Evaluation of Spray Regimes of Monocrotophos to Control Budworm *(Earias spp.)* Damage to Seed Kenaf (*Hibiscus cannabinus* L.)

T. A. Fadare [†] *and N. A. Amusa*
Institute of Agricultural Research and Training,
Obafemi Awolowo University, P.M.B. 5029, Ibadan, Nigeria.
Received: December 2002 Accepted January 2004

Résumé

Fadare, T. A. & Amusa, N. A. Evaluation des Regimes D'atomisation de Monocrotophes pour Regler les Vers du Bouton (Earias spp). Degats Causes Aux Graines De Kenaf (hibiscus Canna Binus L). L'effet du calcul du temps de l'application des monocrotophes sur son efficacité pour le réglage de vers du bouton (*Earias spp*) sur les graines du kenaf a été évalué dans les essais faits dans le terrain à la plantation Mior à Ibadan au Nigéria. Les monocrotophes ont été appliqués au même taux ; trois fois par saison dans quatre phases de croissance différentes et son effet (dans le temps) sur les vers de bouton ont été notés. Les résultats ont démontré que les applications d'atomisations initiées à 50% de l'étape où les fleurs poussent étaient aussi efficaces, que celles initiées à l'étape où les plantes commencent à boutonner pour le réglage des vers de bouton. Les applications initiées à l'étape des boutonnements des fleurs ont résulté en très bas pourcentage des dégâts des vers de bouton (12) et une production des graines de kenaf plus grande (1.444 kg ha^{-1}) comparée au traitement de réglage non atomisé qui a donné une destruction plus élevée des vers de bouton (25) et une production des graines de kenaf plus petite (672 kg) dans la première saison. Les résultats de l'essai de la deuxième saison a suivi la même tendance. Des applications analogues initiées au 50 pourcent de l'étape où les plantes commencent à porter des fruits ont donné 11 pourcent de la destruction des boutons et une production des graines de 1453 kg ha^{-1} comparée au réglage non- atomisé qui a donné 27 pourcent de destruction des vers de bouton et une production de 690 kg ha^{-1} De ces résultats il est claire que l'application chimique initiée au moment de boutonnement de fleurs réduire de manière efficace la destruction des vers du bouton et par conséquent accroître la production de graines du kenaf.

Mots clés: Monocrotophes, vers du bouton, *Hibiscus cannabinus*, régimes d'atomisation.

Abstract

The effect of timing of monocrotophos application on its efficacy for the control of budworm, *Earias spp.* on seed kenaf was evaluated in replicated field trials at Moor Plantation, Ibadan, Nigeria. Monocrotophos was applied at the same rate, three times per season over four different kenaf growth phases and its effect (in time) on budworm attack and damages to young plant shoots, flower and capsules was noted. Results showed that spray

[†] *Corresponding author*

applications initiated at 50 per cent flower set stage were as effective as those initiated at the flower bud stage for budworm control. Applications initiated at the flower bud stage gave very low per cent budworm damage (12) and larger kenaf seed yield (1,444 kg ha^{-1}) as compared to the unsprayed control treatment that gave high per cent budworm damage (25) and smaller kenaf seed yield (672 kg) in the first season. The results of the second season trial followed a similar trend. Similarly, applications initiated at the 50 per cent flower set gave 11 per cent flower bud damage and seed yield of 1453 kg ha^{-1} compared to the unsprayed control that gave 27 per cent budworm damage yield of 690 kg ha^{-1}. From these results, chemical application initiated at the flower bud stage will effectively reduce budworm damage and consequently increase kenaf seed yields.

Keywords: Monocrotophos, budworm, *Hibiscus cannabinus*, spray regimes.

Introduction

Kenaf, *Hibiscus cannabinus* L., is a good source of cellulose fibre for the production of pulp and paper. Worldwide, the kenaf plant is claimed to probably have a wider range of adaptation to climate and soils than any other fibre grown for commercial use. Much research has been conducted on kenaf stems as raw materials for pulp and paper. The leaves and small branches when ground have a high protein for animal food and it is easy to handle (Clark *et al.*, 1962; Miller, 1968; Powell and Wing, 1968; Ciaramello and Azzini, 1969; Bhango *et al.*, 1986; Tardieu, 1987 and Francois *et al.*, 1992).

The realization of better pulping and paper characteristics has added further interest to kenaf research and production activities (Mayberry, 1988). The increase in the global consumption of paper and paper board materials has increased the importance of kenaf as a wood substitute. Kenaf is estimated to be 35 times more productive per unit area of land than pulp wood trees and produces pulp that is equal or superior to many woods (Theisen *et al.*, 1978; Bossio, 1988). Paper produced from kenaf has very good ink-retention characteristics and a tensile strength that is ideal for printing with high-speed presses.

The importance of kenaf in the world economy in general and the Nigerian economy in particular has also been fully discussed and documented (Elliot, 1964; Adeoti, 1991). The kenaf variety, Cuba 108 has been identified as a suitable material for both fibre and seed production in South-Western Nigeria (Adeoti, 1991; Baker, 1965).

For fibre production the kenaf plant does not require any chemical protection from insects (Donnelly, 1966; and Donnelly and Adeyemi, 1966). However adequate and timely chemical protection is a must for the production of seed (Adeyemi, 1970; Fadare, 1974 and 1981). In Nigeria, kenaf is usually grown under rainfed conditions and high populations of flea beetles and other insects that attack both the leaves and the pods (Akinlosotu, 1969; Fadare, 1981; Adeoti, 1991). The effects of the pest attack are often extensive because the peasant farmers lack the insecticides and technologies to control them.

The major industrial use of kenaf in Nigeria is for the production of low cost sacks (Jute bags) for farm produce beans, cocoa, maize and other cereals. As a result of high demand for sacks and the foreign exchange (in export) involvement, two factories, producing sacks were established in the 1960s at Badagry and Jos. Both had processing capacity for over 20,000 tonnes of retted fibre per year. Only one of these is now producing sacks, largely from imported raw material while the other has folded up due to lack of raw material. The average annual production of one factory was then over 20 million sacks. There are also three paper mills in Nigeria; two of these function now below 50 per cent capacity due to lack of long fibre pulp from kenaf. The third one has folded up. Only a limited importation of raw materials is possible due to foreign exchange limitations (Shettima Mustafa, 1990). However, the Nigerian government is making concerted efforts to develop kenaf crop to supply locally, most of the raw materials to feed our factories. This line of research therefore is a relevant production strategy that supports government efforts.

Earlier work suggested that timely chemical (*Carbaryl*) protection for seed kenaf against the budworms, *Earias biplaga* Wlk. and *E. insulana* Boisd. at the onset of flowering is necessary for good yields (Fadare, 1984). Since then there has been no other chemical recommendation for seed kenaf in Southern Nigeria. The budworm is an ubiquitous pest which attacks and causes serious damages to economic crops such as okra, tomato, cotton and kenaf wherever these are cultivated. The budworm attack, if left unchecked could lead to total crop loss. It has been kept under check on these crops (except kenaf) by the application of endosulfan carbaryl or monocrotophos. The budworm also has preferential feeding habit. Initially it bores the tips (shoots) of young kenaf, then moves to feed on flowers as soon as the plants flower and finally to the capsules.

In this study, the performance of monocrotophos applications initiated at four different growth phases of seed kenaf was investigated over two consecutive seasons at Ibadan, Nigeria to confirm earlier findings, establish a spray regime for the chemical and provide alternative chemical in case of non-availability of or pest resistance/tolerance to the recommended carbaryl.

Materials and methods

Four spray regimes of monocrotophos applications were evaluated for pest management on kenaf production for two consecutive seasons at the Institute of Agricultural Research and Training, Moor Plantation, Ibadan (7° 22' E, 3° 58' N), Oyo State, Nigeria. The four regimes were chemical applications initiated at flower bud stage (10 weeks after planting) R_1, 50 per cent flowering (11wap) R_2, onset of fruiting (12 wap) R_3, 50 per cent fruiting (13 wap) R_4 and a no chemical spray control R_5. Each growth phase received three applications of 0.68 ha^{-1} active monocrotophos in 225-l water, at fortnightly intervals. R_1 at 10 weeks after planting, $R_2 = 11$, $R_3 = 12$, $R_4 = 13$. A 9-l pressurized falcon sprayer was used to apply the spray mix to the plants on the field.

Seed of the kenaf variety, Cuba 108 were sown at 50-20cm on the flat during the first week of July for both seasons and later thinned to give 2 plants/stand. Plot size was 5 x 5m and all treatments were replicated six times using a randomized complete block design. All other agronomic practices were carried out as recommended for kenaf production in South-Western Nigeria (Baker, 1965). Parameters recorded were the number of flowers and capsules (fruiting points) damaged by budworms on 10 randomly selected plants per plot and kenaf seed yield obtained from the innermost two rows of each plot. Damage to flowers and capsules were assessed by examining and counting all flowers and/or capsules on the sample plants at each growth phase for budworm feeding activity. Thereafter the total number of damaged flowers or capsules was expressed as a percentage of total (sound plus damaged) for the sample plants. A pre-spray tip borer damage assessment was carried out on each plot by examining the tips of young plants for die-back. All data collected for each season were subjected to statistical analysis using ANOVA and thereafter treatment means were separated using Duncan's multiple range test (DMRT).

Results and Discussion

The results of the experiments are presented in Table 1 and Table 2 and discussed under subheadings experiment 1 and experiment 2.

Experiment 1

The pre-spray tip borer damage figures ranged from 1 to 7 per plot for all treatments and showed no significant differences ($P=0.05$) Table 1. There was no post spray tip borer damage assessment because the budworm moved to and fed on flower soon as the kenaf produced flowers.

In flower damage, treatments R_1 and R_2 were significantly superior to other treatments ($P=0.05$). Treatments R_1 and R_2 reduced the level of damage from 25.00 per cent in the control to 12.00 and 12.50 per cent respectively. This is a 2-fold reduction as compared to the unsprayed control and treatment R_4 (Table 1). Treatment R_3 is significantly inferior to R_1 and R_2 in protective ability

Table 1. Percentage damage to fruiting points and seed yields of kenaf under different spray regimes of monocrotophos (1996).

Treatment	*Pre-spray No. plants bored per plot*	*% Postspray damage*		*% Control*■ *achieved*	*Yield (kg ha⁻¹)*
		Flowers	*Capsules*		
R1	1	12c	19c	54	1444d
R2	2	12c	24bc	43	1040c
R3	4	19ab	30b	28	884b
R4	7	24ab	27bc	34	898b
R5	6	25a	41a	-	672a

■Calculated as: $100\left(1-\frac{t}{c}\right)$. t = damage under a particular treatment, c = control damage.

Means followed by similar letters are not significant at 5% level using Duncan's multiple range test

(P=0.05) but is not different from treatments R_4 and R_5. In capsule damage treatment R_1 was significantly superior to the unsprayed control treatments R_5 and R_3. It reduced the level of damage from 41.50 per cent in the control to 19.00 per cent and this is also a 2-fold reduction. The other treatments were not different from one another (Table 1). Yield figures from all sprayed treatments were significantly larger than the 672kg ha^{-1} from the control; treatment R_1 with a seed yield of 1,444kg ha^{-1} was significantly superior to R_2, R_3 and R_4. Seed yield from treatment R_1 is more than 2-fold increase over that from the control. Seed yield from treatments R_3 and R_4 were not different from each other (Table 1). The per cent control achieved by the sprayed treatments over the unsprayed control were R_1=54.00, R_2=43.00, R_3=28.00 and R_4=34.00 (Table 1).

Experiment 2

The pre-spray tip borer damage figures for experiment 2 were similar but greater than those of experiment 1 and ranged from 11.00 to 14.50 per plot. They were however not significantly different from one another (P=0.05). There was no post-spray assessment for reasons indicated in experiment 1 above. In flower damage, treatments R_1 and R_2 were significantly superior to all other treatments. Treatments R_1 and R_2 had over 2-fold reduction from the level of control damage figures, 27.40%, reduced it further to 10.80 and 12.70 per cent respectively (Table 2). Flower damage figures for R_3 and R_4 were larger than those of the unsprayed control but were not significantly different from one another (Table 2).

Table 2. Percentage damage to fruiting points and seed yields of kenaf under different spray regimes of monocrotophos (1997).

Treatment	*Pre-spray No. plants bored per plot*	*% Postspray damage Flowers*	*Capsules*	*% Control▪ achieved*	*Yield ($kg\ ha^{-1}$)*
R1	11	10c	17b	48	1453d
R2	12	12c	19b	41	1183c
R3	14	18ab	25ab	22	991bc
R4	13	20ab	26ab	20	932b
R5	14	27a	32a	-	690a

▪Calculated as: $100\left(1 - \frac{t}{c}\right)$. t = damage under a particular treatment, c = control damage.

Means followed by similar letters are not significant at 5% level using Duncan's multiple range test.

Percentage capsule damage for sprayed treatments R_1 and R_2 were significantly smaller than those for unsprayed control R_5. Treatments R_1 and R_2 reduced the level of budworm damage from 32.7% in the control to 17.10 and 19.40 per cent respectively. They were however not superior to other sprayed treatments. The seed yield of all sprayed treatments were significantly larger than that of the unsprayed treatment. Treatment R_1 with 1453kg ha^{-1} seed yield had a 2-fold yield increase over the control yield of 690kg ha^{-1}. Treatment R_2 had a significantly larger yield than R_4 and R_5 (P=0.05).

The per cent control achieved over the unsprayed control treatment were R_1=48.00, R_2=41.00, R_3=22.00, R_4=20.00 respectively (Table 2). The results presented above confirmed the earlier findings of Fadare (1984), that mandatory chemical application is required for seed kenaf production in South-West Nigeria and that such chemical sprays must be initiated at the flower bud stage (R_1). Applications initiated at the flower bud stage effectively decimated the initial budworm population that moved to feed on flowers in preference to the young plant tips. As soon as capsules were produced the budworm moved to feed on them but not in total preference. Applications initiated at R_2 were also effective in reducing the levels of budworm damage and enhancing kenaf seed yield but not at the same level as treatment R_1.

The plots that received treatments R_3 and R_4 have had to contend with a much matured budworm population and damage before the chemical intervention, hence higher damages and low yields were recorded from such plots. In kenaf production, the first major point of attack and damage by budworm is the tips of young plants, but as soon as flowers are initiated, the budworms move to and feed on them as compared to young kenaf tips. Similarly the budworms move to feed on capsules as soon as they are produced but not in total preference to flowers. This observation had been reported by Donnelly and Adeyemi (1966), Akinlosotu (1969) and Fadare (1984). Early chemical intervention, (R_1) reduced the levels of damage to flowers and capsules and enhanced kenaf production potentials resulting in larger seed yield. The reverse was recorded for other (later) treatments. This is in agreement with the findings of Adeyemi (1970) on kenaf budworm damage to fruiting points and seed yield. It is probable that early applications of chemical insecticide had wiped out most of the initial immature and less destructive budworm populations. This is in contrast to later applications when the budworms were matured and more destructive. The non-significant differences between treatments R_1 and R_2 in recorded parameters are further evidence that early chemical insecticide intervention has an advantage over later interventions (as in R_3 and R_4). Chemical application for treatment R_1 was made 10 weeks after planting (wap) kenaf, for treatment R_2, 11, R_3, 12 and R_4, 13 wap. At 12 and 13 wap, the plants had lived with budworm attack and damages for three to four weeks after chemical intervention of treatments R_1 and R_2. These later applications of chemical appear to be medicine after death. The data (Table 1 and Table 2) from the unsprayed treatment R_5 further lent credence to the claim of Fadare (1984) for early mandatory chemical protection against budworms on kenaf. Fadare (1974) had earlier reported the need for timely and adequate chemical protection against bollworms on cotton, a fibre crop with similar insect pest problems for the realization of good quality seed cotton yields.

The pest problem on kenaf is not limited to tip boring, flower/capsule damage of the budworms, there is a host of other insects. These other insects are not as difficult to manage as the budworms and borers and they are invariably controlled alongside the budworms (Adeyemi, 1970). It is very clear from these studies that monocrotophos application to seed kenaf from flower bud stage and at two weeks intervals was successful in curtailing and reducing budworm damage. Applications at later stages of kenaf growth were not as successful in curtailing budworms and reducing their damage. This is evidenced by the significantly low budworm damage and larger kenaf seed yields of treatment R_1 compared to others.

It could be concluded therefore that applying monocrotophous at flower bud stage (treatment R_1) is most appropriate on seed kenaf to keep budworm damage low and consequently enhance kenaf production potentials in South-West Nigeria.

References

Adeoti, A. A. 1991. The biology and control of Coniella leaf spot of kenaf (*Hibiscus cannabinus* L.) induced by *Coniella musaiaensis* B. sutton var Hibisci B. Sutton. Ph.D. Thesis, Ahmadu Bello University, Zaria, Nigeria.

Adeyemi, S. A. O. 1970. Annual Report Res. Div. MANR., Western Region, Nigeria. 1968/69 season. 41-45.

Akinlosotu, T. A. 1969. A note on the spiny bollworm, *Earias biplaga* Wlk. of kenaf. *Nigeria Entomology Magazine* 2(1): 1-3.

Amon, B. O. E. 1964. Kenaf in Western Nigeria. In *Second International Kenaf Conference*. Palm Beach, Florida, Dec. 1964. Depart. State Agency for International Development, Washington, D. C. pp. 247-248.

Baker, E. F. I. 1965. Crop Husbandry Sectional Report Res. Division, MANR, Western Region, Nigeria. 1962-64 seasons.

Bhango, M. S., Thehrani., H. S. & Henderson, J. 1986. Effect of planting date, nitrogen levels, row spacing and plant population on kenaf performance in the San Joaquin Valley, California. *Agronomy Journal* 78: 600-640.

Bossio, M. 1988. Kenaf paper. A forest-saving alternative. USDA-ARS. *Agricultural Research* 36(9): 6-8.

Ciaramello, D. & Azzini, A.1969. Kenaf como materia prima para papel, Brazillian Tech. Assoc. Cellulose Paper. Bull. 9.

Clark, T. F. Nelson, G. H. Nieschlag, H. J. & Wolff, I. A. 1962. A search for new fiber crops. V. Pulping Studies on Kenaf. *Tappi* 45(10): 780-786.

Donnelly, J. 1966. Insect pests of kenaf. *Nigeria Entomology Magazine* 1(1): 8 - 9.

Donnelly, J. & Adeyemi, S. A .O. 1966. Entomology Sectional Report, Research Div., MANR, Western Nigeria, 63 64 1963-1964. pp. 35-44.

Elliot, S. 1964. The blending of kenaf fibres with other natural and man-made fibres. In *Second International Kenaf Conference*, Palm Beach Florida, Dec. 1964. Depart, State Agency for Inter. Develop., Washington, D.C. pp. 76-80.

Fadare, T. A. 1974. Effectiveness of some insecticides on the bollworm complex of cotton. *Nigerian Journal of Entomology* 1(1): 43-49.

Fadare, T. A. 1981. Insects associated with kenaf (*Hibiscus cannabinus* L.) in South-Western Nigeria, *I.A.R. & T. Research Bulletin No. 14*.

Fadare, T. A. 1984. Effect of timing of insecticide application to control kenaf insects. *Nigerian Journal of Entomology* 4(2): 43-49.

Francois, L. E., Donovun, D. S. & Mass, E. V. 1992. Yields, vegetative growth and fibre length of kenaf grown in saline soils. *Agronomy Journal* 84(4): 592-598.

Mayberry, D. H. 1988. A new source of paper fibre. *Natural Science*, July 1988. pp. 158-163.

Miller, D. L. 1968. Kenaf fibre for paper making. In *Proc. First Conference on kenaf for pulp.* pp. 66-72 Gainesville, Florida.

Mustafa, Shettima. 1990. Keynote Address to the First Workshop on Kenaf Production Processing and Utilization in Nigeria, 4 - 6 December 1990. Ilorin, Kwara State, Nigeria, pp. 3-5.

Powell, G. W. & J. M. Wing 1968. Kenaf as silage. In *Proc. First Conference on Kenaf for Pulp*, p. 49. Gainseville, Florida.

Robinson, F. E. 1988. Kenaf. A new fibre crop for paper production. *California Agriculture* 42: 31-32.

Tardieu, M. 1987. Agritop. Tropical and Subtropical, Vol. II No. 1, pp. 81-87.

Theisen, A. A., Knox, E. G. & Mann, F. L. 1978. Feasibility of introducing food crops better adapted to environmental stress. National Science. Foundation. Div. Application Res. NSF/RA. 780289. US Govt. Print Office, Washington, D.C.