OnLine Journal of Biological Sciences 1 (11): 1034-1039, 2001

Pesticidal Efficacy of Some Indigenous Plant Oils Against the Mexican Bean Weevil, *Zabrotes subfasciatus*. Boheman. (Coleoptera: Bruchidae).

Ahsanul Haque, A. K. M. Faruquzzam, Hasina Banu, N. Islam, [1]Md. Abdul Alim and Aleya Nasreen
Entomology Division, [1]Soil Science Division, Physiology Division, Bangladesh Jute Research Institute, Shere Bangla Nagar, Dhaka-1207, Bangladesh

Abstract. In a study, dust of deltamethrin @ 2 ppm and 3 ppm (T_8), neem oil (T_3), pithraj oil (T_7), soybean oil (T_1), sesame oil (T_4) and jute oil @ 15 m/kg grain (T_5), applied to kenaf seeds were fully effective up to 3, 3, 3, 2, 2 and 2 months respectively against adults of *Z. subfasciatus* Boheman. While castor oil less effective. (T_1), (T_3), (T_4), (T_5), (T_6) and (T_7) caused effective reduction in oviposition up to 2 months and (T_8) caused effective up to 3 months. The higher doses of plant oils caused more then 70% egg mortality and reduced adult emergence significantly to prevented further infestation but the efficacy of lower doses deteriorated at later stages of sampling. Finally in another trial, each 500 g kenaf seeds of which each 5 % contained separately each of the four stages of *Z. subfasciatus* and also containing 5 pairs of adults, was treated separately with each of the above 8 treatments (only highest doses of T_1 to T_8) and was stored in sealed polythenebags. T_1, T_2, T_3, T_4, T_5, T_6 and T_7 offered 86.85 , 81.40, 91.36, 84.34, 86.77, 84.70 and 83.69% grain protection respectively as against 87.54% infestation in the control experiment during 4 months of storage. The germination ability of seeds was not affected by any treatment.

Key words: Indigenous plant materials, *Zabrotes subfasciatus*, Kenaf

Introduction

Kenaf, a jute substitute, is now grown as raw material for paper-pulp in many countries (Andrew *et al.*, 1980; Jianguang *et al.*, 2000; Masakazu Morimoto, 2001). The paper and pulp mills of Bangladesh have recently introduced kenaf as raw materials along with jute (*Corchorus* spp.) stems (Ahmed, 1997; Anonymous, 1993). Besides, the farmers of Bangladesh have been using Kenaf stick or whole stem in the vegetable garden, betel leave orchards and as fuel. Increased cultivation has resulted in an increased incidence of pest. Among them *Zabrotes subfasciatus*, Boheman is the new major pest responsible for considerable damage of Kenaf seeds in Bangladesh. Z. *subfasciatus*, is commonly known as the Mexican bean weevil. This pest include bruchid insect, which attack seeds of several economically important legumes (Kingsolver, 1990).

The significant annual losses of seed due to bruchids (*Zabrotes subfasciatus*, Boheman.) as reported from many countries have led to scientists to make concentrated efforts for developing control measures against them. Several reports are available on the efficacies of chemicals (Nisa and Ahmad, 1970; Tyler and Binns, 1977; Govindrajan *et al.*, 1978; Yadab *et al.*, 1983; Lekha *et al.*, 1984; Rahman and Yadav, 1985; Yadav, 1987.) and plant oils (Pereira, 1983; Yadav, 1985; Das, 1986; Khalique *et al.*, 1988; Morallo-rejesus, 1990; Rohan, 1990).

However, indiscriminate use of pesticides by farmers and traders to keep the pest population under control has given rise to a situation where there is an urgent need to develop economically and ecologically safer and more sound pest control techniques which could be used both by farmers and traders.

The studies were aimed mostly at protecting the fresh grains against infestation by adult's beetles. This sort of protection could be obtained just through exclusion of adult entry using sealed non- porous/ micro porous containers i.e., beetle - proof containers. But in reality the infestation dose occurs mostly from the hidden source of infestations consisting of different developmental stages already present in some portions of the stored grains rather than by the adults. The actual problem lies in protecting the grains from this type of hidden infestations.

Materials and Methods

The experiments were conducted in the laboratory of Bangladesh Jute Research Institute, Dhaka, Bangladesh during 2000-2001 to test the efficacy of some botanicals and chemical methods against *Zabrotes subfasciatus* (Boheman) on kenaf (*Hibiscus cannabinus* L.) seed. The botanical methods included seed treatments with oils of Soybean (*Glycine max.*) (T_1), Castor (*Ricinus communis* L.) (T_2), Neem (*Azadirachta indica* L.) (T_3), Sesame (*Sesamum indicum* A. juss) (T_4), Jute (*Corchorus* spp.) (T_5) Safflower (*Carthamus tinctorius* L.) (T_6) and Pithraj (*Aphanamixis polystachya* Wall and parker) (T_7), at three different concentrations. The chemical methods included seed treatment with deltamethrin dusts @ 1.0, 2.0 and 3.0 ppm, (T_8), 200 g of well- dried infestation free Kenaf seeds (variety, HC- 95) were subjected to T_1, T_2, T_3, T_4, T_5, T_6, T_7 and T_8, (as mentioned above) or shaking only (as control). From each 10 g seeds were placed in 75-mm. plastic containers. The rest of the seeds of each treatment were stored in a sealed polythene bag in the laboratory under ambient temperature at $27 \pm 1^{\circ}$C and 75% R.H. Five pairs of one-day-old adults of *Zabrotes subfasciatus* were released into each container. Data on adult mortality were recorded after 3 days of release. Then the insects were removed. Subsequently, data on oviposition, egg mortality and adult emergence were recorded. The same procedure was repeated at each month interval for 3 months.

For the 2nd experiment 200 g Kenaf seeds infested with eggs, grabs and pupae of *Z. subfasciatus* in equal proportions were placed in a plastic container. Another 300 g fresh and infestation free Kenaf seeds were added to it. Five pairs of one-day-old adults of *Z. subfasciatus* were also added. Each of this 500 g lots was subjected to T_1, T_2, T_3, T_4, T_5, T_6, T_7 and T_8, (as mention above) or shaking only (as control). Each was replicated 3 times. Each lot was then placed in a sealed polythene bag. The polythene bags were stored in the laboratory under ambient temperature and R.H. (21-29°C and 50- 85% respectively). Data on the number and weight of infested grains (grains having even a single bruchid hole) and healthy grains (grains without any holes) were recorded after 4 months of storage to calculate percent infestation and protection of grains. Healthy seeds were tested for

germination before treatment and also at the end of the experiment.

The treatment mortality of each stage was corrected for control mortality (Abbott, 1925). All the data were analyzed statistically after appropriate transformations.

Results

Deltamethrin @ of 2.0 and 3.0 ppm was toxic causing 100% mortality of adults of *Z. subfasciatus* even after 3rd month. Adult mortality differed significantly between treatments ($p < 0.05$). Neem oil @ 15ml/kg were toxic causing (94.42%) mortality of adults initially and were not significantly differ from deltamethrine (Table 1). All of the plant oils @ 15ml/kg and 10 ml / kg seeds were causing about (89 to 72%) initial mortality of adults were not differ significantly except castor oil. After one month caused about (89-61) percent mortality were observed in all botanicals oil @ 15ml/kg and 10 ml/kg except castor oil. But after 2-month neem oil caised about 78 percent mortality of adult @ 10 ml/kg and 15 ml/kg which was followed by the 15 ml/kg. doses of soybean, sesame, jute and pithraj oil. After 3 moth only neem and pithraj oil @ 15 ml/kg caused about 78 and 67 percent adult mortality and was identical. But soybean @ 15 ml/kg neem @ 10 ml/kg, sesame, jute and safflower @ 15 ml/kg, pithraj @ 10 ml/kg caused about (62 to 56 %) adult mortality.

Reduction in oviposition: Deltamethrin caused 84 to 100 percent reduction in oviposition up to 3rd month and were significantly different from all plant oils. Among the plant oils initially about 97 to 96 percent reduction of oviposition were observed in safflower oil when applied @ 15 ml/kg and 10 ml/kg of seed. This was followed by the reduction of oviposition @ 15 ml/kg of soybean, jute, pithraj and neem oil. Castor oil did not so initially. After one and two months neem oil @ 15 ml/kg provided maximum 95 percent reduction in oviposition in kenaf seeds among the plant oil was followed by Soybean oil @ 15 ml/kg while lowest was observed in castor oil @ 5 ml/kg. After 3 month the highest doses of neem, jute and pithraj oil caused about 57 to 53 percent reduction in oviposition. But the lowest doses of all plant oil not sufficient reduction of ovipositor.

Effect on ovicidal and adult emergence: Deltamethrin @ 3 and 2 ppm were 100 percent ovicidal even after 3rd month while plant oils @ 15 ml/kg was so initially. Neem and soybean oil @ 15 ml/kg retained it very high toxicity up to the 2nd month and was statistically different from all other plant oil in same doses. After 2nd month plant oil @ 15 ml/kg was moderately ovicidal even after 3rd month. Deltamethrin @ 3 ppm and 2 ppm were effecting for 3rd month in restricting further progeny multiplication just through killing adult released. On the other hand, neem oil @ 15 ml/kg and pithraj or soybean oil at the same doses were effective for 2 and 3 months after treatment respectively in preventing 100 percent adult emergence through the successive lethal actions on subsequent stages. Thus they prevented further infestations to fresh seeds from emerged adults. The lower doses of plant oils after 3 month of treatment caused about 22 to 45 percent reduction in oviposition however adult emergence were sufficient to destroy the grains in following month.

Results presented in Table 2, reveal that, the highest (87.54) percentage of seed infested (by count) was incurred in the control (only shaking) and was statistically different from all other treatments. The lowest (9.42) percentage of seed infested (by count) was observed in deltamethrin @ 3 ppm that was closely followed by neem, soybean and jute oils @ 15 ml/kg respectively.

Neem oil @ 15 ml/ kg and deltamethrin @ 3 ppm ensured above 90 percent protection of Kenaf seeds against *Z. subfasciatous*. All other plant oils @ 15 ml/kg. also offered very high levels about (84 to 87) percent of protection of seeds during the period. The lowest (12.08) percentage of seed protection was observed in untreated seeds and was significantly difference from al other treatment.

The original germination ability of Kenaf seeds was not adversely affected by any treatment. Slight reduction in germination about (3.33- 3.85) percent was observed but the reduction was not statistically different from original rate of germination.

Discussion

The persistent toxicity of deltamethrin to the adults of pulse beetle was in agreement with the findings of Rahaman and

Table 1: Toxicity of plant materials after ageing for 1hr, 1, 2, and 3 month on kenaf seeds to the adults and subsequent stages of *Z. subfasciatus*.

Date of seed treatment/ Date of exposure to insects.	Treatments	Doses (ml/kg seeds)	Adult mortality (%)	Reduction in oviposition (%)	Egg mortality (%)	Reduction of adult emergence (%)
18-03-2001/ 18-03-2001	Soybean oil (T_1)	15	77.77b (62.18)	95.10b (77.34)	100a (90.00)	100a (90.00)
		10	72.22b (58.46)	89.33c (70.96)	82.22bc (65.34)	98.13ab (82.22)
		5	44.44e (41.75)	55.34f (48.07)	77.11bc (61.64)	89.89c (71.60)
	Castor oil (T_2)	15	55.55e (48.24)	71.78d (58.04)	98.42a (85.22)	99.61c (87.37)
		10	38.89e (38.51)	83.55d (66.16)	85.23bc (68.09)	97.75c (81.57)
		5	38.89e (38.51)	49.31f (44.62)	79.96bc (63.44)	89.88c (71.47)
	Neem oil (T_3)	15	94.42ab (81.31)	93.10b (75.50)	100a (90.00)	100a (90.00)
		10	77.77b (62.18)	92.00c (73.63)	96.24ab (82.87)	99.61 ab (87.37)
		5	61.11d (51.49)	83.54d (66.08)	89.02ab (73.79)	98.12b (83.29)
	Sesame oil (T_4)	15	88.88b	89.90c	97.17a	99.61a

			(73.60)	(69.02)	(83.77)	(87.37)
		10	66.66cd	86.67c	92.07a-c	98.87a-c
			(55.21)	(68.65)	(76.55)	(84.79)
		5	55.55e	66.21d	94.51ab	98.13b
			(48.24)	(54.48)	(76.56)	(82.22)
	Jute oil (T_5)	15	83.33b	94.22b	94.37a	99.61a
			(65.90)	(76.12)	(81.31)	(87.37)
		10	72.33bd	90.89c	71.89c	96.99c
			(58.54)	(72.53)	(62.84)	(82.40)
		5	66.66cd	53.31f	61.68c	82.40d
			(54.73)	(46.91)	(51.88)	(65.27)
	Safflower oil (T_6)	15	72.22bd	97.11b	100a	100a
			(58.46)	(80.44)	(90.00)	(90.00)
		10	72.22bd	96.21b	91.95ac	99.61a
			(58.46)	(79.18)	(79.59)	(87.37)
		5	44.44e	66.89d	78.65bc	92.13c
			(41.75)	(52.48)	(62.54)	(73.74)
	Pithraj oil (T_7)	15	88.88b	94.00b	84.66a	98.86a
			(73.60)	(75.87)	(75.87)	(85.87)
		10	77.77b	86.41c	73.56c	96.2c
			(62.18)	(68.41)	(60.21)	(79.43)
		5	55.55e	71.54d	72.29bc	92.51c
			(48.24)	(57.83)	(58.81)	(74.38)
	Deltamethrin (T8)	3 ppm	100a	100a		-
100a						
			(90.00)	(90.00)		-
(90.00)						
		2 ppm	100a	100a		-
100a						
			(90.00)	(90.00)		-
(90.00)						
		1ppm	94.42ab	100a		-
100a						
			(81.31)	(90.00)		-
(90.00)						
18-03-2001/	Soybean oil (T_1)	15	77.77bc	90.99b	100a	100a
18-04-2001			(62.18)	(72.58)	(90.00)	(90.00)
		10	61.22bc	77.54d	78.47d	95.19b
			(51.49)	(61.72)	(62.36)	(77.57)
		5	44.44c	42.04g	69.88f	83.23c
			(41.75)	(40.42)	(56.73)	(65.87)
	Castor oil (T_2)	15	38.89cd	80.04cd	93.24c	95.85b
			(38.51)	(63.47)	(75.12)	(78.44)
		10	22.22d	69.94e	74.11e	91.34c
			(27.81)	(56.76)	(59.45)	(72.97)
		5	22.22d	38.65g	61.09f	82.88c
			(27.81)	(38.43)	(51.41)	(65.58)
	Neem oil (T_3)	15	88.89b	92.32b	100a	100a
			(73.60)	(73.95)	(90.00)	(90.00)
		10	77.78bc	72.23d	90.37c	93.75bc
			(62.18)	(58.22)	(71.99)	(75.74)
		5	55.56 c	47.77f	70.52ef	94.15b
			(48.24)	(43.73)	(57.16)	(76.23)
	Sesame oil (T_4)	15	83.33bc	76.52d	92.84c	94.83b
			(65.90)	(61.04)	(74.58)	(77.15)
		10	66.67bc	59.15f	83.23cd	91.56c
			(54.73)	(50.28)	(65.85)	(73.19)
		5	50.00c	40.75g	70.42ef	85.45c
			(45.00)	(39.67)	(56.06)	(67.60)
	Jute oil (T_5)	15	77.78bc	76.07d	89.62cd	95.62b
			(62.18)	(60.75)	(71.27)	(78.28)
		10	55.56 c	66.13de	61.12f	90.40c
			(8.24)	(54.42)	(51.43)	(72.04)
		5	61.11 bc	49.20f	54.94f	72.00d
			(51.49)	(44.54)	(47.84)	(58.06)
	Safflower oil (T_6)	15	72.22 bc	69.18f	96.39b	100a
			(58.46)	(56.29)	(79.08)	(90.00)
		10	72.22 bc	66.47ef	78.98d	92.35bc

			(58.46)	(52.83)	(62.73)	(73.99)
		5	38.89 cd	37.33g	60.28f	82.78c
			(38.51)	(37.65)	(50.94)	(65.52)
	Pithraj oil (T_7)	15	83.33 bc	81.23c	75.61e	94.59b
			(65.90)	(64.35)	(60.45)	(76.76)
		10	72.22 bc	71.95d	63.85f	90.89c
			(58.46)	(58.02)	(53.06)	(72.47)
		5	44.44c	50.79f	58.87f	83.01c
			(41.75)	(45.46)	(50.12)	(65.68)
	Deltamethrin (T8)	3 ppm	100a 100a	100a	100a	
			(90.00)	(90.00)	(90.00)	(90.00)
		2 ppm	100a 100a	100a	100a	
			(90.00)	(90.00)	(90.00)	(90.00)
		1ppm	83.32bc	90.13b	91.71c	100a
			(69.88)	(71.72)	(73.30)	(90.00)
18-03-2001/	Soybean oil (T_1)	15	72.22b	89.53b	83.60b	94.38b
18-05-2001			(58.46)	(71.15)	(66.16)	(76.80)
		10	55.56bc	70.73c	73.74b	93.89b
			(48.24)	(57.25)	(59.19)	(75.74)
		5	44.44d	39.98e	66.18c	79.21e
			(41.75)	(39.22)	(54.46)	(62.89)
	Castor oil (T_2)	15	44.44d	75.45c	81.09b	91.53c
			(41.75)	(60.30)	(64.28)	(73.13)
		10	22.22f	66.08c	64.89c	86.24d
			(27.81)	(54.39)	(53.69)	(68.31)
		5	22.22f	34.01f	50.54e	78.53e
			(27.81)	(35.66)	(45.31)	(62.41)
	Neem oil (T_3)	15	77.78b	89.32b	84.48b	100a
			(62.18)	(70.99)	(66.84)	(90.00)
		10	72.22b	67.26c	70.01b	90.78c
			(58.49)	(55.10)	(56.80)	(72.37)
		5	38.78d	45.87d	59.21de	80.69e
			(38.44)	(42.63)	(50.31)	(63.95)
	Sesame oil (T_4)	15	77.78b	73.10c	75.61b	89.69d
			(62.18)	(58.78)	(60.43)	(71.32)
		10	50.00c	53.01d	69.90b	85.47d
			(45.00)	(46.73)	(56.73)	(67.84)
		5	33.33de	33.50f	58.41de	74.54c
			(34.78)	(35.35)	(49.84)	(59.71)
	Jute oil (T_5)	15	72.22b	69.91c	84.48b	92.07c
			(58.46)	(56.75)	(66.88)	(73.75)
		10	55.56bc	59.04cd	57.34de	80.67e
			(48.24)	(50.21)	(49.22)	(63.94)
		5	38.89d	38.94e	48.98e	62.25f
			(38.51)	(38.60)	(44.42)	(52.10)
	Safflower oil (T_6)	15	61.11bc	54.12d	79.44b	94.96b
			(51.49)	(47.37)	(63.05)	(77.10)
		10	61.11bc	53.14d	61.30cd	82.35 de
			(51.49)	(46.80)	(51.54)	(65.18)
		5	38.89d	31.22f	47.83e	69.88f
			(38.51)	(33.97)	(43.75)	(56.74)
	Pithraj oil (T_7)	15	6.67b	69.59c	73.98b	89.32d
			(54.73)	(56.54)	(59.35)	(70.92)
		10	61.11bc	63.63c	53.71e	83.56 de
			(51.49)	(52.91)	(47.13)	(66.12)
		5	38.89d	44.32d	47.10e	69.91f
			(38.51)	(41.73)	(43.34)	(56.74)
	Deltamethrin (T_8)	3 ppm	100a	100a	100a	100a
			(90.00)	(90.00)	(90.00)	(90.00)
		2 ppm	100a	89.02b	100a	100a
			(90.00)	(72.28)	(90.00)	(90.00)
		1ppm	77.78b	89.15b	82.58b	97.54a
			(62.18)	(70.80)	(65.35)	(81.23)
18-03-2001/	Soybean oil (T_1)	15	61.11c	44.02d	72.86b	86.41b
18-06-2001			(51.49)	(41.32)	(58.62)	(68.41)
		10	38.89d	30.21e	57.09bc	74.81c
			(38.51)	(33.34)	(49.08)	(59.88)
		5	27.78e	25.86ef	32.61de	48.02g

		(31.54)	(30.56)	(34.81)	(43.86)
Castor oil (T_2)	15	44.44d	46.73cd	69.66b	80.29b
		(41.75)	(43.12)	(56.59)	(63.67)
	10	27.77e	32.36e	59.90bc	63.77e
		(31.54)	(34.66)	(50.72)	(53.00)
	5	22.22f	23.01f	29.60 e	48.19g
		(27.81)	(28.65)	(32.96)	(43.96)
Neem oil (T_3)	15	77.78b	57.13b	74.23b	94.94b
		(62.18)	(49.10)	(59.50)	(77.06)
	10	55.56cd	44.69d	63.73b	78.13b
		(48.24)	(41.95)	(52.98)	(62.13)
	5	27.77e	35.48e	37.41d	48.88g
		(31.54)	(36.56)	(37.70)	(44.36)
Sesame oil (T_4)	15	55.56cd	53.01bc	61.83bc	75.91c
		(48.24)	(46.73)	(51.86)	(60.64)
	10	27.78e	37.06e	53.61c	60.81ef
		(31.54)	(37.49)	(47.07)	(51.25)
	5	22.22f	21.86f	29.84e	44.75g
		(27.81)	(27.86)	(33.10)	(41.98)
Jute oil (T_5)	15	61.11c	56.27b	75.23b	79.61b
		(51.49)	(48.60)	(60.17)	(63.18)
	10	38.89d	40.32d	52.54c	57.55 fg
		(38.51)	(39.41)	(46.46)	(49.34)
	5	22.22f	26.84ef	28.78e	42.99h
		(27.81)	(31.20)	(32.44)	(40.97)
Safflower oil (T_6)	15	55.56cd	43.22d	65.54b	76.50b
		(48.24)	(41.11)	(54.06)	(61.02)
	10	38.89d	30.70 e	54.78c	67.79d
		(38.51)	(33.64)	(47.75)	(55.43)
	5	27.77e	22.29f	28.83e	50.65g
		(31.54)	(28.16)	(32.45)	(45.37)
Pithraj oil (T_7)	15	66.67bc	52.67bc	61.77bc	68.70e
		(54.73)	(46.53)	(51.81)	(55.99)
	10	55.56cd	44.06d	38.44d	56.69f-g
		(48.24)	(41.58)	(38.31)	(48.85)
	5	22.22f	28.20ef	27.50e	37.19h
		(27.81)	(32.06)	(31.62)	(37.57)
Deltamethrin (T8)	3 ppm	100a	100a	100a	100a
		(90.00)	(89.09)	(89.09)	(89.09)
	2 ppm	100a	92.36a	97.25a	100 a
		(90.00)	(74.67)	(83.85)	(89.09)
	1ppm	66.67bc	83.85ab	78.33b	96.28b

Figures in parentheses are transformed (Arcsine) means of three replications. Means followed by the same letter(s) do not differ significantly by DMRT at 5% level.

Table 2: Effect of botanical and chemical treatments on infestation b y and protection against *Z. subfasciatus* and on germination of Kenaf seeds during 4 months of storage (February, 2001 to May, 2001.)

Treatments	Infested seeds (%) (by count)	Protected (healthy) seeds (%) (by weight)	Reduction of germination from original rate (%)
Soybean oil (T_1)	11.30de	86.85c	3.37a
	(19.63)	(68.77)	
Castor oil (T_2)	16.29b	81.40b	3.41a
	(23.78)	(64.48)	
Neem oil (T_3)	9.63e	91.36d	3.33a
	(18.06)	(72.98)	
Sesame oil (T_4)	14.37bc	84.34bc	3.64a
	(22.27)	(66.73)	
Jute oil (T_5)	11.92c-e	86.77c	3.39a
	(20.18)	(68.74)	
Safflower oil (T_6)	13.36bd	84.70bc	3.85a
	(21.43)	(66.98)	
Pithraj oil (T_7)	14.50bc	83.69bc	3.52a
	(22.36)	(66.20)	
Deltamethrin (T_8)	9.42e	90.47d	3.35a
	(17.86)	(72.31)	
Control	87.54a	12.08a	-
(Only shaking)	(69.43)	(20.30)	

Figures in parentheses are transformed (Arcsine) means of 3 replications.
Means followed by same letter(s) do not differ significantly by DMRT at 5 % level.

Yadav (1985). The quick knockdown effects of deltamethrin as reported in other case (Chen *et al.*, 1985) resulted in complete mortality of adults before they laid any eggs.

The initially toxicity of neem, soybean oil cause more than 90 percent adult mortality was conformity with the findings of other workers (Das, 1986; Khalique *et al.*, 1988). The number of eggs laid by the beetle on kenaf seeds was always high when lower doses of plant oil were used on Kenaf seeds (Table 1). Maximum protection using higher doses was very likely in the doses contained more active materials than lower dose. The present results on the reduction of oviposition, adult emergence was in agreement with the results reported by (Hall *et al.*, 1991; Kingsolver *et al.*, 1990; Hall *et al.*, 1990; Chinwada *et al.*, 1993).

Egg mortality as previously claimed (Ali *et al.*, 1983; Hall *et al.*, 1990; Chenwada *et al.*, 1993) was comparable with the present findings. The present toxicity of plant oils as observed here with the agreement the findings of Das, 1986. But the plant oils could not maintain it effectiveness with the passing of time.

The toxicities/efficacies of chemical and plant oils as observed in experiment 1 was well reflected in the 2nd experiment. The fore going discussion clearly suggested that the efficacies of Neem oil and Deltamethrin in protecting kenaf seeds against *Z. subfasciatus* during 4 months of storage should not be considered as the definite indication of their persistence over that period. This would be simply a mistake. Because the hidden infestation and emerged adults were killed within 2-months of treatment and there was no further entry of adults from out side to cause no infestations, the protection offered beyond 2 months was actually due to prevention of adult entry by the containers. However, the persistence to deltamethrin as observed here confirmed their reported efficacy (Nisa and Ahmad, 1970; Rahman and Yadav, 1985) to protect grains for 4 months when stored in containers accessible to the entry of adult bruchids.

The germination of Kenaf seeds with and without treatment of plant materials did not show adverse effect on viability of seeds (Hall *et al.*, 1991). There might be no residual toxic action of the plant oils on the viability of the seeds (Adgeh, 1989).

Acknowledgments

The author is grateful to Dr. Ai Min Lieu, (Ex) Agriculture officer IJO for showing keen interest in the work and help to identify the weevil. The author is also grateful to the authority of BJRI for providing necessary facilities for this study.

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