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Management of Pulse beetle, *Callosobruchus chinensis* Linn. using botanicals

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Abstract
Under storage condition the botanicals like neem kernel powder (*Azadirachta indica*), and pongam oil (*Pongamia glabra*) were most effective and adhatoda leaf powder (*Adhatoda vasica*) was less effective against pulse beetle, *Callosobruchus chinensis* Linn. (Bruchidae; Coleoptera). The germinability of black gram seeds treated with tested botanicals and oils was comparatively less in adhatoda leaf powder and notchi leaf powder treatments when compared other with botanicals and oils tested. The germination percentage was high in neem kernel powder among the treatments. However a decreasing trend in the germination percentage was observed both in the botanicals and oils treated and untreated seeds.

Keywords: Pulse beetle, *Callosobruchus*, Bruchides, Botanical management.

1. Introduction
Pulses are the ancient food crops with evidence of their cultivation for over 8000 years. They are biologically rich source of protein and essential minerals and complement well with cereal based diet because of high amount of lysine. Indian Council of Medical Research has recommended an average daily consumption of 40 grams of pulses. Hence there is an urgent need for increasing the pulses production to meet the growing demand for consumption. The pulse beetle *Callosobruchus chinensis* is reported to be the major pest infesting all types of pulses both in the field and in storage. The differential rate of damage infected by *C. chinensis* in different pulses was reported to be 68, 56, 49 and 52 per cent in cowpea, bengal gram, red gram and green gram respectively over a storage period of 6 months [5]. The grain damage was as high as 69.93% under storage condition [6]. This pest is a serious problem at small farmers' level, village traders and average households where storage conditions are poor and inadequate. To control the pulse beetle in storage, a number of synthetic organic insecticides such as malathion and dichlorvos have been recommended. The admixture synthetic insecticide with food grains has more recently been banned in many countries. There are also reports that the pulse beetle is developing resistance to malathion [7]. In contrast, plant products traditionally used against pulse beetle appear to be quite safe and promising. Several authors have reported the insecticidal action and growth inhibiting effects of plant products on *C. maculatus* [3]. Botanicals and vegetable oils can be used to keep the stored pulse free from pulse beetle attack. Therefore, studies were undertaken to manage pulse beetle with plant products and to find the viability of the plant product treated seeds.

2. Material and methods
The present study was conducted in the Entomology laboratory of Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal, U.T of Pondicherry from May 2005 to February 2006.

2.1 Mass culturing of pulse beetle
Pulse beetles required for the study were mass reared on green gram (local variety) in the laboratory. The moisture content of the grains was adjusted to 11.0 per cent by sun drying to have uniform moisture content. The mass culturing was initiated by confining 10-20 freshly emerged beetles in the plastic containers of 59 x 21 x 18 cm having 500 g of green gram which were then covered with kada cloth and secured tightly with rubber band. Such containers were stacked in iron shelves. Mass culturing of *C. chinensis* was done at room temperature in the plastic container and observed daily. Adult beetles were collected for the study.

a) Botanical treatments

Coconut oil, pongam oil, illuppai oil, castor oil, vasambu rhizome powder, neem kernel powder, notchi leaf powder, adhatoda leaf power, activated clay and control which have insecticidal and ovicidal value were identified for this study. The plant materials collected were shade dried and made into powder in a grinder. The concentration of botanicals powder in all the cases was uniform .and maintained at 5 g/Kg seed. The vegetable oils and activated clay were collected from the local market. The concentration of vegetable oils in all the cases was uniform and maintained at 5 ml/Kg. But in case of activated clay the dosage was 10 g/Kg. The seeds of black gram variety were sun dried to the moisture content of 9 per cent. Healthy seeds were separated and selected for the experimental purpose. The details of treatments along with dosage are furnished in table 1.

Table 1: Treatment details of the study

Treatment	Common name	Scientific name	Dose/kg
T_1	Coconut oil	*Cocos nucifera*	5 ml
T_2	Pongam oil	*Pongamia glabra*	5 ml
T_3	Illuppai oil	*Madhuca indica*	5 ml
T_4	Castor oil	*Ricinus communis*	5 ml
T_5	Vasambu rhizome powder	*Acorus calamus*	5 g
T_6	Neem kernel powder	*Azadirachta indica*	5 g
T_7	Notchi leaf powder	*Vitex negundo*	5 g
T_8	Adhatoda leaf powder	*Adhatoda vasica*	5 g
T_9	Activated clay	-	10 g
T_{10}	Control	-	-

2.2 Efficacy of botanicals and oils

The botanicals and oils were thoroughly mixed with healthy black gram seeds and placed in plastic containers of 59 x 21 x 18 cm size, which were covered with plastic cover lid and used for further experiments. For each treatment 100 g of seeds were drawn. Each 100 g seeds was placed into small size plastic containers and covered with kada cloth, secured with rubber band and kept stacked in iron shelves. Each treatment was replicated thrice. Ten pairs of newly emerged adults were released in each replication. The same procedure was adopted for all the treatments. After the 30th day the percentage of bore holes was counted. This experiment was continued upto 10 months. The interval between each observation was 30 days.

2.3 Germination test

The germination test was conducted with 100 seeds from each treatment in four replications following rolled paper towel method as prescribed by ISTA. The test was conducted at room temperature and a germination period of 7 days was adopted throughout the study. The normal seedlings were counted and expressed as germination percentage. The germination was recorded at monthly interval upto 10 months. The design followed for all the experiments was Complete Randomized Design and statistical analyses were carried out by IRRISTAT. Number and percentage values were converted into arcsine transformation.

3. Results and Discussions

3.1 Efficacy of botanicals and oils against pulse beetle

The efficacy of the botanicals and oils was expressed by the number of seeds present with bore holes (Table 2). Since the botanicals and oils were directly mixed with the seeds the adult pulse beetle came in direct contact with the botanicals and oils. Among all the botanicals and oils, the neem kernel powder was highly effective and the bore holes present in the pulses seeds were gradually increased every month. Maximum bore holes of 32.66 per cent was observed in adhatoda leaf powder treatment and an increasing trend in bore hole per cent was recorded invariably in all treatments (Table 2). The percentage of reduction of bore holes over control one month after treatment ranged between 99.51and 98.15. Neem kernel powder was with highest reduction over control (99.51%) and adhatoda leaf powder was with lowest reduction over control (98.15%) among the botanicals and oils tested. An increasing trend of infestation was recorded due to reduction in efficacy of botanicals and oils and that could be observed over a period of ten months. However, the treatments were superior to control, which could be evinced from the population reduction of beetle in treated pulse seeds.

Though the results obtained have shown that the pulse grain could be protected from *C. chinensis* by treating the seeds with botanicals and oils but their efficacy was slowly reduced as indicated by the increase in the per cent bore hole. This observation was in consonance with earlier findings [1, 4, 9, 13]. That the efficacy was extended for a short period only. The reason for the reduction in the population of the pulse beetle could be due to oviposition deterrent activity present in the different oils and botanicals. Previous works [1, 10, 12, 13] support the present findings that the active compound present in the botanicals and oils offer ovicidal and repellent activity which protect the pulse seeds treated with different botanicals and oils.

3.2 Viability of seeds in botanicals and oils treated black gram seeds

In the present study germination percentage one month after treatment in untreated seeds was 80.0 per cent whereas, the germination percentage was ranged between 81and 90 per cent in the treated seeds (Table 3). The germination percentage was gradually reduced over the period of 10 months *i.e.,* May 2005 to February 2006. However the germination percentage was on par with untreated check in all the treatments except neem kernel powder, vasambu rhizome powder, activated clay and pongam oil which indicates that these treatments did not affect germination to a large extent (Table 3).

The present findings are in accordance with the reports of (12) who reported that the tested grain protectant activity of six plant extracts,

did not impair the germination in any of the treated seeds. Our findings are also in agreement with the reports of (2) who reported that the initial germination of black gram was 96 per cent, while it declined to 89.66 per cent in control at 30 DAT and was found on par with lakke leaf powder (89%) and castor oil (90%), malathion dust (93%) with significantly higher germination in sweet flag rhizome powder (93%) followed by neem seed kernel powder (91.33%).This indicated that the germination percentage was found to be reduced when treated with botanicals and oils, even after 30 DAT.

4. Conclusion

Among all the botanical treatments, neem kernel powder @5 g/kg seed can be recommended for the management of the pulse beetle in store house.

5. Acknowledgements

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Table 2: Efficacy of botanicals and oils against pulse beetle, *Callosobruchus chinensis*

S. No	Treatments	Per cent bore hole										mean
		1st Month	2nd Month	3rd Month	4th Month	5th Month	6th Month	7th Month	8th Month	9th Month	10th Month	
T1	Coconut Oil	1.00 (5.72)a	2.29 (8.70)de	10.28 (18.70)e	10.18 (18.61)ef	15.85 (23.46)de	20.69 (27.05)g	22.36 (28.22)ef	21.93 (27.92)f	24.84 (29.90)e	30.05 (33.24)de	15.94
T2	Pongam Oil	0.58 (4.36)a	1.28 (6.47)abc	4.97 (12.88)bc	6.77 (15.08)bc	9.93 (18.37)abc	12.62 (20.81)c	15.37 (23.08)b	17.10 (24.43)b	18.32 (25.34)bc	24.74 (29.83)b	11.16
T3	Illuppai oil	0.73 (4.90)a	1.80 (7.70)bcd	7.04 (15.38)d	8.25 (16.69)cd	13.56 (21.60)b-e	16.16 (23.70)e	18.41 (25.40)d	19.30 (26.06)d	21.30 (27.48)d	27.37 (31.54)c	13.39
T4	Castor oil	0.89 (5.41)a	1.96 (8.04)cde	9.20 (17.65)e	9.24 (17.69)de	15.01 (22.79)cde	18.93 (25.79)f	21.32 (27.49)e	20.90 (27.20)e	22.70 (28.45)d	28.26 (32.11)cd	14.84
T5	Vasambu powder	0.62 (4.53)a	1.40 (6.78)a-d	6.10 (14.30)cd	7.34 (15.72)bc	11.24 (19.58)ad	15.13 (22.89)d	17.04 (24.38)c	18.26 (25.30)c	19.25 (26.02)c	26.86 (31.22)c	12.32
T6	Neem Kernel Powder	0.45 (3.83)a	0.85 (5.29)a	3.29 (10.45)a	5.13 (13.09)a	7.61 (16.01)a	9.92 (18.35)a	11.45 (19.78)a	14.34 (22.25)a	16.17 (23.71)a	17.14 (24.46)a	8.63
T7	Notchi leaf powder	1.05 (5.87)a	2.96 (9.89)ef	12.30 (20.53)f	11.33 (19.67)f	16.69 (24.11)de	21.22 (27.43)g	23.29 (28.85)f	22.44 (28.27)f	27.34 (31.52)f	31.26 (33.99)ef	16.98
T8	Adathoda leaf powder	1.70 (7.40)a	3.62 (10.97)f	14.34 (22.25)g	15.17 (22.92)g	18.45 (25.44)e	22.56 (28.35)	25.58 (30.38)g	26.76 (31.15)g	27.65 (31.72)f	32.66 (34.85)f	18.84
T9	Activated clay	0.50 (4.07)a	1.05 (5.87)ab	4.24 (11.88)ab	5.94 (14.11)ab	8.37 (17.18)ab	11.09 (19.45)b	14.70 (22.55)b	15.16 (22.91)a	17.12 (24.44)ab	18.69 (25.61)a	9.68
T10	Control	92.30 (74.79)b	80.90 (64.18)g	81.72 (64.75)h	95.73 (78.36)h	84.80 (67.81)f	96.16 (78.71)i	95.54 (77.89)h	95.57 (77.88)h	97.29 (80.73)g	98.44 (83.06)g	91.84
Over all mean		9.98 (3.85)**	9.81 (1.88)**	15.34 (1.47)**	17.50 (1.79)**	20.15 (4.39)**	24.44 (0.49)**	26.50 (0.99)**	27.17 (0.70)**	29.19 (1.33)**	33.54 (1.25)**	
CD(p =0.05)												

Treatments CD value at 0.05 per cent level: 0.65.

Months CD value at 0.05 per cent level: 0.65.

Treatments and Months interaction CD value at 0.05 per cent level: 2.07

Figures in the parenthesis are arc sine transformed values

Mean in a column followed by same letter are significantly not different

**Significant at 0.05 per cent level

Table 3: Viability of black gram seeds treated with botanicals and oils

T. No.	Germination per cent											mean
	Treatments	1st Month	2nd Month	3rd Month	4th Month	5th Month	6th Month	7th Month	8th Month	9th Month	10th Month	
T_1	Coconut Oil	83.00 (65.75)abc	82.00 (64.92)bc	81.00 (64.18)ab	79.00 (62.74)ab	79.00 (62.74)ab	78.00 (62.05)ab	78.00 (62.05)abc	76.00 (60.70)abc	75.00 (60.01)abc	75.00 (60.01)abc	78.60
T_2	Pongam Oil	87.00 (68.90)cd	87.00 (68.90)de	85.00 (64.18)cd	83.00 (65.67)cd	82.00 (64.92)b	81.00 (64.18)b	81.00 (64.18)cd	79.00 (62.74)cd	78.00 (62.05)cd	77.00 (60.01)bc	82.00
T_3	Illuppai oil	86.00 (68.07)bcd	85.00 (67.33)cd	84.00 (66.50)bcd	82.00 (64.92)bc	82.00 (64.92)b	79.00 (62.74)ab	78.00 (62.05)abc	78.00 (62.05)bcd	77.00 (61.35)bcd	75.00 (60.01)abc	80.60
T_4	Castor oil	84.00 (66.50)abc	82.00 (64.92)bc	81.00 (64.18)ab	81.00 (64.18)bc	79.00 (62.74)ab	78.00 (62.05)ab	77.00 (61.35)ab	77.00 (61.35)abc	75.00 (60.01)abc	74.00 (59.35)ab	78.80
T_5	Vasambu powder	86.00 (68.07)bcd	85.00 (67.24)cd	83.00 (65.67)bc	82.00 (64.92)bc	82.00 (64.92)b	81.00 (64.18)b	79.00 (62.74)bcd	75.00 (62.74)cd	78.00 (62.05)cd	78.00 (62.05)c	81.30
T_6	Neem Kernel Powder	90.00 (71.78)d	89.00 (70.69)e	87.00 (68.90)d	87.00 (68.90)e	86.00 (68.07)c	85.00 (67.24)c	82.00 (64.92)d	81.00 (64.18)d	79.00 (62.74)d	78.00 (62.05)c	84.40
T_7	Notchi leaf powder	82.00 (64.92)abc	82.00 (64.92)bc	81.00 (64.18)ab	80.00 (63.48)bc	78.00 (62.05)a	77.00 (61.35)a	75.00 (60.01)a	76.00 (60.70)abc	76.00 (60.70)a-d	75.00 (60.01)abc	78.20
T_8	Adathoda leaf powder	81.00 (64.31)ab	79.00 (62.74)ab	79.00 (62.74)a	79.00 (62.74)ab	78.00 (62.05)a	77.00 (61.35)a	75.00 (60.01)a	75.00 (60.01)ab	74.00 (59.35)ab	74.00 (59.39)ab	77.10
T_9	Activated clay	89.00 (70.96)d	87.00 (68.90)de	87.00 (68.90)d	86.00 (68.07)de	86.00 (68.07)c	85.00 (67.24)c	82.00 (64.92)d	81.00 (64.18)d	78.00 (62.08)cd	77.00 (61.35)bc	83.80
T_{10}	Control	80.00 (63.48)a	79.00 (62.05)a	78.00 (62.05)a	76.00 (60.70)a	77.00 (61.35)a	77.00 (61.35)a	77.00 (60.35)a	74.00 (59.35)a	73.00 (58.69)a	73.00 (58.69)a	76.40
Over all mean		84.80	83.60	82.60	81.50	80.90	79.80	78.20	77.60	76.30	75.60	-

Months CD value at 0.05 per cent level: 0.78.
Treatments and Months interaction CD value at 0.05 per cent level: 2.4
Treatments CD value at 0.05 per cent level: 0.78

**Significant at 0.05 per cent level.
Figures with in the parenthesis are arc sine transformed values
Mean in a column followed by same letter are significantly not different

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