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Management of *Corcyra cephalonica* Stain. by botanicals and its effect of infestation on stored sesamum seeds

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Abstract
Eight plant products, *viz*. neem leaf powder, NSK powder, curry leaf powder, custard apple leaf powder, citrus peel powder, turmeric powder, begunia leaf powder and karanj leaf powder, each @ 5 g/kg seeds were used for management study of *Corcyra cephalonica* on two sesamum varieties (Smarak and Amrit). Highest larval mortality, pupal mortality and minimum adult emergence were recorded on seeds treated with NSK powder up to a tune of 81.67%, 8.33% and 10.00% as compared to 5.00%, 0% and 95.00% in control in Smarak whereas 83.33%, 6.67% and 10.00% with respect to 6.67%, 0% and 93.33% in control in Amrit respectively. NSK powder treated sesame seeds showed highest germination of 91.67% in Smarak and 92.00% in Amrit. Per cent adult emergence of *Corcyra cephalonica* and weight loss of seeds were recorded on three sesamum varieties, *viz.* Smarak (white), Amrit (brown) and Prachi (black) after two months of infestation. Variety Prachi showed minimum infestation by *Corcyra cephalonica* exhibiting lowest adult emergence (36.67%) with highest phenol (2.72 mg/g) and protein (17.10%) content as compared to variety Smarak (93.67%), where phenol and protein content was 1.30 mg/g and 13.74%, respectively. In Amrit, the adult emerged was recorded 85.33%.

Keywords: *Corcyra cephalonica*, management, botanicals, sesamum seeds, varieties

Introduction
Sesamum (*Sesamum indicum)* is an ancient oilseed crop, regarded as "queen of oilseeds", cultivated throughout the tropical and subtropical regions of the world. Sesamum seeds are rich source of fatty acids like oleic acid (40-50%) and linoleic acid (35-45%), protein, mineral ash, crude fibre, oxalates, soluble carbohydrates and vitamins like A, E and B complex including calcium and phosphorus (Annual report 2014-15, Dept. of Agriculture, Cooperation and Farmers Welfare, GOI). India is the 5th largest producer of sesamum in the world. The crop is grown in an area of 17.78 lakh hectares with an annual production of 0.67 million tonnes in India (Annual report 2016-17, Dept. of Agriculture, Cooperation and Farmers Welfare, GOI). Sesame occupies 2nd position after groundnut as far as export of oilseeds is concerned. In Odisha, sesamum is grown over an area of about 212.85 thousand hectares and the annual production is around 0.55 lakh tonnes (Annual report 2015-16, Directorate of Agriculture and Food Production, Odisha). In the state, sesamum varieties like Nirmala, Prachi, Amrit, Subhra and Smarak are grown mainly in the districts like Ganjam, Malkangiri, Sundargarh, Sambalpur, Dhenkanal, Angul and Bolangir (Patnaik *et al*., 2013) [11].

According to the report of All India Coordinated Research Project (AICRP) on sesamum and niger (2013-14), rice moth (*Corcyra cephalonica*) and red flour beetle (*Tribolium castaneum*) were found to be the most serious pests of sesamum in storage. *C. cephalonica* causes a great loss to stored sesamum seeds by feeding. In case of higher infestation, the entire seed stock is converted into a black webbed mass that emits a characteristic foul smell and becomes unfit for human consumption (Wadaskar *et al*., 2016) [13]. Qualitative loss leads to reduction in seed vigour and germination percentage. A loss in germinability of sesamum seed up to 95% was noticed which seems to be a major threat to the farmer (Kumar, 2012) [9].

In storage, use of botanicals is eco-friendly and these are easily available, low cost alternatives to the hazardous synthetic chemical pesticides for pest management and they reportedly pose no harm to the environment and human health. In the present study, botanicals like neem leaf,

neem seed, curry leaf, custard apple leaf, citrus leaf, begunia leaf, karanj leaf and turmeric powder are used to determine the best protection of sesamum seeds against storage pests.

Materials and Methods

Laboratory experiments were conducted to study the management of *Corcyra cephalonica* on sesamum varieties during the year 2018-19 in the Department of Entomology, Odisha University of Agriculture and Technology (OUAT), Bhubaneswar, Odisha. Several seed quality parameters like protein content, phenol content, oil content, seed germination and vigour on both uninfested and infested sesamum seeds at pre- and post-experimental periods were also estimated.

Eggs of *Corcyra cephalonica* were collected from the Biocontrol Laboratory of Department of Entomology and were mass-cultured by spreading 0.2 cc eggs of rice moth in one kg of broken sesamum seeds in a plastic jar (25 cm long x 10 cm diameter). Three cultures were prepared on three sesamum varieties (Smarak, Amrit and Prachi). All jars were covered with muslin cloth and tied with rubber band. Regular observation of moth emergence was done. Adults obtained from the culture were released in egg laying apparatus that was made with a plastic funnel (18 cm long x 13 cm diameter), with the lower side fitted with a wire gauge (60 mm mesh) and eggs were collected beneath on a glass plate on which the apparatus was placed. Collected eggs were further released into jars containing sesamum seeds and a series of culture also maintained to obtain sufficient adults for further investigation.

To study the susceptibility to *Corcyra cephalonica* infestation, fresh and cleaned seeds of three varieties of sesamum, *viz.* Smarak, Amrit and Prachi, were used. Fifty gram of sesamum seed was taken in plastic jars (9 cm long x 8 cm diameter) for each variety and replicated 15 times, where twenty numbers of freshly hatched larvae were released into each jar with the help of camel hair brush. All jars were kept under laboratory condition for two months. Number of adults emerged at regular interval and final weight loss of seeds were recorded after two months of treatment.

For the management study of rice moth by botanicals, leaves of locally available neem (*Azadiracta indica*), curry leaf (*Murraya koenigii*), custard apple (*Annona squamosa*), begunia (*Vitex negundo*), karanj (*Pongamia pinnata*) and citrus peel (*Citrus limon*) were dried under shed and were ground to powder form. Locally available neem seed kernels and dry turmeric rhizomes (*Curcuma longa*) were collected and ground to powder form. Sesamum seeds (50 g) were taken and were thoroughly mixed with required quantity of plant product (5 g/kg seeds). Twenty freshly emerged 1st instar larva of rice moth were released into each jar. Nine treatments were maintained by taking seed and leaf powder along with untreated control. Each treatment was replicated thrice (Figure 1). Observations were taken at 5, 10, 15, 20, 25, 30 and 35 days after treatment (DAT) and the data on larval and pupal mortality and adult emergence were recorded. Lists of plant products and concentration used for the management of *Corcyra cephalonica* are given in Table 1.

Table 1: Plant products and concentration used for the management of *Corcyra cephalonica* Stain

Treatment No.	Common name of plant products	Scientific name	Dose (g/kg of seed)
T_1	Neem	*Azadiracta indica*	5.0
T_2	NSK powder	*Azadiracta indica*	5.0
T_3	Curry leaf	*Murraya koenigii*	5.0
T_4	Custard apple	*Annona squamosa*	5.0
T_5	Citrus peel	*Citrus limon*	5.0
T_6	Turmeric powder	*Curcuma longa*	5.0
T_7	Begunia	*Vitex negundo*	5.0
T_8	Karanj	*Pongamia pinnata*	5.0
T_9	Control	-	-

In both infested and uninfested seeds, total protein and oil content was estimated by Lowry's method (Lowry *et al*., 1951) [10] and Soxhlet extraction method (Sadasivam and Manickam, 1992) [12] respectively. Total phenol content was estimated by the method as described by Bray and Thorpe (1954) [5]. The laboratory test for germination of sesamum seed was conducted as per the ISTA rules by adopting top of paper method. Four hundred seeds from each treatment were placed in petri dishes containing moistened blotting paper and covered with lid to maintain the moisture or prevent evaporation. Petri dishes were kept in the germinator maintained at constant temperature of 25±1ºC and relative humidity of 95%. The first count was taken after three days and final count after six days. On the day of final count, the number of normal seedlings was counted and the per cent seed germination was calculated as follows.

$$\text{Germination (\%)} = \frac{\text{Number of normal seedlings}}{\text{Total number of seeds}} \times 100$$

Twenty normal seedlings were randomly selected in each treatment from all the replications on the final count day of germination test. The seedling length was measured for the twenty seedlings and their mean calculated in centimetres. The dry weight of twenty seedlings was taken using an electronic balance and the dry weight per seedling was calculated and expressed in grams. The seed vigour indices were calculated as per the following formulae suggested by Abdul-Baki and Anderson (1973) [1].

Seed vigour index-I = Seed germination (%) × Mean seedling length (cm)

Seed vigour index-II = Seed germination (%) × Mean seedling dry weight (g)

The observations recorded in various experiments were subjected to appropriate transformation and data analysis was carried out as per the standard procedures (Gomez and Gomez, 1984) [6].

Result and Discussion

Per cent adult emerged and weight loss of seeds from three sesamum varieties, *viz.* Smarak (white), Amrit (brown) and Prachi (black) after 2 months of infestation was recorded (Table 2). It is evident from the table that highest adult emerged from variety Smarak was 93.67% and the lowest emergence was found in variety Prachi (36.67%). In Amrit,

the adult emerged was recorded 85.33%. These findings are in close agreement with the observation taken by Kumar (2012) [9]. Highest weight loss of 20.51% was found in the variety Smarak and the lowest of 5.11% was recorded in Prachi. In case of Amrit the weight loss was 18.85%.

Table 2: Varietal seed characters of sesamum cultivars and adult emergence of *Corcyra cephalonica* Stain

Varieties	Colour	No. of adult emerged (%)®	Weight loss of seeds (%)®
Smarak	White	93.67(76.60)^{a}*	20.51(4.52)^{a}**
Amrit	Brown	85.33(67.66)^{b}*	18.85(4.33)^{a}**
Prachi	Black	36.67(37.24)^{c}*	5.11(2.20)^{b}**
S.E.m(±)		1.075	0.093
C.D.(0.05)		4.10	0.35

®Mean of 15 replications
* figures in parentheses are angular transformed values
** figures in parentheses are square root transformed values
Mean followed by similar letters in a column are not significantly different

Effect of plant products on survival of rice moth *Corcyra cephalonica* Stain.

To find out the relative efficacy of the plant products from *Corcyra cephalonica* attack, products of eight plant species including neem leaf powder, NSK powder, curry leaf powder, custard apple leaf powder, citrus peel powder, turmeric powder, begunia and karanj leaf powder (at a rate of 5g/kg seeds) were thoroughly mixed with sesamum seeds and 1st instar larva of *C. cephalonica* were released and kept for differential storage period. Effect of these products on larval mortality, pupal mortality and adult emergence were recorded.

Larval mortality, adult emergence of *Corcyra cephalonica* Stain. and weight loss of sesamum seeds on variety Smarak

On variety Smarak, the mortality of 1st instar larva *C. cephalonica* varied from zero to 50.00% among the treatments at 5 DAT with maximum mortality of 50.00% found in NSK powder treatment followed by 43.33% in T_1. At 10 DAT, the lowest larval mortality was recorded in control, i.e. 1.67%, while highest mortality of larva was recorded 61.67% in NSK powder treatment (T_2), which was at par with neem leaf powder (T_1). Among the botanicals used, lowest mortality recorded in T_6 was 11.67%, where the seeds were treated with turmeric powder. At 15 DAT, larval mortality varied from 3.33% to 76.67% among the treatments with lowest larval mortality 13.33% was recorded among the botanicals in T_6 where turmeric power was used. At 30 DAT, maximum mortality 81.67% was found in NSK powder treatment (T_2) followed by neem leaf powder (78.33%) as compared to control (T_9), where mortality was only 5%. The karanj leaf power, custard apple leaf power and begunia leaf power treatments were the next best treatments showing larval mortality of 71.67%, 66.67% and 60.00%, respectively (Table 3). These findings are fully corroborated with observations of Jhala *et al.* (2018) [8].

Maximum Pupal mortality of 8.33% was found both in neem leaf powder (T_1) and NSK powder (T_2), with a minimum of 0% in curry leaf powder (T_3), citrus peel powder (T_5), turmeric leaf powder (T_6) and control (T_9). In T_7 and T_8, seeds treated with begunia and karanj leaf powder, pupal mortality of 1.67% and 6.67%, respectively, were recorded (Table 4). These findings are in close agreement with the findings of Jhala *et al.* (2018) [8].

Adult emergence varied from 10.00% in NSK powder treatment (T_2) to 95.00% in control (T_9) (Table 4). Maximum adult emergence among botanical treatments was noticed in turmeric powder (T_6) (83.33%) followed by in citrus peel powder (T_5) (70.00%). Present studies are in conformity with the findings of Kumar *et al.* (2012) [9], who reported the lowest number of moth emergence was 15.33% and highest was 68.66% on sesamum seed treated with neem seed powder and turmeric powder, respectively.

Weight loss per cent of treated seeds was determined after two months of treatment. The initial weight of seeds in each treatment was recorded before the larval infestation. Data presented in Table 4 revealed that there is a significant difference in all the treatments as compared to control. Among the botanicals used, highest weight loss per cent was found in turmeric powder (T_6) was 18.23%, followed by citrus peel powder (T_5) (15.06%). The weight loss per cent in T_3 (12.74%), T_7 (10.42%), T_4 (9.65%), T_8 (8.88%) and T_1 (7.34%), were recorded. The present findings are supported by the results of Kumar *et al.* (2012) [9] who reported the lowest weight loss per cent of 6.3% in neem seed powder treatment against 35.6% in control due to *Corcyra cephalonica* infestation in sesamum seeds.

Fig 1: Management study *Corcyra cephalonica* Stain. on variety Smarak and Amrit

Table 3: Relative efficacy of different plant products on larval mortality of *Corcyra cephalonica* Stain. (variety Smarak)

Tr. No.	Treatments	Dose (g/kg of seeds)	Mortality of larvae (%)						
			5 DAT*	10 DAT*	15 DAT*	20 DAT*	25 DAT*	30 DAT*	35 DAT*
T_1	Neem leaf powder	5.00	43.33 (41.16)^{ab}	56.67 (48.84)^{ab}	71.67 (57.91)^{ab}	73.33 (58.93)^{ab}	76.67 (61.14)^{a}	78.33 (62.40)^{ab}	78.33 (62.40)^{ab}
T_2	NSK powder	5.00	50.00 (45.00)^{a}	61.67 (51.76)^{a}	76.67 (61.14)^{a}	78.33 (62.29)^{a}	80.00 (63.55)^{a}	81.67 (64.81)^{a}	81.67 (64.81)^{a}
T_3	Curry leaf powder	5.00	23.33 (28.86)^{d}	26.67 (31.07)^{d}	30.00 (33.16)^{d}	35.00 (36.24)^{e}	36.67 (37.26)^{d}	36.67 (37.26)^{e}	36.67 (37.26)^{e}
T_4	Custard apple leaf powder	5.00	38.33 (38.24)^{bc}	43.33 (41.13)^{c}	50.00 (45.00)^{c}	63.33 (52.74)^{c}	65.00 (53.73)^{bc}	66.67 (54.75)^{cd}	66.67 (54.75)^{cd}
T_5	Citrus peel powder	5.00	10.00 (18.05)^{e}	18.33 (25.31)^{e}	23.33 (28.86)^{d}	26.67 (31.07)^{f}	28.33 (32.14)^{e}	30.00 (33.16)^{e}	30.00 (33.16)^{e}
T_6	Turmeric powder	5.00	8.33 (16.60)^{e}	11.67 (19.89)^{e}	13.33 (21.34)^{e}	13.33 (21.34)^{g}	16.67 (24.05)^{f}	16.67 (24.05)^{f}	16.67 (24.05)^{f}
T_7	Begunia leaf powder	5.00	40.00 (39.21)^{bc}	43.33 (41.16)^{c}	51.67 (45.96)^{c}	56.67 (48.84)^{d}	58.33 (49.83)^{c}	60.00 (50.79)^{d}	60.00 (50.79)^{d}
T_8	Karanj leaf powder	5.00	40.00 (39.21)^{bc}	48.33 (44.04)^{bc}	63.33 (52.74)^{b}	68.33 (55.77)^{bc}	70.00 (56.79)^{b}	71.67 (57.86)^{bc}	71.67 (57.86)^{bc}
T_9	Control		0.00 (0.64)^{f}	1.67 (4.73)^{f}	3.33 (8.83)^{f}	5.00 (12.92)^{h}	5.00 (12.92)^{g}	5.00 (12.92)^{g}	5.00 (12.92)^{g}
	S.E.m(±)		1.508	1.884	1.937	1.139	1.330	1.579	1.579
	C.D.(0.05)		4.48	5.60	5.75	3.38	3.95	4.69	4.69

*Mean of three replications
Figures in parentheses are angular transformed values
DAT = Days after treatment
Mean followed by similar letters in a column are not significantly different

Table 4: Relative efficacy of different plant products on the pupal mortality, adult emergence and weight loss of sesamum seeds (variety Smarak)

Tr. No.	Treatment	Dose (g/kg of seeds)	Pupal mortality (%)®	Adult emergence (%)®	Weight loss of seeds (%) after 2 months®
T_1	Neem leaf powder	5.00	8.33 (2.94)^{a} **	13.33 (21.34)^{f} *	7.34 (2.71)^{h} **
T_2	NSK powder	5.00	8.33 (2.94)^{a} **	10.00 (18.05)^{f} *	6.56 (2.56)^{i} **
T_3	Curry leaf powder	5.00	0.00 (0.71)^{b} **	63.33 (52.74)^{c} *	12.74 (3.57)^{d} **
T_4	Custard apple leaf powder	5.00	6.67 (2.64)^{a} **	26.67 (31.07)^{e} *	9.65 (3.11)^{f} **
T_5	Citrus peel powder	5.00	0.00 (0.71)^{b} **	70.00 (56.84)^{c} *	15.06 (3.88)^{c} **
T_6	Turmeric powder	5.00	0.00 (0.71)^{b} **	83.33 (65.95)^{b} *	18.23 (4.27)^{b} **
T_7	Begunia leaf powder	5.00	1.67 (1.25)^{b} **	38.33 (38.19)^{d} *	10.42 (3.23)^{e} **
T_8	Karanj leaf powder	5.00	6.67 (2.64)^{a} **	21.67 (27.60)^{e} *	8.88 (2.98)^{g} **
T_9	Control		0.00 (0.71)^{b} **	95.00 (77.08)^{a} *	19.30 (4.39)^{a} **
	S.E.m(±)		0.270	1.823	0.02
	C.D.(0.05)		0.80	5.42	0.06

®Mean of three replications
*figures in parentheses are angular transformed values
** Figures in parentheses are ($\sqrt{x+0.5}$) transformed values
Mean followed by similar letters in a column are not significantly different

Larval mortality, adult emergence of *Corcyra cephalonica* Stain. and weight loss of sesamum seeds on variety Amrit

On 5 DAT the mortality of 1st instar larva of *C. cephalonica* was found to be maximum in NSK powder treatment (43.33%) followed by 38.33% in T_1 where the seeds were treated with neem leaf powder. In control minimum larval mortality was found (1.67%). On the 10 DAT, the lowest larval mortality recorded in control was 5.00%. While the highest mortality of larva was recorded 58.33% in NSK powder (T_2) followed by neem leaf powder (T_1) was 48.33%. Similar trends were observed during 15, 20 and 25 DAT. Observation on 30 DAT revealed that, the maximum mortality of 83.33% was found in NSK powder treatment (T_2) followed by neem leaf powder in (T_1) was 75.00% and in control only 6.67% mortality was found. In treatments karanj leaf powder (T_8), custard apple leaf powder (T_4) the larval mortality was found to be 65.00% each followed by in begunia leaf powder (T_7) was the next best treatments showing 58.33% larval mortality (Table 5). These findings are in close agreement with the findings of Jhala *et al.* (2018) [8].

Maximum pupal mortality mortality of (6.67%) was found in neem leaf powder (T_1), NSK powder (T_2) and karanj leaf

powder (T_8). No pupal mortality was noticed in case of curry leaf powder (T_3), citrus peel powder (T_5), turmeric leaf powder (T_6) and in control (T_9).

In both T_7 and T_4 where the seeds were treated with begunia and custard apple leaf powder respectively, the pupal mortality was hardly 3.33% (Table 6). These findings are supported by Jhala *et al.* (2018) [8].

Adult emergence varied from 10.00% (T_2) to 93.33% (T_9) among the treatments. The maximum per cent of adult emergence was noticed in turmeric powder (T_6) was 85.00% followed by in citrus peel powder (T_5) and curry leaf powder (T3) were 71.67% and 63.33% respectively. The lowest adult emergence recorded in NSK powder treatment (T_2) was only 10.00% (Table 6). Present studies are in conformity with the findings of Kumar *et al.* (2012) [9].

Among the treatments, the weight loss percentage varied from 6.46% in NSK powder treatment (T_2) to 19.01% in control (T_9). The highest weight loss per cent of 18.01% was seen in T_6 (turmeric powder) followed by citrus peel powder (T_5) was 14.89%. In T_3, T_7, T_4, T_8 and T_1 the weight loss per cent was 12.00%, 10.34%, 9.00%, 7.90% and 7.28% were recorded in curry leaf powder, begunia leaf powder, custard apple leaf powder, karanj leaf powder and neem leaf powder treatments respectively (Table 6). All these findings are supported by Jhala *et al.* (2018) [8] and Kumar *et.al.* (2012) [9].

Table 5: Relative efficacy of different plant products on larval mortality of *Corcyra cephalonica* Stain. (variety Amrit)

Tr. No.	Treatment	Dose (g/kg of seeds)	Mortality of larvae (%)						
			5DAT*	10DAT*	15DAT*	20DAT*	25DAT*	30DAT*	35DAT*
T_1	Neem leaf powder	5.00	38.33 (38.24)^{a}	48.33 (44.04)^{ab}	65.00 (53.76)^{b}	71.67 (57.91)^{a}	73.33 (58.93)^{a}	75.00 (60.00)^{b}	75.00 (60.00)^{b}
T_2	NSK powder	5.00	43.33 (41.16)^{a}	58.33 (49.83)^{a}	76.67 (61.14)^{a}	76.67 (61.14)^{a}	78.33 (62.29)^{a}	83.33 (65.95)^{a}	83.33 (65.95)^{a}
T_3	Curry leaf powder	5.00	20.00 (26.45)^{b}	25.00 (29.93)^{d}	28.33 (32.09)^{d}	30.00 (33.16)^{e}	33.33 (35.25)^{c}	36.67 (37.26)^{e}	36.67 (37.26)^{e}
T_4	Custard apple leaf powder	5.00	33.33 (35.25)^{a}	38.33 (38.24)^{bc}	46.67 (43.09)^{c}	56.67 (48.84)^{bc}	63.33 (52.74)^{b}	65.00 (53.73)^{c}	65.00 (53.73)^{c}
T_5	Citrus peel powder	5.00	10.00 (18.05)^{c}	16.67 (24.05)^{de}	26.67 (31.07)^{d}	26.67 (31.07)^{e}	28.33 (32.09)^{c}	28.33 (32.09)^{f}	28.33 (32.09)^{f}
T_6	Turmeric powder	5.00	6.67 (14.76)^{c}	10.00 (18.43)^{e}	11.67 (19.89)^{e}	13.33 (21.34)^{f}	15.00 (22.79)^{d}	15.00 (22.79)^{g}	15.00 (22.79)^{g}
T_7	Begunia leaf powder	5.00	33.33 (35.25)^{a}	36.67 (37.26)^{c}	48.33 (44.04)^{c}	50.00 (45.00)^{c}	56.67 (48.87)^{b}	58.33 (49.80)^{d}	58.33 (49.80)^{d}
T_8	Karanj leaf powder	5.00	35.00 (36.27)^{a}	43.33 (41.16)^{b}	60.00 (50.79)^{b}	60.00 (50.79)^{b}	63.33 (52.74)^{b}	65.00 (53.76)^{c}	65.00 (53.76)^{c}
T_9	Control		1.67 (4.73)^{d}	5.00 (4.73)^{f}	5.00 (10.67)^{f}	6.67 (14.76)^{g}	6.67 (14.76)^{e}	6.67 (14.76)^{h}	6.67 (14.76)^{h}
	S.E.m(±)		2.017	2.193	2.219	1.467	1.483	1.259	1.259
	C.D.(0.05)		5.99	6.52	6.59	4.36	4.41	3.74	3.74

*Mean of three replications
Figures in parentheses are angular transformed values
DAT = Days after treatment
Mean followed by similar letters in a column are not significantly different

Table 6: Relative efficacy of different plant products on the pupal mortality, adult emergence and weight loss of sesamum seeds (variety Amrit)

Tr. No.	Treatment	Dose (g/kg of seeds)	Pupal mortality (%)®	Adult emergence (%)®	Weight loss of seeds (%) after 2 months®
T_1	Neem leaf powder	5.00	6.67 (2.64)^{a} **	18.33 (25.31)^{g} *	7.28 (2.70)^{h} **
T_2	NSK powder	5.00	6.67 (2.64)^{a} **	10.00 (18.43)^{h} *	6.46 (2.54)^{i} **
T_3	Curry leaf powder	5.00	0.00 (0.71)^{b} **	63.33 (52.74)^{d} *	12.00 (3.46)^{d} **
T_4	Custard apple leaf powder	5.00	3.33 (1.80)^{a} **	31.67 (34.23)^{ef} *	9.00 (3.00)^{f} **
T_5	Citrus peel powder	5.00	0.00 (0.71)^{b} **	71.67 (57.91)^{c} *	14.89 (3.86)^{c} **
T_6	Turmeric powder	5.00	0.00 (0.71)^{b} **	85.00 (67.21)^{b} *	18.01 (4.24)^{b} **
T_7	Begunia leaf powder	5.00	3.33 (1.80)^{a} **	38.33 (38.22)^{e} *	10.34 (3.22)^{e} **
T_8	Karanj leaf powder	5.00	6.67 (2.64)^{a} **	28.33 (32.09)^{f} *	7.90 (2.81)^{g} **
T_9	Control		0.00 (0.71)^{b} **	93.33 (75.24)^{a} *	19.01 (4.36)^{a} **
	S.E.m(±)		0.310	1.473	0.03
	C.D.(0.05)		0.92	4.38	0.10

®Mean of three replications
*figures in parentheses are angular transformed values
** Figures in parentheses are ($\sqrt{x+0.5}$) transformed values
Mean followed by similar letters in a column are not significantly different

Effect of infestation of *Corcyra cephalonica* on seed quality parameters of sesamum seeds (variety Smarak)

After two months of treatment, germination per cent, Seedling length and Seed vigour index of treated seeds were determined. Germination per cent varied from 52.33% in control (T_9) to 91.67% in T_2 where the seeds were treated with NSK powder. The highest being found in T_2 was 91.67% followed by 88.33%(T_1), 84.33% (T_8), 82.33% (T_4), 78.33% (T_7), 67.33% (T_3) and 59.67% (T_6) in neem leaf powder, karanj leaf powder, custard apple leaf powder, begunia leaf powder, curry leaf powder and turmeric powder treatment respectively. Seedling length varied from 7.51cm to 8.74cm in T_9 to T_7. There was no significant variation observed among treatments with respect to seedling dry weight and was varied from 0.023g to 0.034g. Highest seed vigour index-I (765.71) was obtained in NSK powder treatment (T_2) and lowest of 393.19 was found in control. In case of neem leaf powder (T_1) seed vigour index-I was found to be 728.06 followed by T_8 (714.55), T_7 (684.63), T_4 (649.61), T_3 (523.23), T_5 (496.09) and T_6 (455.83). The highest seed vigour index-II (3.15) was obtained from T_2 and the lowest (1.22) was recorded in control (Table 7). These findings support the observations taken by Kumar (2012) [9] who reported that rice moth infestation causes up to 94% seed damage was accompanied with rapid loss of germination per cent (2 to 54%) and vigour index of sesamum seeds was 733.12 with least infestation and was 266.56 with high infestation of *Corcyra cephalonica*.

Effect of infestation of *Corcyra cephalonica* on seed quality parameters of sesamum seeds (variety Amrit)

Germination per cent of treated seeds varied from 54.00% in control (T_9) to 92.00% in T_2 (NSK powder treatment). In custard apple leaf powder (T_4) and karanj leaf powder (T_8) germination per cent are at par. The highest being found in T_2 (NSK powder) was 92.00% followed by T_1(89.00%), T_4(84.33%), T_8(83.67%), T_7(79.00%), T_3(70.33%), T_5(64.33%) and T_6(59.33%) were in neem leaf powder, custard apple leaf powder, karanj leaf powder, begunia leaf powder, curry leaf powder, citrus peel powder and turmeric powder treatment respectively. Seedling length varied from 6.99cm to 8.64cm in T_9 to T_4. Seedling dry weight varied from 0.028g to 0.039g with no significant variation among treatments. Highest seed vigour index-I (759.09) was found in T_2 (NSK powder treatment) and lowest (379.27) was recorded in control. In neem leaf powder treatment (T_1) seed vigour index-II was 756.81 followed by T_4 (728.92), T_8 (696.65), T_7 (672.53), T_3 (531.91), T_5 (474.89) and T_6 (442.40). The highest seed vigour index-II (3.52) was found in T_2 and the lowest (1.48) was recorded in T_6 where the seeds were treated with NSK powder and turmeric powder respectively (Table 8). These findings support the observations taken by Kumar (2012) [9].

Biochemical analysis of sesamum varieties

Protein content and phenol content and oil content were estimated in both uninfested and infested seeds of sesamum (Table 9 & Figure 2,3,4). In the uninfested seeds highest oil content was noticed in Smarak (48.65%) and the lowest in Amrit (42.05%) whereas Prachi contained 45.75% oil. Oil content in infested seeds was 42.60% in Smarak, 43.10 % in Prachi and 40.35% in Amrit. Maximum protein content of uninfested seeds was estimated to be 17.10%, 15.18% and 13.74% in variety Prachi, Amrit and Smarak, respectively. Protein content of infested sesamum seeds were also recorded up to a tune of and 19.26% in Prachi, 18.14% in Amrit and 17.44% in Smarak. In case of uninfested seeds the maximum phenol content was observed in variety Prachi (2.72mg/g) followed by Amrit (2.02mg/g) and Smarak (1.30mg/g). Phenol content of infested seeds was also estimated, where it was 2.80mg/g in Prachi, 2.37mg/g in Amrit and 1.87mg/g in Smarak.

Table 7: Seed quality parameters of treated seeds of Smarak variety after two months of infestation

Treatments	Germination (%)*	Seedling length (cm)*	Seedling dry weight (g)*	Seed vigour index-I*	Seed vigour index-II*
T_1	88.33 (70.04)^{b}	8.24^{c}	0.034^{a}	728.06^{b}	3.03^{b}
T_2	91.67 (73.23)^{a}	8.35^{bc}	0.034^{a}	765.71^{a}	3.15^{a}
T_3	67.33 (55.14)^{f}	7.80^{d}	0.025^{d}	525.23^{f}	1.68^{f}
T_4	82.33 (65.15)^{d}	7.89^{d}	0.029^{c}	649.61^{e}	2.39^{d}
T_5	63.33 (52.73)^{g}	7.83^{d}	0.025^{d}	496.09^{g}	1.60^{f}
T_6	59.67 (50.57)^{h}	7.64^{e}	0.023^{e}	455.83^{h}	1.39^{g}
T_7	78.33 (62.26)^{e}	8.74^{a}	0.028^{c}	684.63^{d}	2.22^{e}
T_8	84.33 (66.69)^{c}	8.47^{b}	0.032^{b}	714.55^{c}	2.70^{c}
T_9	52.33 (46.34)^{i}	7.51^{e}	0.023^{e}	393.19^{i}	1.22^{h}
S.E.m(±)	0.335	0.052	0.0004	4.185	0.029
C.D.(0.05)	0.99	0.15	0.001	12.44	0.09

*Mean of 3 replications

Figures in parentheses are angular transformed values

Mean followed by similar letters in a column are not significantly different

Table 8: Seed quality parameters of treated seeds of Amrit variety after two months of infestation

Treatments	Germination (%)*	Seedling length(cm)*	Seedling dry weight(g)*	Seed vigour index-I*	Seed vigour index-II*
T_1	89.00 (70.64)^{b}	8.47^{a}	0.038^{ab}	756.81^{a}	3.17^{b}
T_2	92.00 (73.59)^{a}	8.23^{a}	0.039^{a}	759.09^{a}	3.52^{a}
T_3	70.33 (57.00)^{e}	7.63^{b}	0.031^{dc}	531.91^{e}	2.32^{d}
T_4	84.33 (66.69)^{c}	8.64^{a}	0.034^{cb}	728.92^{b}	2.76^{c}
T_5	64.33 (53.33)^{f}	7.19^{cd}	0.029^{d}	474.89^{f}	1.76^{ef}
T_6	59.33 (50.38)^{g}	7.42^{bc}	0.028^{d}	442.40^{g}	1.48^{f}
T_7	79.00 (62.73)^{d}	8.18^{a}	0.035^{a}	672.53^{d}	2.74^{c}
T_8	83.67 (66.16)^{c}	8.21^{a}	0.034^{b}	696.65^{c}	2.84^{c}
T_9	54.00 (47.29)^{h}	6.99^{d}	0.029^{d}	379.27^{h}	1.50^{f}
S.E.m(±)	0.363	0.098	0.0014	8.05	0.102

C.D.(0.05)	1.08	0.29	0.004	23.92	0.30

*Mean of 3 replications
Figures in parentheses are angular transformed values
Mean followed by similar letters in a column are not significantly different

Table 9: Oil, protein and phenol content of healthy and infested seeds of sesamum varieties

Varieties	Oil content (%)	Protein content (%)	Phenol content (mg/g)
Uninfested seeds			
Smarak	48.65	13.74	1.30
Amrit	42.05	15.18	2.02
Prachi	45.75	17.10	2.72
Infested seeds			
Smarak	42.60	17.44	1.87
Amrit	40.35	18.14	2.37
Prachi	43.10	19.26	2.80

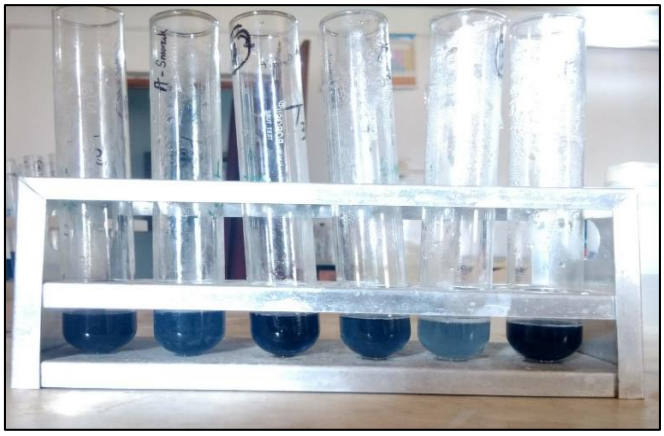

Fig 2: Estimation of protein content

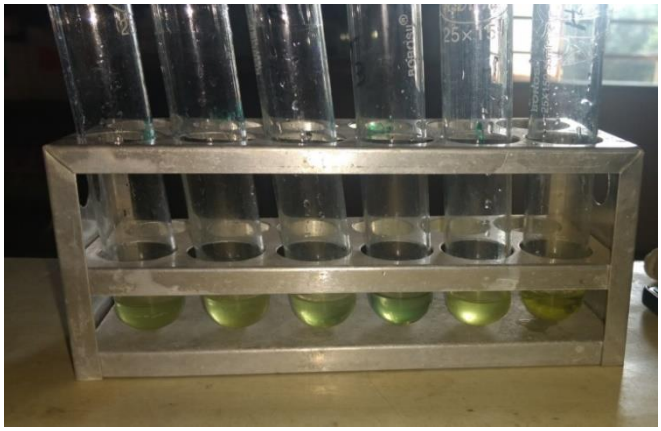

Fig 3: Estimation of total phenol

Fig 4: Estimation of oil content

Conclusions

Under Bhubaneswar agro-climatic conditions of Odisha the rice moth *Corcyra cephalonica* Stain. is a major pest of stored sesamum. White seeded variety (Smarak) was found to be more vulnerable to rice moth infestation than the black seeded variety (Prachi). Sesamum cultivars having higher level of proteins and phenolic content proved more resistannce to *Corcyra cephalonica* infestation. The relative efficacy of plant products revealed that NSK power is most effective as it inhibits larval development as well as adult emergence. Viability of seeds is found to be least affected in case of NSK powder and neem leaf powder treatments.

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