Tropical and Subtropical Agroecosystems

THE EFFICACY OF SOME INDIGENOUS MEDICINAL PLANT EXTRACTS FOR THE CONTROL OF UPLAND RICE STEM BORERS IN NIGERIA.

[EFICIENCIA DE EXTRACTOS DE PLANTAS MEDICINALES INDIGENAS PARA CONTROL DE BARRENADORES DEL TALLO DE ARROZ EN NIGERIA]

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SUMMARY

Field experiments were conducted during the 1999 and 2000 wet seasons at the National Cereal Research Institute, Amakama sub-station, Umuahia, Nigeria to evaluate the efficacy of aqueous and acetone extracts of some indigenous medicinal plants for the control of upland rice stem borers. The treatments consisted of 2.5, 5 and 10% each of aqueous and acetone extracts of seed kernels of neem (*Azadirachta indica* A. Juss), nutmeg (*Monodora myristica* (Gaertn.) Dunal, physic-nut (*Jatropha curcas*. L.), castor-oil (*Ricinus communis* L.), synthetic insecticide: monocrotophos and the untreated check. The monocrotophos was applied at 400g a.i./ha. The treatments were applied at the tillering stage and at the panicle initiation stage. The results showed that the monocrotophos and a number of the plant seed kernel extract treatments significantly ($P<0.05$) reduced the % deadhearts and % whiteheads caused by stem borers. The yield of the rice culture in the two years trials were significantly ($P< 0.05$) higher in monocrotophos treated plants and in a number of the plants extracts treated plants than the control. Comparatively, neem seed and physic-nut seed kernel extracts were superior to the other plant extracts in controlling stem borers and influencing yields of the crop. The results suggest, that aqueous and acetone extracts of neem seed kernel and physic nut seed kernel can be used by upland rice farmers to control stem borers and obtain higher crop yields.

Key words: upland rice, stem borers, indigenous medicinal plant.

RESUMEN

Se efectuaron estudios de campo durante las estaciones lluviosas de 1999 y 2000 en el Instituto Nacional de Investigación en Cereales, Sub-estación Amakama, Umuahia, Nigeria, para evaluar la eficacia de extractos acuosos y con acetona de plantas medicinales indígenas para el control de barrenadores del tallo de arroz. Los tratamiento fueron 2.5, 5 y 10% de extracto acuoso o de acetona de pericarpio de semilla de neem (*Azadirachta indica* A. Juss), nutmeg (*Monodora myristica* Gaertn. Dunal), jatrofa (*Jatropha curcas*. L.), aceite de ricino (*Ricinus communis* L.), un insecticida sintético (monocrotophos) y un control negativo. El insecticida sintético fue aplicado a razon de 400g /ha. Los tratamientos se aplicaron en las etapas de crecimiento vegetativo y reproductivo (formación de la panícula). Tanto el monocrotophos como varios de los extractos redujeron ($P<0.05$) el daño causado por los barrenadores. En comparación con el control, la producción de arroz fue mayor durante los dos años en los tratamientos con insecticida y con varios de los extractos vegetales. Los extractos de neem y jatrofa fueron mejores que otros extractos en el control de los barrenadores mejorando la producción de arroz. Los resultados sugieren que los extractos acuosos y/o de acetona del neem y jatrofa pueden ser empleados para el control del barrenador del arroz.

Palabras clave: arroz, barrenadores de tallo, plantas medicinales.

INTRODUCTION

Insect pests are among the principal causes of low yields of rice in the major rice growing areas of the world (Anon., 1970). Stem borers comprising of various species of lepidopterous moths and dipterous stalked eyed, diopsid species are classified as serious insect pests of rice (Kapur, 1967, Keizi and Syuniti, 1967).

In the vegetative stage of the rice plant, stem borers' larvae bore into and feed on the leaf sheath causing broad longitudinal whitish areas at the feeding sites. This prevents the central leaf whorls from unfolding, causing them to turn brownish and die, bringing about the condition known as "dead hearts". During the reproductive stage of the rice plant, the stem borers' larvae cut the growing parts leading to the condition known as "White heads" (Gupta and O' toole, 1986). Zahirul (1990) estimated the average yield loss to *Scirpophaga incertulas* at 17%. Kok and Varghese

(1966) had estimated losses of 31 to 38% when 50 to 60 day old rice plants were attached by stem borers. Israel and Abraham (1967) had estimated in the Philippines that for every 1% dead heart an estimated 1.6% yield loss was incurred while for every 1% whitehead, the yield loss was estimated at 2.2%.

Successful control of stem borers of rice has been achieved through the use of a number of the conventional insecticide (Gupta and O' toole, 1986, Verma and Singh, 1987, Hill and Waller, 1988). However, the indiscriminate use of insecticides have resulted in a number of undesirable side effects such as the emergence of resistant species of insects, environmental pollution and hazards to farmers, to mention a few (Hassall, 1990). Also, the cost of agro-chemicals can limit their use by resource-poor farmers.

Natural products based on the indigenous use of botanicals could be one way of mitigating the problems associated with the inappropriate use of synthetics. Shukle *et. al;* (1992) evaluated the field efficacy of 3% neem oil solution and 5% neem seed kernel extract and reported a significant reduction in the populations of the green leaf hopper, the white backed plant hopper and the leaf folder in treated plots of rice when compared with the untreated plots.

This study evaluates the field effectiveness and performance of four indigenous medicinal plant extracts for the control of upland rice stem borers and to assess the impact on the crop's yield.

MATERIALS AND METHODS

The upland rice variety used for the study was FARO 43, a medium duration variety. The experiment was laid out in a randomised complete block design consisting of twenty-six treatments each replicated three times. The experimental plots measured 4m x 3m with a 2m path demarcating plots. The experimental field was mechanically cleared, disc ploughed and then disc-harrowed. The treatments consisted of extracts of seeds of four local medicinal plants namely: neem *(Azadirachta indica A. Juss),* nutmeg (*Monodora myristica (Gaertn) Dunal, physic* nut (*Jatropha curcas* L.) and castor oil (*Ricinus communis* L.). The other treatments consisted of the synthetic insecticide, monocrotophos, an organophosphate insecticide incorporated in the study for comparison with the botanicals and the untreated check. The trials were conducted during the early planting season of 1999 and 2000 at the National Cereal Research Institute (NCRI), sub-station, Amakama, Umuahia, Abia State, Nigeria, and the treatments were:

1. 2.5% Acetone neem seed kernel extract (NSKE)
2. 5% Acetone neem seed kernel extract (NSKE)
3. 10% Acetone neem seed kernel extract (NSKE)
4. 2.5% Aqueous neem seed kernel extract (NSKE)
5. 5% Aqueous neem seed kernel extract (NSKE)
6. 10% Aqueous neem seed kernel extract (NSKE)
7. 2.5% Acetone nutmeg seed kernel extract (NMSKE)
8. 5% Acetone nutmeg seed kernel extract (NMSKE)
9. 10% Acetone nutmeg seed kernel extract (NMSKE)
10. 2.5% Aqueous nutmeg seed kernel extract (NMSKE)
11. 5% Aqueous nutmeg seed kernel extract (NMSKE)
12. 10% Aqueous nutmeg seed kernel extract (NMSKE)
13. 2.5% Acetone physic nut seed kernel extract (PNSKE)
14 5% Acetone physic nut seed kernel extract (PNSKE)
15 10% Acetone physic nut seed kernel extract (PNSKE)
16 2.5% Aqueous physic nut seed kernel extract (PNSKE)
17 5% Aqueous physic nut seed kernel extract (PNSKE)
18 10% Aqueous physic nut seed kernel extract (PNSKE)
19 2.5% Acetone castor oil seed kernel extract (COSKE)
20 5% Acetone castor oil seed kernel extract (COSKE)
21 10% Acetone castor oil seed kernel extract (COSKE)
22 2.5% Aqueous castor oil seed kernel extract (COSKE)
23 5% Aqueous castor oil seed kernel extract (COSKE)
24 10% Aqueous castor oil seed kernel extract (COSKE)
25 Monocrotophos applied @ 400g a.i. /ha
26 Untreated check (control).

Preparation of the botanical extracts

Shelled seeds of neem, nutmeg, physic- nut and castor oil were sun dried for one week before oven drying at 60^0c for 12hrs. The seed kernels were then milled into powder using a locally constructed grinder operated by a 2-horse power electric motor.

Preparation of acetone extracts of the plant materials

For the acetone extracts of the plant materials 100g of each plant seed powder was separately weighed into a conical flask containing 500mls of analytical grade acetone. The content was thoroughly stirred and left for 12h, after which it was stirred again and filtered through a whatman filter paper no. 42. The filtrate was put into a 500ml round bottomed flask and connected to the reflux system of a soxhlet apparatus and extracted for four hours. Thereafter, the acetone was recovered by redistilling the content in the soxhlet extractor. The botanicals extracted were preserved until use.

To prepare 2.5% acetone extract, 25mls of each extract was separately measured into a 2litre beaker and distilled water added to make up one litre. One (1) ml of 1% liquid soap was added to each as emulsifier. Similarly, 5% and 10% acetone extracts were prepared by mixing 50mls and 100mls of the plant extracts with appropriate amounts of distilled water to make one litre content respectively. One (1) ml of 1% liquid soap was similarly added to each as emulsifier.

Preparation of aqueous extracts of the plant materials.

The 2.5% aqueous extract of each botanical was prepared by soaking 25g of the powdered seek kernel of each plant material in one litre of hot water and left to stand for 12hours, then filtered through muslin cloth. Additional water was added to make up one litre of filtrate, and to this was added 1ml of 1% liquid soap as emulsifier before field application as described in Karim *et al.* (1992). Five (5%) percent and 10% aqueous extracts of the botanical were prepared as described above, but by using 50g and 100g of the powdered seed kernels respectively.

Planting of rice, application of treatments and data collection

Five seeds of FARO 43 were planted per hole at a spacing of 25cm x 25cm. A pre-emergence herbicide, Ronstar at the rate of 5 litres per hectare plus Roundup at the rate of 2 litres per hectare were applied a day after planting for weed control. In addition, one hand weeding was done. All other cultural operations in the production of upland rice, such as application of fertilizer were carried out according to the recommended practices (NCRI, 1988, WARDA, 1995).

The various botanical treatments, at the specified concentrations and monocrotophos at 400g a.i/ ha were applied twice, first at the tillering stage and the second at the panicle initiation stage. At each application, plants were sprayed to run-off point.

Dead heart counts were taken just before the booting stage by counting the number of tillers showing dead heart in twenty alternate stands taken diagonally in each plot. The total number of tillers in the same twenty stands were also counted, a method used by Lazaro *et al.* (1993). Whitehead counts were taken ten days to the harvesting of the rice from twenty alternate stands taken diagonally in the plots. The total numbers of productive tillers in the same twenty stands were counted. The percentage dead hearts and white heads were computed by using the formulae:

$$\% \text{ dead heart} = \frac{\text{No. of dead hearts in 20 stands}}{\text{Total No. of productive tillers in the 20 stands}} \times 100$$

$$\% \text{ Whitehead} = \frac{\text{No. of whiteheads in 20 stands}}{\text{Total No. of productive tillers in the 20 stands}} \times 100$$

The yield of the rice in the various treatments were obtained from the middle rows, that is from a net plot of 3.5m x 2.5m with the outer row being discarded in each plot. The percentage dead hearts and whiteheads were subjected to square root transformation before analysis of variance. All the means were then compared using Duncan's New Multiple Range Test at 5% significant level.

RESULTS

The effects of the plant extracts and conventional insecticide on stem borers infestation in upland rice measured from damage indices, namely from % dead hearts and % whiteheads in the 1999 and 2000 trials are presented in table 1 while the yield of the crop under various treatments are presented in Table 2.

Table 1: Field efficacy of acetone and aqueous extracts of some local medicinal plants and monocrotophos against upland rice stem borers during the 1999 and 200 planting seasons assessed from dead hearts (% DH) and whiteheads (% WH)

	% Stem Borer Damage				%Reduction of stem borer damage over control			
Treatments	**DH 1999**	**WH 1999**	**DH 2000**	**WH 2000**	**DH 1999**	**WH 1999**	**DH 2000**	**WH 2000**
NSKE	3.7ab	6.7bcd	9.0 abcdefg	21.2 bcde	46.4	52.8	43.8	31.8
NSKE	4.9 bcd	6.3 bc	8.1 abcdef	17.9 abc	29.0	55.6	49.4	42.4
NSKE	3.7 ab	5.0 ab	4.6 ab	18.7 abcd	46.4	46.8	71.3	39.8
NSKE	5.8 cde	7.6 bcdef	7.3 abcde	25.3 bcdefg	15.9	46.5	54.4	18.6
NSKE	4.0 abc	7.2.bcdef	5.5 abcd	25. 4bcdefg	42.0	49.3	65.6	18.3
NSKE	3.6 ab	6.1 bc	7.0 abcde	22.9 bcdef	47.8	57.0	56.3	26.4
NMSKE	6.5 de	9.7 def	9.9 cdefg	18.0 abc	5.8	31.7	38.1	42.1
NMSKE	5.0 bcd	9.9 ef	11.7 efgh	18.2 abc	27.5	30.3	28.9	41.5
NMSKE	3.5 ab	7.6 bcdef	10.6 defg	24.1 bcdefg	49.3	46.5	33.8	22.5
NMSKE	4.9 bcd	10.0f	5.1 abc	25.3 bcdefg	30.0	29.6	68.1	18.6
NMSKE	4.6 bcd	9.4 def	8.1 abcdef	24.1 bcdefg	33.3	33.8	49.4	22.5
NMSKE	3.7 ab	8.7 cdef	11.5 efgh	21.4 bcde	46.4	38.7	28.1	31.2
PNSKE	4.5 abc	8.5 cdef	8.0 abcdef	27.6 defg	34.8	40.1	50	11.3
PNSKE	4.0 abc	6.8 bcde	8.1 abcdef	17.1 ab	42.0	52.1	49.4	45.0
PNSKE	3.6 ab	6.6 bcd	6.8 abcde	20.9 bcde	47.8	53.5	57.5	32.8
PNSKE	4.0 abc	8.1 bcdef	7.6 abcde	32.4g	42.0	43.0	52.5	-4.18
PNSKE	3.8 ab	8.3 cdef	9.2 abcdefg	28.0 efg	44.9	41.5	42.5	10.0
PNSKE	3.0ab	7.1bcdef	8.1abcdef	21.0bcde	56.5	50.0	49.4	32.5
COSKE	3.8 ab	8.6 cdef	9.7 bcdefg	26.4 cdefg	44.9	39.4	39.4	15.1
COSKE	3.3 ab	8.3 cdef	8.5 abcdef	24.6 bcdefg	52.2	41.5	46.9	20.9
COSKE	3.2 ab	8.5 cdef	13.1 fgh	26.3 cdefg	53.6	40.1	18.1	15.1
COSKE	5.8 cde	8.8 cdef	10.5 defg	25.8 bcdefg	15.9	38.0	34.4	17.0
COSKE	3.9 ab	11.9 fg	14.1 gh	28.5 efg	43.5	16.2	11.9	8.4
COSKE	3.3 abc	9.9 ef	11.0 efg	26.8 cdefg	52.2	30.3	31.3	13.8
Monocrotophos @ 400g a. i /ha	2.5 a	3.1a	4.3 a	11.7a	67.8	78.2	73.1	62.4
Untreated check (control)	6.9 e	14.2 g	15.0 h	31.1 fg	-	-	-	-

Means in the column followed by similar letter(s) superscript are not significantly different according to Duncan's New Multiple Range Test ($p>0.05$)

In the 1999 trial, the % dead heart were significantly reduced in the plant extract- treated plants and monocrotophos treated plants than in the control ($p<0.05$), except in a few of the plant extracts treated plants which were not significantly different from the control (Table 1). The % whiteheads in 1999 showed that apart from the 5% aqueous COSKE, all the other treatments significantly reduced the % whiteheads when compared with the control ($p<0.05$). The monocrotophos treated-plots produced the lowest stem- borers damage in 1999, though this was not significantly different ($p<0.05$) from a few of the plant extract treatments (Table 1). The % reduction in dead heart in the 1999 trial ranged from 5.8 to 67. 8% while the whiteheads ranged from 16.2 to 78.2%.

In the 2000 trial, the % dead hearts were similarly, significantly reduced in the plant extracts and monocrotophos –treated plants than in the control, except in a few of the plant extracts treatments (Table 1), which were not significantly different from the control. The % whiteheads followed similar trend in 2000 trial, with monocrotophos treatment and a number of the plant extracts treatments significantly reducing % whiteheads while a number of the plant extract treatments did not significantly reduced % whiteheads when compared with the control (Table 1). Comparatively, the monocrotophos treated plants had the lowest stem borers damage although this was significantly different from a number of the plant extracts – treated plants. The % reduction in dead hearts in the 2000 trial ranged from 11.9 to 73.1% while that of whiteheads ranged from – 4.2 to 62.4%. The results of the two-year trials with the plant extracts showed that the acetone-extracts were slightly more potent than the aqueous extracts.

Table 2: Field efficacy of acetone and aqueous extracts of some local medicinal plants and monocrotophos against stem borers of upland rice and effects on yield.

	Yield (kg/ha)		Yield increase over control (in kg)	
Treatment	1999	2000	1999	2000
NSKE	2242 def	1097 bcdefg	1300	622
NSKE	2250 def	1714 hi	1308	1249
NSKE	2433 ef	1783 hi	1491	1318
NSKE	1717 bcd	952 abcdefg	775	487
NSKE	2242 def	1638 hi	1300	1173
NSKE	1983 cde	1486 fgh	1041	1021
NMSKE	1517bc	648 ab	575	183
NMSKE	1725 bcd	1413 fgh	783	948
NMSKE	1550 bc	1440 fgh	608	975
NMSKE	1750 bcd	823 abcde	808	368
NMSKE	1533 bc	1288 cdefgh	591	823
NMSKE	1667 bcd	952 abcdefg	725	487
PNSKE	1992 cde	709 ab	1050	244
PNSKE	2050 cde	1448 fgh	1108	643
PNSKE	2058 cde	1349 defgh	1116	983
PNSKE	1567 bc	1029 bcdefg	625	564
PNSKE	1933 bcde	1356 efgh	991	891
PNSKE	1933 bcde	1333 cdefgh	991	868
COSKE	1783bcd	815abcd	84	350
COSKE	1808 bcd	945 abcdef	866	480
COSKE	1525 bc	853 abcde	583	388
COSKE	1333 ab	571 ab	391	106
COSKE	1792 bcd	731 ab	850	266
COSKE	1683 bcd	800 abc	741	335
Monocrotophos @ 400g a. i /ha	2725 f	2011 i	1783	1546
Untreated check (control)	942a	465a	-	-

Means in the same column followed by similar letter(s) superscript are not significantly different according to Duncan's New Multiple Range Test ($p>0.05$).

The yields in the 1999 and 2000 trials, in many of the plant extract – treatments and monocrotophos – treatment were significantly ($p<0.05$) higher than the control (Table 2). Generally, the trend observed was higher yield in the monocrotophos – treated plots than in other treatments, although this was not significantly different from a number of the plant extracts treatment. Among the plant extracts, NSKE showed some superiority over the others in stem borer control and in influencing yield, followed by PNSKE.

DISCUSSION

Boring lepidopterous and dipterous insects constitute a major hindrance to cereal production in West Africa (Harris, 1962, Breniere 1976). Dominant stem borer species that were associated will upland rice culture in Southeastern Nigeria include: *Diopsis thoracica* West wood (Diopsidae) *Diopsis* sp. nr. *apicalis* Dalm. (Diopsidae), *Chilo* sp (Pyralidae) and *Scirpophaga subumbrosa* Meyrick (Pyralidae) (Emosairue, 1993).

Dead hearts recorded in the untreated check in the two-year trial ranged from 6.9 to 16% of stems while whiteheads ranged from 14.2 to 31.1%. These data corroborate the earlier report of Emosairue (1993) who working on the status of stem borers in Calabar, Southeastern Nigeria, reported deadhearts ranging from 19.7 to 26.3% on two upland rice varieties in an early season planting (May- August) and 17.0 to 30% on late season crop (September-December). He similarly reported % whiteheads ranging from 16.5 to 21.0 % on early planting and 6. 5 to 9.7% for late season planting. These reports implicated stem borers as serious pests of upland rice culture in Southeastern Nigeria whose effective control would improve the yield of the crop. Israel and Abraham (1967) had computed and reported in the Philippines that an increase of 1% dead heart would result in a yield loss of 1.6% in rice while for every 1 % increase in whitehead an estimated 2.2% yield lost would be expected.

Natural products from plants have been reported extensively to be rich sources of bioactive substances

against a wide range of insect pests on many crops worldwide (Schmutterer 1985, Jacobson, 1986, Saxena, 1989, Chiu, 1992). However, in Africa, there have been more investigations with plant products on post harvest pests than on any other group such as field pests (Jackai, 1993).

The results of the two year trial with the acetone and aqueous extracts of the selected plant materials and monocrotophos – a synthetic insecticide, showed that monocrotophos was superior in efficacy to the plant extracts in the control of the stem bores. However, the efficacy of monocrotophos was at par with that of a number of the plant extracts treatment. These results are in harmony with a number of reports from Asian countries where some extensive field trials with indigenous plant materials on insect pests of arable crops have been carried out. Notable examples are the studies of Soon, (1992), Pradhan, (1992), Shukla, (1992), Hameed, (1992), Soejitno, (1992) and Chiu, (1992). Soon (1992), for example, reported that the use of 5% NSKE, 3% Neem oil and monocrotophos in rice field at Tamil Nadu Agricultural University, India, significantly reduced the damage of whorl maggot *(Hydrellia philippina)* as well as the incidence of dead hearts and whiteheads. Soon (1992) similarly reported that extracts of plants namely *A. indica; Vinca rosea, Vitex negundo* significantly reduced the whitefly population on cotton. Chiu *et al*, (1992) on the other hand reported that extracts of the meliaceous plants, *Melia azedarach* and *M. toosendan* showed strong feeding inhibiting properties against larvae of *Spodoptera litura* and the cabbage worm.

The mode of action of many plant materials is believed to be any one or a combination of the following effects: contact, stomach or systemic poison, fumigant, antifeedant, repellent, ovicidal, sterilant and growth – inhibitor (Chiu, 1992).

CONCLUSIONS

Grain yields in all the plants extracts and monocrotophos treatments were higher that the control and significantly higher than the control in a number of the plant extracts treatments. Incorporating the plant extracts treatments into upland rice production especially the aqueous extracts of the evaluated plant materials in the area, which is easy to prepare will help to improve the crop yield in resource-poor-farmers upland rice field, as well as increase monetary returns for their investment. More skilled farmers however may use the acetone extracts of the plant materials, which proved more potent than the aqueous extracts.

The use of the plant extracts especially the aqueous extracts will be easily adopted by the resource poor farmers' upland rice fields, who so far produce the bulk of the rice in the area.

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