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PRE AND POST HARVEST SEED PESTS OF *PONGAMIA PINNATA* AND THEIR MANAGEMENT

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Abstract

Increased rate of tree planting is felt very much needful nowadays to reclaim waste lands and to arrest further ecological degradation besides to meet the needs of local communities by providing fuel wood and fodder for man and his cattle. Thus plantation forestry have grown phenomenally, accelerated by government departments and farmers as a commercial activity incorporating tree species of high commercial and industrial value. Fast growing native tree species *Pongamia pinnata* is extensively used in afforestation programme. This requires large quantities of good quality seeds. Seeds are liable to damage by insect pests and diseases even when they are maturing on the trees or under storage rendering them completely nonviable. Severe infestation by scale insect *Paracoccus marginatus* and *Ferrisia virgata* were observed during early fruit maturing stages. The affected fruits turn brown due to mass feeding by nymphs and adults. Fruits fall before maturing. High level incidence of gall midge *Asphondylae pongamiae* was observed during flowering period of *P. pinnata* particularly in Hosur, Krishnagiri area. 80-95% of flowers are attacked. Infested flower turn to gall and fruit development and seed setting is affected. During storage Saw toothed grain beetle *(Oryzaephilus surinamensis),* Cigarette beetle (*Lasioderma serricorne)* and *Red* flower beetle *(Tribolium castaneum*) infests seeds. Pteromalid *Anisopteromalus calandrae* was also collected from stored seeds.

Keywords: wild animals; road kill; vehicles; KMTR

Introduction

Demand for large scale development of plantations of economically important indigenous as well as fast growing exotic tree species through Trees outside Forests (ToF) programme has been progressively increasing in the recent past. State Forest Departments are on a mission to increase the forest and tree cover which is the main component of the State's Forest Policy. This is carried out through programmes like enhancing tree cover outside forests for livelihood security, rehabilitation and restoration of degraded forests, scheme of raising tree species on private farm lands besides increasing forest / tree cover inside forests and coastal area plantation. Thus, the plantation forestry have grown phenomenally through massive urban forestry projects, accelerated by government departments and farmers as a commercial activity incorporating tree species of high commercial and industrial value. Fast growing native tree species *Pongamia pinnata* is now extensively used in afforestation programme. This requires large quantities of good quality seeds. Seeds are liable to damage by insect pests and diseases even when they are maturing on the trees or under storage rendering them completely nonviable. National and regional priorities on certain tree species,

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suitable for afforestation programmes and the necessity to store their seeds for a period of time warrants investigation on seed pest problems and their management. Mathur *et al.,* (1958) documented the insect pests of flowers, seeds and fruits of forest trees. Butani (1978) documented the insect pests of *Tamarind* seeds during storage. Meshram *et al.,* (1986) listed the insect pests of forest tree seeds. Pillai *et al.,* (1989) made preliminary investigation on the nature and extent of infestation by Bruchids and also the impact on germination of *Acacia nilotica* seeds. Joseph and Oommen (1960) estimated post harvest loss due to stored pests to be approximately 10%. Methods have been suggested for the protection of forest seeds of few tree species against insect pests during storage (Singh and Bhandari, 1986, Sen serma *et al.,* 1988). The present study aims to identify the key pests problems associated with pre and post-harvest seeds of *Pongamia*.

Materials and Method

Area such as Pillur, Dimbam, Krishnagiri, Hosur, Pollachi, Mettur and Erode in Tamilnadu and Kulathupuzha, Kollam, Idukki, Perumbavoor and Palghat in Kerala where the tree species under study is prevalent was visited regularly during flowering, fruiting and seed setting periods. Samplings were done in the field for pest incidence. Pre and post-harvest insect pests were identified and categorized based on infestation. Field collected samples were brought to lab and stored. Parts like inflorescence or maturing fruits were maintained in glass troughs covered with fine mesh nets. Buds, flower or fruit feeding stages were maintained for observation on emergence of life stages, life cycle and damage assessment. Seeds are stored in Glass troughs of 500ml capacity covered with muslin cloth. Stock culture of key pests were maintained in the laboratory on respective seed host under standard conditions to study the life cycle events, behavior, biology, fecundity etc. Percentage infestation in flower buds (Inflorescence), immature fruits was assessed by random sampling for insect population of sap feeders and bud feeders or borers. Infestation level is categorized as per the classes mentioned below:

Up to 25%	Low
25% – 65%	Medium
Above 60%	High

Field collected fruits/seeds were segregated into 10-15 samples of 250gm. Seeds or fruits were visually observed for holes or feeding injury. Number of such damaged seeds/fruits in each lot is assessed and percent infestation level was calculated by the formula.

$$\text{\% infestation level } \frac{\text{No of damaged seeds}}{\text{Total No of Seeds}} \text{x 100}$$

Freshly emerged 10 male and 10 female insects were introduced in to 250gm of un-infected healthy seeds and left undisturbed. Dead insects were removed as and when noticed at the base of the glass trough. The seeds were kept till fresh adults emerged. Emerging adults were removed to avoid re-infestation in the seeds. Weight of the seeds was taken after all adults emerged. 6 replicates were maintained along with control where insects were not introduced. Difference in weight between the control and treated (infested) is taken as the intensity of damage by a species on seeds during storage.

Lab experiments were arranged to identify treatments for safe storage of seed. Since *Bruchus* sp. was found to cause major damage management measures were attempted for this species alone. 500 grams of fresh seeds were treated with various chemicals like plant based extracts, synthetic pesticides. Plant based extracts were prepared through standard procedures and compared with locally available selected, safe commercial pesticides. Seeds were immersed for two minutes in the treatment solution. Surfactant teepol was also added for uniform spreading. Seeds were allowed to dry for some time and taken in glass jars (5”x7”). Synthetic pesticides like monocrotophos, dichlorvos, were used as insecticides. 20 numbers of adult insects were introduced in to the treated seeds and mortality of insects were assessed every 24hrs till 100% of insects were dead. Treated seeds were again introduced with insects 30, 60 and 90 days after treatments for assessing the duration of effectiveness or persistency of treatments.

In order to study the protective effectiveness of treated seed storing materials, small jute bags that could hold 500 gm. of seeds were prepared. These bags were soaked in desired concentrations of pesticides and then well dried. The dried impregnated bags will be filled insect free, untreated seeds and the mouth of the bags tied. Each bag was placed in glass jars separately and required number of insects released into the jar. Mortality counts recorded periodically. Treated bags were again introduced with insects 30, 60 and 90 days after treatments for assessing the duration of effectiveness or persistency of treatments.

Treatments selected for seed pest management includes Tobacco extract (5 to 20%), Neem oil emulsion (2 to 15%) Neem Seed Kernel Extract (5%) Commercial Neem formulation (Nimbecidine). Pesticides like Dichlorvos (0.06%) and Monocrotophos (0.05%) were also compared.

Data obtained were analyzed for effect of treatments at various concentrations by ANOVA and the means grouped by Duncan’s multiple-range test. SPSS 20 software was used for analysis.

Results

Insect pests during flowering and fruiting period are given in **Table 1**. High level incidence of gall midge *Asphondylae pongamiae* was observed during flowering period of *P. pinnata*. 80-95% of flowers were attacked. Infested flower turn to gall and fruit development and seed setting is affected. Severe infestation by scale insect *Paracocus marginatus* and *Ferrisia virgata* were observed during early

Table 1: Insect pests during pre and post-harvest period of *P. pinnata*.

Tree Species	Period							
	PRE HARVEST				POST HARVEST			
	FLOWERING	Pest Category	FRUITING	Pest Category	CARRIED OVER	Pest Category	STORAGE	Pest Category
Pongamia pinnata	*Asphondylae pongamiae*	Regular	*Ferisia virgata*	Sporadic	*Bruchus* sp.	Persistant	*Bruchus* sp.; *Oryzaephilus surinamensis; Lasiderm serricorne; Tribolium castaneum*	Persistant

fruit maturing stages in *P. pinnata.* The affected fruits turn brown due to mass feeding by nymphs and adults. Fruits fall before maturing. During storage – *Oryzaephilus surinamensis (*Saw toothed grain beetle), *Lasioderma serricorne* (Cigarette beetle), *Tribolium castaneum* (Red flower beetle) and *Corcyra cephalonica* were found to infest. *A. pongamiae* infestation on *P. pinnata* was very high during March April (70-90%) which remained more or less at the same level during May which is the fag end of flowering in Pongamia (**Fig. 1**). Low level of Scale insect infestation started on *P. pinnata* during April increased to medium level during May and declined as the fruits matured during June **(Fig. 2).**

Feeding damage by various species varied on seeds during storage. In case of *P. pinnata,* almost 136 and 119 gm. of seed weight is lost during storage due to *Bruchus* sp beetle and *T. castaneum* infestation respectively. No significant difference was observed between infestation by *O. surinamensis* and *L. serricorne.* **(Table 2).** In case of *P. pinnata* damage by *Bruchus* sp. was more compared to *L. serricorne* and *O. surinamensis.* The lepidopteran species damage was much less than the coleopteran species.

Comparison of percent mortality due to seed treatment with plant based chemicals showed that 15% Neem oil resulted in 100% mortality

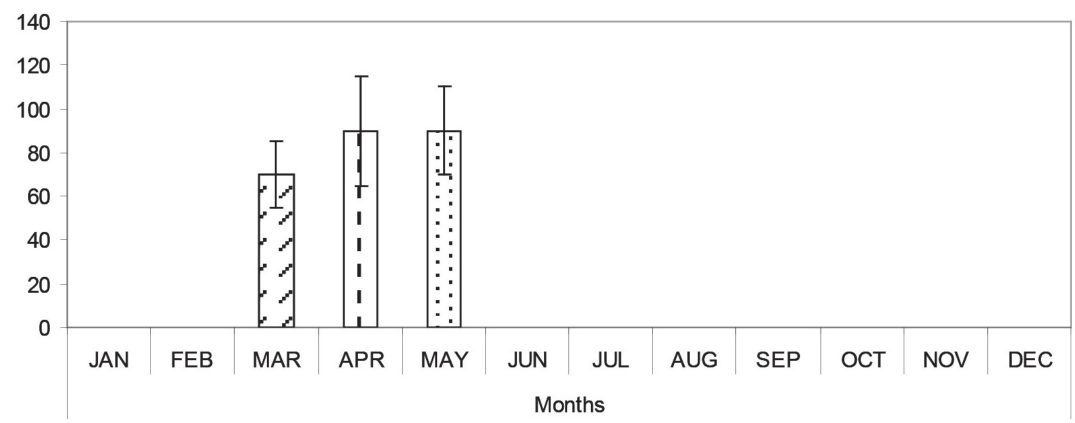

Fig. 1: Percent infestation by *A pongamia* on *P. pinnata* flowers

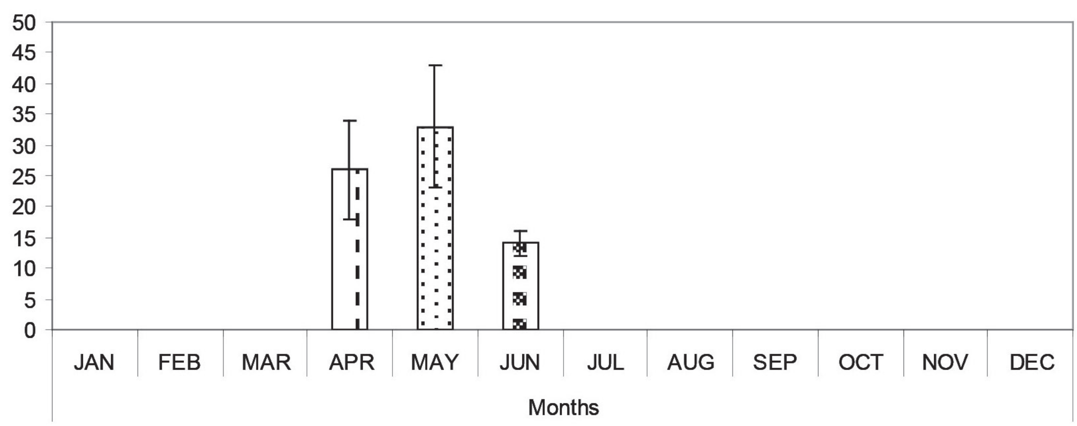

Fig. 2: Percent infestation by *scale insects on P. pinnata* flowers

Table 2: Damage Assessment

Species	Treatment	Mean	SD	SE
Pongamia pinnata	*Bruchus* sp.	136.42a	15.08	3.15
	L. serricorne	86.75b	6.24	3.15
	O. surinamensis	85.25b	14.03	3.15
	T. castaneum	119.92a	5.63	3.15
	Control	3.42c	3.37	3.15

of *Bruchus* sp. during the first 24 hrs. followed by 0.09% Nimbecidine. 80% dry Neem seed powder resulted in 100% mortality by 48h. 20% tobacco extract could result 90% mortality by 72 h. 100% mortality was observed during 72hrs on treatment with NSKE. Pesticides like Dichlorvos (0.06%) and Monocrotophos (0.05%) showed 100% mortality within 24hrs (**Table 3).**

Studies on the persistency of the chemicals showed that 0.09% Nimbecidine and 80g/kg Neem powder treated seeds resulted in 50% mortality of *Bruchus* sp. 30days after treatment. The effect was much less 60 days after treatment. Pesticide treated seeds were able to cause 90-100% mortality 30days after treatment. 60 DAT the mortality rate has been reduced to 48-56%. All other treatments did not result in significant mortality of insects after the time gap of 30, 60 and 90 days after treatment **(Table 4).**

0.09% Nimbecidine treated gunny bags were effective in protecting seeds from *Bruchus* sp beetle attack and also causing 100% mortality of adult beetles within 72 hours. Monocrotophos and Dichlorvos treated receptacles were efficient in bringing 100% mortality of adult beetles (**Table 5**). 60% mortality was observed in *Bruchus* sp with gunny bags treated with Dichlorvos (0.06%) 30 DAT. Monocrotophose (0.05%) treated gunny bags showed a maximum of 64% mortality 30 DAT. No other plant based extracts treated receptacles showed persistency of chemicals treated that can result in significant mortality 30 to 90 DAT **(Table 6).**

Discussion

P. pinnata is fast growing native tree species which are being planted extensively under various plantation programmes. This requires raising of large quantities of seedlings in nurseries. Insect damage to flower, fruit and seeds causes partial or complete seed crop loss. This results in inefficient and un-economical seed collection. Uninfected seeds collected from field or stored can only help in raising quality seedlings. Therefore, the present study was undertaken to identify the spectrum of insect pests during pre and post-harvest period, extent of damage and feasible management measures to control insect attack during storage of *Pongamia pinnata*.

Lamprey *et. al*. (1974) showed that even minor damages to the vital part of the embryo like the radicle or hypocotyl can result in the death of the seeds. In the present study infestation by *Bruchus* sp., *O. surinamensis, L. serricorne and T. castenum* infestation in pongamia result in complete death of seeds and can render seeds nonviable. Similarly *A. pongamiae* infestation during pre-harvest in *P. pinnata* result total loss of fruit development.

Table 3: Treatment with plant based Extracts – *Bruchus* sp.

Treatment	Conc	Day 1			Day 2			Day 3		
		Mean	SD	SE	Mean	SD	SE	Mean	SD	SE
Control	–	2	4.5	4.51	4	5.5	4.92	2	4.5	3.63
Dichlorvos (0.06%)	–	92	8.4	4.51	100	0.0	4.92	100	0.0	3.63
Monocrotophos (0.05%)	–	96	5.5	4.51	100	0.0	4.92	100	0.0	3.63
NSKE (80 %)	–	40	7.1	4.51	72	13.0	4.92	92	4.5	3.63
Neem oil	0.02	38	4.5	4.51	94	5.5	4.92	100	0.0	3.63
	0.05	46	5.5	4.51	96	5.5	4.92	100	0.0	3.63
	0.1	54	5.5	4.51	98	4.5	4.92	100	0.0	3.63
	0.15	94	8.9	4.51	94	8.9	4.92	100	0.0	3.63
Neem seed powder	20000 ppm	22	16.4	4.51	70	14.1	4.92	100	0.0	3.63
	40000 ppm	34	8.9	4.51	62	8.4	4.92	100	0.0	3.63
	60000 ppm	44	5.5	4.51	74	8.9	4.92	100	0.0	3.63
	80000 ppm	74	8.9	4.51	100	0.0	4.92	100	0.0	3.63
Nimbecidine	3 ppm	4	5.5	4.51	52	8.4	4.92	74	8.9	3.63
	6 ppm	10	10.0	4.51	52	14.8	4.92	56	13.4	3.63
	9 ppm	56	8.9	4.51	92	11.0	4.92	92	11.0	3.63
Tobacco extract	0.05	2	4.5	4.51	2	4.5	4.92	12	16.4	3.63
	0.1	4	8.9	4.51	16	15.2	4.92	14	21.9	3.63
	0.15	14	16.7	4.51	20	21.2	4.92	56	5.5	3.63
	0.2	40	23.5	4.51	54	21.9	4.92	90	7.1	3.63

Damage to the flower or fruit depends in the percentage infestation by various insects during pre-harvest period. The level of infestation comes down as the flowering period ends and fruiting period taken over. The infestation in maturing fruits by sap feeding insects comes down as the fruits mature. Wali Rehman (1995) found that 86% of seed infesting insects belonged to the order Coleoptera and others were Lepidoptera and Hymenoptera. In the present study coleopterans were found to be the major groups of pests during storage.

But seed feeding insects infests matured fruits and gets carried over to storage. In the case of *P. pinnata* all the four species of beetles were able to re-infest seeds during storage and cause severe damage in terms of seeds weight loss. Wagner *et al* (1991) has pointed out that infestation rate in good seed years following poor seed years is often low because

Table 4: Persistency of seed treatments – *Bruchus* sp.

Treatment	Conc	30 DAT			60 DAT			90 DAT		
		Mean	SD	SE	Mean	SD	SE	Mean	SD	SE
Control	–	0.0	0.0	4.9	4.0	5.5	4.9	10.0	10.0	1.6
Dichlorvos (0.06%)	–	98.0	4.5	4.9	56.0	23.0	4.9	45.0	10.0	1.6
Monocrotophos (0.05%)	–	92.0	4.5	4.9	48.0	25.9	4.9	44.0	5.5	1.6
NSKE (80%)	–	0.0	0.0	4.9	0.0	0.0	4.9	0.0	0.0	1.6
Neem oil	0.02	0.0	0.0	4.9	0.0	0.0	4.9	0.0	0.0	1.6
	0.05	20.0	7.1	4.9	2.0	4.5	4.9	0.0	0.0	1.6
	0.1	22.0	8.4	4.9	6.0	8.9	4.9	0.0	0.0	1.6
	0.15	0.0	0.0	4.9	0.0	0.0	4.9	0.0	0.0	1.6
Neem seed powder	20000 ppm	0.0	0.0	4.9	2.0	4.5	4.9	0.0	0.0	1.6
	40000 ppm	20.0	7.1	4.9	4.0	8.9	4.9	0.0	0.0	1.6
	60000 ppm	46.0	27.0	4.9	6.0	8.9	4.9	0.0	0.0	1.6
	80000 ppm	0.0	0.0	4.9	0.0	0.0	4.9	0.0	0.0	1.6
Nimbecidine	3ppm	0.0	0.0	4.9	0.0	0.0	4.9	0.0	0.0	1.6
	6 ppm	50.0	14.1	4.9	44.0	25.1	4.9	0.0	0.0	1.6
	9 ppm	20.0	27.4	4.9	4.0	5.5	4.9	0.0	0.0	1.6
Tobacco extract	0.05	10.0	7.1	4.9	0.0	0.0	4.9	0.0	0.0	1.6
	0.1	8.0	8.4	4.9	2.0	4.5	4.9	0.0	0.0	1.6
	0.15	12.0	8.4	4.9	2.0	4.5	4.9	0.0	0.0	1.6
	0.2	18.0	13.0	4.9	8.0	8.4	4.9	0.0	0.0	1.6

the insect population is low and infestation rates after good seed years are high due to increased multiplication of insect population during good seed years. In tree species with long fruiting periods, insect populations may build up through season (Wagner *et al* 1991). *Caryedon gonagra* attack both young seeds on the plant as well as stored seeds (Singh and Bhandari 1988) with low field infestation on *Acacia nilotica* and high infestation during storage. El atta (1993) demonstrated speed of seeds destruction in relation to the multiplication rate and life cycle events of *Caryedon serratus.*

Insect species with short life cycle are able to damage seed with in short time under optimal conditions. *Menechamus* sp. with a life cycle of 4 weeks completely destroyed a seed lot in three months (Wagner *et al*., 1991). In the present study *Bruchus* sp. and *T. castaneum* were able to result in significant damage of pongamia seeds in storage. This could be due to the reduction in moisture content of seeds during storage and or the emerged larvae may be unable to penetrate the seed coat of mature dry seeds (Wagner *et al.,* 1991). Though the activities of some insects may not

Table 5: Receptacle Treatment with plant based Extracts – *Bruchus* sp.

Treatment	Conc	Day 1			Day 2			Day 3		
		Mean	SD	SE	Mean	SD	SE	Mean	SD	SE
Control	–	2.00	4.47	3.80	4.00	5.48	4.23	2.00	4.47	3.33
Dichlorvos (0.06%)	–	94.00	5.48	3.80	100.00	0.00	4.23	100.00	0.00	3.33
Monocrotophos (0.05%)	–	96.00	5.48	3.80	100.00	0.00	4.23	100.00	0.00	3.33
NSKE (80%)	–	0.00	0.00	3.80	0.00	0.00	4.23	0.00	0.00	3.33
Neem oil	0.02	0.00	0.00	3.80	0.00	0.00	4.23	0.00	0.00	3.33
	0.05	14.00	13.42	3.80	14.00	13.42	4.23	26.00	5.48	3.33
	0.1	16.00	15.17	3.80	14.00	19.49	4.23	32.00	10.95	3.33
	0.15	0.00	0.00	3.80	0.00	0.00	4.23	0.00	0.00	3.33
Neem seed powder	20000 ppm	0.00	0.00	3.80	0.00	0.00	4.23	0.00	0.00	3.33
	40000 ppm	0.00	0.00	3.80	0.00	0.00	4.23	0.00	0.00	3.33
	60000 ppm	0.00	0.00	3.80	0.00	0.00	4.23	0.00	0.00	3.33
	80000 ppm	0.00	0.00	3.80	0.00	0.00	4.23	0.00	0.00	3.33
Nimbecidine	3ppm	14.00	13.42	3.80	14.00	13.42	4.23	26.00	5.48	3.33
	6 ppm	52.00	8.37	3.80	76.00	8.94	4.23	94.00	8.94	3.33
	9 ppm	30.00	10.00	3.80	62.00	13.04	4.23	74.00	8.94	3.33
Tobacco extract	0.05	2.00	4.47	3.80	2.00	4.47	4.23	12.00	16.43	3.33
	0.1	0.00	0.00	3.80	8.00	8.37	4.23	4.00	8.94	3.33
	0.15	14.00	16.73	3.80	20.00	21.21	4.23	38.00	16.43	3.33
	0.2	24.00	15.17	3.80	24.00	11.40	4.23	32.00	8.37	3.33

be stopped altogether at a given storage conditions any reduction of temperature and moisture content below the physiologically optimal will delay their development. Storage conditions like light, dark and dampness also influence like reproductive success (Singh and Bhandari, 1988).

Infestation during flowering and fruiting in the field is difficult to control. Application of chemical pesticides is practically not possible and will be too expensive for trees. Determining the management measures which are to be undertaken based on the assessment of the level of infestation and the type of treatment which should be taken depends on the pest species and the extent of damage. In the present study infestation by *A. pongamiae* in *P. pinnata* flower buds is the only serious infestation where in almost 100% of flower buds are transformed into galls. Covering flowering or fruit bearing branches with nets is applicable only in limited extent particularly in seed orchards and will be labour intensive in large areas. Control by spraying with endosulphan, fenitrothion and monocrotophos on branches

Table 6: Persistency of receptacle treatments – *Bruchus* sp.

Treatment	Conc	30 DAT			60 DAT			90 DAT		
		Mean	SD	SE	Mean	SD	SE	Mean	SD	SE
Control	–	2.00	4.47	3.15	4.00	5.48	2.22	0.00	0.00	1.65
Dichlorvos (0.06%)	–	60.00	15.81	3.15	60.00	12.25	2.22	36.00	11.40	1.65
Monocrotophos (0.05%)	–	64.00	8.94	3.15	42.00	8.37	2.22	14.00	11.40	1.65
NSKE (80 %)	–	0.00	0.00	3.15	0.00	0.00	2.22	0.00	0.00	1.65
Neem oil	0.02	0.00	0.00	3.15	0.00	0.00	2.22	0.00	0.00	1.65
	0.05	2.00	4.47	3.15	2.00	4.47	2.22	0.00	0.00	1.65
	0.1	8.00	8.37	3.15	0.00	0.00	2.22	0.00	0.00	1.65
	0.15	0.00	0.00	3.15	0.00	0.00	2.22	0.00	0.00	1.65
Neem seed powder	20000 ppm	0.00	0.00	3.15	2.00	4.47	2.22	0.00	0.00	1.65
	40000 ppm	0.00	0.00	3.15	0.00	0.00	2.22	0.00	0.00	1.65
	60000 ppm	0.00	0.00	3.15	0.00	0.00	2.22	0.00	0.00	1.65
	80000 ppm	0.00	0.00	3.15	0.00	0.00	2.22	0.00	0.00	1.65
Nimbecidine	3ppm	2.00	4.47	3.15	0.00	0.00	2.22	0.00	0.00	1.65
	6 ppm	22.00	14.83	3.15	10.00	12.25	2.22	0.00	0.00	1.65
	9 ppm	6.00	8.94	3.15	0.00	0.00	2.22	0.00	0.00	1.65
Tobacco extract	0.05	0.00	0.00	3.15	0.00	0.00	2.22	0.00	0.00	1.65
	0.1	2.00	4.47	3.15	0.00	0.00	2.22	0.00	0.00	1.65
	0.15	4.00	5.48	3.15	0.00	0.00	2.22	0.00	0.00	1.65
	0.2	14.00	11.40	3.15	4.00	5.48	2.22	0.00	0.00	1.65

with fruits had controlled field infestation (Singh and Bhandari 1987). Southgate (1983) attempted physical shielding of individual fruit bearing branches with nets in *Acacia* spp and found that it is labour intensive and applicable in small scale. Field infestation has been managed by spraying individual flower/fruit bearing branches with 0.25% endosulfan or fentrothion or 0.05% monocrotophos or dichlorvos (Singh and Bhadari, 1987). But the limitation here is the limited accessible branches (Singh, 1976). Moreover treated fruits or foliage cannot be used as fodder or medicine (El Atta, 1993). Such treatments can also affect pollinators and natural enemies visiting flowers for feeding honey (Johnson, 1983). Fruits of *S. emarginatus* are used for medicine and other preparation. Therefore pesticide application in trees cannot be made.

Reduction or total elimination of insect infestation during pre-harvest period is important when the pest species are able to continue infestation in seeds under storage also. Therefore, insects and infested seeds should be eliminated during processing and seeds should be insect-free before storage. Therefore detection and elimination of insects after field collection is important to decide if control measures are to be initiated before storing. Before storing seeds, it is important to detect pest infestation for taking up control measures that will prevent losses. Less time and effort is required for deployment and can provide evidence of infestation which could multiply during storage. Use of traps for the detection of pests in seed lots is necessary in such situations. Traps cause less damage to the seeds and will provide the first evidence of an infestation that may be carried over from field to storage. It helps to provide prophylactic treatments prior to storing (Dick, 1987).

Elimination of insect infested seeds during seed cleaning is the first step in management of insects decaying storage. This will help to avoid multiplication and further damage of storage seeds. However in situation where total elimination of pests during processing is difficult and chances of fresh infestation during storage are expected chemical treatment of seeds or the storage receptacle is necessary. Based on the seed type, infestation type and quantity of seeds to be protected methods of seeds or receptacle treatment need to be decided. Efficacy, minimum risk to user and environmental safety need to be considered when chemicals are selected for treatment. In the present study plant based extracts like products like NSKE, Neem oil, Neem seed powder, tobacco extract and a commercial Neem based product Nimbecidine were used to test the efficacy in protecting seeds during storage. NSKE was not very effective in providing protection of seeds during storage. Many of the extracts and the commercial Neem based formulation were effective at higher concentrations in bringing about significant mortality though not within 24 hrs. when treated with seeds. Pesticides were effective resulting is 100% mortality within 24 hrs. Singh and Bhandari (1988) demonstrated the effect of mixing phorate or pyrethrin with seeds. Light dusting of insecticides like Malathion, pyrethrin or hexachloride was recommended for long term storage by Cremer (1990).

Apart from being environmentally safe, plant based formulation are safe to human beings and cheap compared to commercial insecticide (Golob and Webley, 1980). Traditionally used plant protectants release a strong odor which is usually avoided by insects. In this present study, significant mortality observed when treated with plant based extracts could be due to the fumigating effect of such chemicals. Neem products do not usually kill insects but delay or inhibit their development. (Soon and Bottrell, 1994). Jute sacks treated with Neem oil or Neem extract prevented the entry of weevils in to the grain (NRC 1992) which suggests repellent action.

Conclusion

In the present study serious infestation during pre and post-harvest was recorded in *P. pinnata. A. pongamiae* converts almost all flower buds to galls during flowering in *P. pinnata. F. virgata* scales infests maturing fruits. *Bruchus* sp. *O. surinamensis*, *L. serricorne* and *T. castaneum* severely damage *P. pinnata* seeds during storage. All coleopteran species were found to reinfest seeds during storage. Feeding damage by various species varied on seeds during storage. In case of *P. pinnata* damage by *Bruchus* sp. was more compared to *L. serricorne* and *O. surinamensis.* The lepidoptean species damage was much less than the coleopteran species.

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