.71)^{e}
Control	20.2 (2.47)^{ab}	43.6 (4.28)^{c}
L. S	**	**
F – Value	128.57	65.66
Concentration (g / 25g grain)		
2.5	20.0 (3.07)^{a}	42.7 (5.43)^{a}
5.0	10.9 (2.20)^{b}	27.3 (3.80)^{b}
7.5	10.1 (2.05)^{b}	24.4 (3.71)^{b}
L. S	**	**
F – Value	0.29	0.21

Figures in parentheses are means of $\sqrt{n+1}$. Means in parentheses followed by same superscripts within same column are not significantly different at P = 0.05 according to SNK test. L. S= Level of significance. ns = Not significant. ** = significant at 0.01 level of probability.

Results presented in Figure 1 shows that plant powders had significant effect (F = 0.29) on percentage damage caused by *T. castaneum* on millet grain. Sugar apple treated grain had the least per cent damaged grain among the plant materials that were all statistically same (spider plant = 27.2, basil = 22.2, hyptis = 27.2, sugar apple = 10.6, desert date=11.1, negro coffee = 36.1). But the least treatment was however, not as effective in protecting grain damage as in pirimphos-methyl with 0.00%. Generally, By and large, all the treatments differed significantly (F = 0.21) from the untreated control with 88.3% damaged grain. Furthermore, Table 4 shows that the various concentrations of plant powders had no significant effect on percentage grain damage; however grain damage reduces with increase concentration of plant materials.

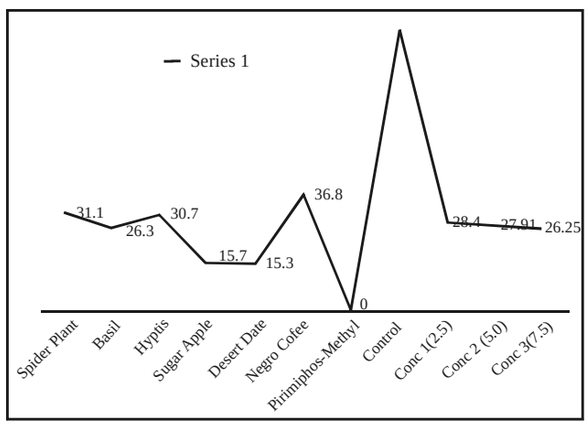

Figure 1: Effect of plant powders and concentrations on percentage grain damage at 63 days after treatment.

Results show a significant interaction between plant materials and concentration on adult mortality at 22 hours after treatment. Pirimphos-methyl treatment had a significantly higher adult mortality than all the other plant materials at all the tested concentration (F = 2.67). In 2.5g concentration, adult mortality caused by basil was statistically (F = 2.67) same with mortality caused by negro coffee. The two later plant materials caused significantly (F = 1.95) higher adult mortality than hyptis, sugar apple, desert date spider plant and the untreated control which are comparable. In 5.0g and 7.5g concentration, mortality caused by basil, hyptis, sugar apple, desert date and negro coffee are statistically the same and comparable with mortality caused by pirimphos-methyl in 7.5g concentration, however, spider plant treatment did not perform better than untreated control in causing adult mortality in all the tested concentration. At 72 hours after treatment, p-methyl in 7.5g concentration cause high adult mortality than the remaining treatments (Table 3). Next to

Table 3. Effect of interaction between plant material and concentration on adult mortality at 22 and 72 hours after treatment .

Plant Material	Hours After Treatment					
	22 HAT			72 HAT		
	2.5g	5.0g	7.5g	2.5g	5.0g	7.5g
Spider Plant	0.00 (0.71)^{e}	0.00 (0.71)^{e}	0.00 (0.71)^{e}	0.17 (0.79)^{bc}	0.17 (0.79)^{bc}	1.00 (1.13)^{bc}
Basil	0.50(0.94)^{cd}	1.00(1.17)^{cd}	0.83 (1.11)^{cd}	0.50 (0.94)^{bc}	0.83 (1.07)^{bc}	0.33 (0.88)^{bc}
Hyptis	0.17 (0.79)^{e}	0.33(0.88)^{cd}	0.33 (0.88)^{cd}	0.00 (0.71)^{cd}	0.33 (0.88)^{bc}	0.17 (0.79)^{bc}
Sugar apple	0.17 (0.79)^{e}	0.33(0.88)^{cd}	0.50 (0.94)^{cd}	0.67 (0.99)^{bc}	1.67 (1.43)^{b}	1.50 (1.41)^{b}
Desert date	0.17 (0.79)^{e}	1.00(1.13)^{cd}	1.83 (1.47)^{cd}	0.33 (0.88)^{bc}	0.50 (0.97)^{bc}	0.67 (1.03)^{bc}
Negro coffee	0.33 (0.88)^{cd}	0.33(0.88)^{cd}	1.50(1.37)^{cd}	0.50 (0.97)^{bc}	0.67 (1.03)^{bc}	0.17 (0.79)^{bc}
Pirimphos - methyl	3.00 (1.86)^{b}	4.00 (2.11)^{a}	2.50 (1.69)^{c}	2.00 (1.56)^{b}	1.00 (1.17)^{bc}	2.50 (1.67)^{a}
Control	0.00 (0.71)^{e}	0.00 (0.71)^{e}	0.00 (0.71)^{e}	0.00 (0.71)^{cd}	0.00 (0.71)^{cd}	0.00 (0.71)^{cd}
L. SF - Value	**2.67	**2.67	**2.67	**1.95	**1.95	**1.95
L. SF - Value	**2.67	**2.67	**2.67	**1.95	**1.95	**1.95

Figures in parentheses are means of √ n + 1
Means in parentheses followed by same superscripts in the same column and row within a subset are not significantly different at P = 0.05 according to SNK test
L. S = Level of significance. ns = Not significant. ** = significant at 0.01 level of probability.

it in effectiveness was sugar apple in 5.0g and 7.5g concentration which are comparable with spider plant, basil, desert date and negro coffee in all the three tested concentrations and in turn these later four plant materials are comparable with the untreated control.

Table 4 clearly shows that there is significant interaction between plant material and concentration on larval development and adult emergence. Pirimphos-methyl suppresses larval development and adult emergence at all the tested concentration. At 15 days after treatment, pirimphos-methyl suppresses larval development completely at all the tested concentration. However, the suppression caused by Pirimphos-methyl is comparable to the suppression caused by all the plant powders at all

Table 4. Effect of interaction between plant material and concentration on larval count and adult emergence.

Plant Material	Hours After Treatment					
	22 HAT			72 HAT		
	2.5g	5.0g	7.5g	2.5g	5.0g	7.5g
Spider Plant	20.9 (3.35)^{b}	26.3 (3.94)^{b}	18.1 (3.19)^{ac}	73.5 (7.04)^{b}	50.2 (6.50)^{c}	50.0 (5.80)^{c}
Basil	17.6 (3.25)^{ac}	9.0 (2.43)^{ac}	5.5 (1.99)^{bc}	13.0 (3.43)^{cd}	13.3 (3.29)^{cd}	52.4 (7.18)^{c}
Hyptis	16.7 (2.79)^{ac}	22.0 (3.49)^{b}	23.8 (3.68)^{b}	18.3 (3.38)^{cd}	31.9 (5.20)^{bc}	34.7 (5.35)^{c}
Sugar apple	8.8 (2.32)^{ac}	6.3 (1.82)^{bc}	0.2 (0.78)^{bc}	20.4 (4.14)^{cd}	16.0 (3.26)^{cd}	2.1 (1.47)^{cd}
Desert date	16.3 (2.81)^{ac}	0.8 (0.96)^{bc}	0.7 (0.92)^{bc}	36.0 (5.33)^{bc}	2.7 (1.63)^{cd}	1.8 (1.32)^{cd}
Negro coffee	27.7 (4.07)^{b}	26.1 (3.96)^{b}	20.8 (3.19)^{b}	81.5 (8.88)^{b}	3.0 (8.11)^{b}	53.1 (6.82)^{c}
Pirimphos - methyl	0.0 (0.71)^{bc}	0.0 (0.71)^{bc}	0.0 (0.71)^{bc}	0.00 (0.71)^{cd}	0.00 (0.71)^{cd}	0.00 (0.71)^{cd}
Control	60.5 (5.86)^{a}	60.5 (5.86)^{a}	60.5 (5.86)^{a}	130.8 (11.43)^{a}	130.8 (11.43)^{a}	130.8 (11.43)^{a}
L. SF - Value	0.68	0.68	0.68	2.47	2.47	2.47

Figures in parentheses are means of √ n + 1
Means in parentheses followed by same superscripts in the same column and row within a subset are not significantly different at P= 0.05 according to SNK test
DAT = Days after treatment. L. S= Level of significance. ns= Not significant. ** = significant at 0.01 level of probability

the tested concentration. Similarly, at 42 DAT pirimphos-methyl suppresses adult emergence completely at all the tested concentrations. However, suppression caused by pirimphos-methyl is comparable to those caused by all the treatments at all the tested concentration, except in spider plant and negro coffee at 2.5g concentration which are comparable, but suppresses adult emergence significantly higher than the control.

DISCUSSION

The present study shows that at 22 hours after treatment all plant materials were effective in causing significant adult mortality with the exception of Spider plant. However Desert date proved to be the most effective among all the plant material at 22 hours after the release of beetles into the treated grains, although it was not significantly different from Basil and Negro coffee. This significant effect of plant materials at 22 hours after treatment may depend on several factors such as plant preparation (powders) and chemical composition of the plant, for instance, Ivbijaro and Agbaje (1986) reported that ground form of plant material perform better than ungrounded form. On the chemical composition, Su (1976) and Lale, (2002) have reported that, the toxic effect of lemon oil is due to limonene contained in the oil, while azadirine have been identified as the major insecticidal component of *Melia azaderach* F. The findings of this work corroborate with the findings of other workers who have reported the effectiveness of various plant leaves powders used as grain protectants against various insect pests of stored products including *T. castaneum* (Lawrence and Ajai, 1993; Obong - ofori *et al.*, 1998; Lawrence, 1998; Dialoke *et al*., 2004). Although active ingredients of the experimental plant were not investigated in the present study, it could be suggested that, the insecticidal effect of the tested plant powders was probably caused by their strong odours. So the inability of spider plant to cause any mortality at 22 hours after treatment may be attributed to the emission of much less odour by its powder being a palatable leafy vegetable.

Among others, sugar apple which was slightly effective at 22 hours after treatment, hence has proved to be most effective plant powder in causing significant adult mortality at 72 hours after treatment. This finding agrees with the work of Lawrence and Ajai (1993), where 27%, 33% and 67% mortality of adult *T. castaneum* was caused by ethanol extract of Sugar apple leaves at 1, 3 and 5 days after exposure, respectively. The inability of the remaining plant powders to cause significant adult mortality at 72 hours after treatment may probably be due to atmospheric loss of strong odors of the plants.

At 15 days post treatment, sugar apple and desert date proved to be the most effective plant powders in suppressing larval development and were even comparable to that of synthetic Pirimphos - methyl. Similarly, these same plants suppresses adult emergence better than the remaining plant powders at 42 days after treatment. This is indicative of the presence of insecticidal activity in these two plant powders against *T. castaneum*, however, negro coffee and spider plant perform worse than untreated control in suppressing larval development and adult emergence, probably because *T. castaneum* found these two plant powders more palatable than the millet grain which as a result recorded more adult emergence than the untreated control.

Also at 63 days after treatment, sugar apple and desert date still proved to be the most effective plant powders in the control of *T. castaneum* by recording minimal grain damage and loss in grain weight. This has probably proved the effectiveness of sugar apple and desert date in controlling *T. castaneum* in millet grain. Slightly effective plant powders in reducing grain weight loss and grain damage were spider plant and hyptis, however, negro coffee reduces grain weight loss better than spider plant and hyptis, this may probably be due to vegetable nature and food constituent of the negro coffee plant, which the experimental insect found more nutritious than the millet as witnessed in Table 3 where negro coffee did not suppress larval development and adult emergence better than the untreated control treatment.

Effect of Concentration

On the effect of concentration, the result of present study clearly shows that insecticidal activity of plant powders depends on the rate of application of insecticidal material. Similar findings were earlier reported by various workers (Opareake and Dike, 2006; Yusuf and Ahmed, 2005; Asawalam and Emosairue, 2006), who in separate studies reported that the efficacy of various plant products tested against storage insect pests increase with increasing dose of the plant products. However, the findings of Bhagat and Tripathi (1989) contrasted with these, who have reported a decreasing efficacy of neem leaf powder with increasing concentration from 1 to 3 grams /100g grain.

Effect of Interactions

On the effect of plant powders and concentration, the result of this study shows that, 2.5g concentration of all the plant powders was the least effective in the control of *T. castaneum* on millet grain. However, the mortality in 7.5g concentration was statistically same with that of 5.0g concentration. But maximum grain protection was

recorded in the 7.5g concentration at 15 and 45 days after the release of beetles into the treated and untreated grain. It was observed that millet grain treated with two higher concentrations of Sugar apple and Desert date were the most effective in reducing adult emergence and grain weight loss at 54 and 63 days after treatment respectively. By and large, increasing the concentration of the various plant powders alone can not provide maximum grain protection without minimizing the level of damage incurred during threshing.

Conclusions

This study clearly shows the effectiveness of sugar apple and desert date when compared with the remaining plant powders in protecting stored millet grain against damage by *T. castaneum* during the study period. These two plant powders cause significantly higher adult mortality of 1.00 and 1.29 at 22 and 72 hours after treatment respectively, which resulted in a significant reduction in larval count, adult emergence and grain weight loss at 15, 45 and 63 days after treatment respectively. However, negro coffee and spider plant were found to be the worse treatment in reducing damage cause by *T. castaneum*. Furthermore, increase concentration (from 2.5g to 7.5g / 25g grain) of plant powders brought about an increase in their efficacy. The result of this study shows that an appreciable level of protection in stored millet grain against damage by *T. castaneum* could be achieved by using leave powders of Sugar apple and Desert date as control materials.

REFERENCES

Asawalam, E. F. and Emosairue, S. O. 2006. Comparative efficacy of pepper *Piper guineense* (Schum and Thonn) powder and pirimiphos - methyl dust against *Sitophilus zeamais* Motsch (Coleoptera: curculionidae) in stored maize. *Nigerian Journal of Entomology*. **23** : 30 - 33

Bhagat, O. P. and Tripath, V. K. 1989. The efficacy of neem in combination with tulsi against *Rhyzopertha dominica* (F.) in stored maize. *Neem News Letter* 6 **(4)** : 46.

Cornes, M. A. 1973. A check list of insects associated with stored prodducts in Nigeria. Technical Report of Nigerian Stored Product Research Institute, No. **11** : 73 - 98.

Dialoke, S. A., Agu, C. M. and Onyia, V. W. 2004. A study of the efficacy of some plant extract in controlling weevil infestation in the humid tropics. In : (Agbede, O. O., Idris, M. B., Rahaman, S. A., Ari, M. M., Ogora, I. M. and Asumugha, G. N. eds). *Mobilizing Investors for Sustainable Agricultural Research, Development and Production in Nigeria.* 638 - 371 **PP**. Proceedings of the 38th Annual Conference of the Agricultural Society of Nigeria Held at Collage of Agriculture Lafia, Nassarawa State. 17 - 21 October, 2004.

Ivbijaro, M. F. and Agbaje, M. 1986. Insecticidal activities of *Pipper guineense* Schum. and Thorn. and *Capsicum* species on the cowpea bruchids, *Callosobruchus maculatus* (F.).*Insect Science and Its Application*. **7**: 521 - 524.

Lale, N. E. S. 2002. Stored product entomology and acarology in Tropical Africa. Mole Publication, Maiduguri. 204 **PP**.

Lale, N. E. S. and Yusuf, B. A. 2000. Insect pests infesting stored pearl millet, *Pennisetum glaucum* (L.) R. Br. in Northeastern Nigeria and their damage potential. *Cereal Research Communication*. **28**, 1 - 2.

Langer, R. H. M. and Hill, G. D. 1982. Agricultural Plants. Cambridge University press. London. 344 **PP**.

Little, M. T. (1978). Agricultural experimentation: Design and Analysis. Published by John Wiley. New York. 350 **PP**.

Lawrence, E. W. 1998. Biological activity of sorghum tannin extracts on the stored grain pests *Sitophilus oryzae* (L.), *Sitotroga cerealella* (Olivier) and *Tribolium castanuem* (Herbst). *Insect Science and its Application*. **18** : 117 - 23

Lawrence, A. D., Williams and Mansingh, A. 1993. Pesticidal plants - insecticidal activity in leaf extracts of sixty plants. *Insect Science and Its Application*. **14** : 5/6 697-700

Obeng - Ofori, D., Reichmuth, C. H., Bekele, A. J. and Hassanali, A. 1998. Toxicity and protectant potential of Camphor, a major component of essential oil of *Ocimumkilimandscharicum,* against four stored product beetles. *International Journal of Pest Management.* **44** : 4 203 - 209.

Onwueme, I. C. and Sinha, T. D. 1991. Field crop production in Tropical Africa. Michael Heath Ltd. England. 479 **PP**.

Oparaeke, A. M. and Dike, M. C. 2006. *Monodora myristica* (Gaertn) Dunal(Myristicaceae) and *Allium cepa* L. (Liliaceae) as protectants against cowpea seed bruchids, *Callosobruchus maculates* (F.) infesting stored cowpea Seed. *Nigerian Journal of Etomology*. **22** : 84 - 92.

Purseglove, J. W. 1985. Tropical Crops: Monocotyledons. Volume 1 and 2 Combined. Longman Publishers. 607 **PP**.

Ruskin, F. R. 1996. Crop of Africa. National Academy Press, Washington DC. 383 **PP**.

Su, H. C. F. 1976. Toxicity of chemical component of lemon Oil to cowpea weevils. *Journal of General Entomology Society*. **11** : 297 - 301.

Yusuf, S. R. and Ahmed, B. I. (2005). Effect of application rates of some plant materials on the control of maize weevil (*Sitophilus zeamais* Mots) in stored maize. *Journal of Pure and Applied Sciences*. 8 **(2)** : 180 - 187.

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ERRATUM

Volume 3 (1) page 23 table 2 division 3 can be read as Seedling throwing technique

Name of the spiders	42 DAT	48 DAT	53 DAT	66 DAT	88 DAT	102 DAT	109 DAT	113 DAT
L. pseudoannulata	18	7	19	21	7	H	H	H
C. formosana	2	14	7	11	22	H	H	H
T. javanas	15	9	9	26	0	H	H	H
A. catenulata	0	2	14	117	112	H	H	H
Plexippus spp	0	0	8	9	8	H	H	H

H - Crop harvested, DAT- Days after transplantation.

Volume 3 (2) page 437 title can be read as

Biology and mating behaviour of *Coranus spiniscutis* Reuter (Hemiptera: Reduviidae), a key predator of rice gundhy bug *Leptocorisa varicornis* Fabricius - **M. Anto Claver and A. Daniel**

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Effect of neem kernel aqueous extract (NKAE) on growth and development of red slug caterpillar, *Eterusia magnifica* Butl in tea in North-East India - Rimpi Das, B. C. Chutia, M. Sarmah, A. Rahman, Monorama Borthakur and B. K. Barthakur