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Efficacy of plant products and vegetable oils against *Callosobruchus chinensis* (L.) on stored chickpea

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Abstract
Efficacy of plant powders and vegetable oils against *Callosobruchus chinensis* (L.) on stored chickpea research work was carried out in the laboratory of Department of Entomology, NU, SASRD. This investigation was done during February 2021 to April 2021. The different plant powders like *Pongamia pinnata* (Karanja), *Murraya koenigii* (curry leaves), *Ocimum sanctum* (tulsi), *Syzygium aromaticum* (Clove) were used at 5%w/w, while vegetable oils like Sesame oil, Sunflower oil, Groundnut oil, Mustard oil and Castor oil were used at 1%v/w in this investigation. This research also included a chemical check Malathion 5% dust at 1% w/w and untreated plot. The experiment was conducted under Completely Randomized Design with three replication and single factor unit. From the results it evident that 100% reduction in oviposition was observed in the seeds treated with vegetable oils (0.00%), followed by *Syzygium aromaticum* plant powders while the least reduction of Oviposition was seen in the seeds treated with *Murraya koenigii* (9.66%). The adult emergence after 5 consecutive days was highest in the seeds treated with *Murraya koenigii* (3.77%) and no adults emerged when the seeds were treated with vegetable oils (0.00%). The percentage of infestation and percentage of weight loss of chickpea seeds after 60 DAT was found highest in the seeds treated with curry leaf powder (17.04%, 19.6%respectively) while least 0.00% was found in the seeds treated with vegetable oils. When we observe the seed viability of the treated seeds it can be said that all the seeds were viable but highest percentage of germination was found in the seeds treated with *Syzygium aromaticum* (88%) and least when seeds were treated with castor oil (52%).

Keywords: *Callosobruchus chinensis* (L.), chickpea, plant powders, vegetable oils, chemical check Malathion 5% dust

Introduction
Chickpea (*Cicer arietinum* L.) also known as Bengal gram belonging to the family Fabaceae is one of the highly nutritious pulse crops grown in India and world. This crop occupies third place in the list of the most important legume crops in the world next to dry bean and peas (FAO, 2003). India is the largest producer of chickpea contributing to around 63% of the world's total population (ICRISAT, 2007). Chickpea contains 38-59% and 25.3- 28.9% of carbohydrates and proteins respectively (Pulse, 1991). This crop with an area of 14.8 million ha in the world produces 14.28 million tons of which 88% of area & 84% of production is contributed by Asia (FAOSTAT, 2014). In India Chickpea occupies an area of 6.67 million ha with an annual production of 5.3 million tones and yield of 844 kg/ha (CMIE, 2011). It is unfortunate that despite of serious efforts to increase the production of chickpea in India, insects have been causing tremendous losses not only to the crops growing in fields but also to post harvest commodities during storage (Nakakita, 1998). Among them, bruchids belonging to the *Callosobruchus maculates* (Fab) *C. Chinensis Linn* and *C. analis* (Fab) are considered most common in India *C. chinensis* also known as pulse beetle is known to cause heavy damage to stored pulses and pigeon pea is most affected crop followed by green gram and chick pea (Yadav & Pant, 1978 and Southgate, 1982, Rahman *et al.*, 1942 and Arora, 1972).
The pulse beetle *Callosobruschus chinensis* (Coleoptera: Bruchidae) is a major storage pest of economically important legume grains such as lentils, cowpeas, green gram and black gram apart from chickpea, pigeon pea (Talukdor and Howse, 1994; Park *et al.*, 2003; Sagheer *et al.*, 2013; Tesfu and Emana, 2013). *Callosobruchus* has been found to cause weight loss, decreased germination potential and reduction in commercial value of seeds (Booker, 1967; Caswell, 1981). Protein loss of 45.6-66.3% and 55-69% seed weight loss was recorded when attacked by *Callosobruchus* species (Kim *et al.*, 2003; Islam *et al.*, 2013).

Another report showed that there was an average weight loss of 32-64% due to the infestation of *C. chinensis* in different parts of Africa and South Asia under stored conditions (Aslam *et al.,* 2002; Ketoh *et al.,* 2005; Raja *et al.,* 2008). *Callosobruschus chinensis* is a commonly encountered species in Nagaland belonging to the family Bruchidae of order Coleoptera. This bruchid is considered as the most notorious among the insect pest of stored grain pulses. The species of the genus *Callosobruchus* mainly which is seen mainly in tropical and sub-tropical regions start their infestation in the field when the crop is matured and increases during storage (Ghosh, 1937).

For the control and management of stored grain pests, different techniques have been practiced like, use of microwave energy, biological control, and changing of storage temperature (Haque and Islam, 2011; Loganathan *et al.,* 2011; Purohit *et al.,* 2013). The stored cereals are vulnerable to damage by adult as well as immature stages of granivorous insects which leads to reduction in quantity and quality of grains (Freeman, 1973; Adams and Schultan, 1978; Nakakita, 1998). This led to worldwide interest in the development of many alternative strategies like use of plant products for protecting the stored grain pests other than pesticidal pollution (Prakash and Rao, 1989; Tiwari *et al*., 1990). The efficacies of various botanicals have been found against different stored grain pests (Roa *et al*., 1990; Prakash *et al*., 1990; Ratnasekera and Rajapakse, 2009).

Considering all the points mentioned above, the present research investigation entitled "Efficacy of plant powders and vegetable oils against *Callosobruchus chinensis* (L.) on stored chickpea" will be undertaken with the following objectives:

1. To observe the effect of plant powders and vegetable oils on oviposition and adult emergence of *C. chinensis* on stored chick pea.
2. To observe the effect of plant powders and vegetable oils on seed viability.

Materials and Method

The present investigation entitled "Efficacy of plant powders and vegetable oils against *Callosobruchus chinensis* (L.) on stored chickpea was carried out during the period of February – April 2021 in the Laboratory, Department of Entomology, SASRD, Nagaland University. The experimental site is located at 25º 45' 45" latitude and longitude of 93º 53' 04". It is located at an elevation of 310 meters above mean sea level, with sub-tropical and humid weather and an average rainfall of 2000-2500mm, with a mean temperature ranging between 21º - 35 ºC.

The experiment was laid in Completely Randomized Design (CRD) with three replications and eleven treatments. The eleven treatments included plant powders like *Pongamia pinnata* (Karanja), *Murraya koenigii* (curry leaves), *Ocimum sanctum* (tulsi), *Syzygium aromaticum* (Clove), Sesame oil, Sunflower oil, Groundnut oil, Mustard oil, Castor oil, Malathion 5% dust, Untreated control. This information is depicted in the Table no. 1.

Stock culture

Pure cultures of *C. chinensis* has been obtained from the laboratory of Department of Entomology; SASRD and were maintained on chick pea seeds which were procured from the local market, cleaned and sundried then heated at 60°C for one hour in oven to eliminate any hidden infestation. These seeds were then used as host crop for the growth of pulse beetle. These seeds were maintained in plain plastic jars with their mouths closed with muslin cloth and perforated with small holes for the passage of air flow. Stock culture was kept in the laboratory storage cabin at ordinary room temperature and relative humidity. This culture was used for obtaining adult bruchids of same age for releasing in the different treatments under investigation**.**

General characteristics of test insect:

Eggs are small, oval and scale like which are glued on the grain singly but many eggs may be seen on a single grain. The larvae mainly cause damage by feeding inside the grain. In the early stages, it is whitish, scarabeiform with a light brown head which is prognathous, wrinkled body and later on it acquires a creamy hue. It chews a circular hole near the seed coat till only a thin layer of seed covering is left intact. This gives an appearance of lid or dark spot. This seems to be an indication of larvae entering into pupation. The adult escapes through this hole. The adult is a small, oval and chocolate coloured beetle measuring 3 – 4 mm in length and 1.5 – 2.0 mm in breadth. The antennae of the male are pectinate type and the female are serrate type. Sexual dimorphism is observed in these beetles in their sizes, male beetle is smaller than the female beetle.

Table 1: Treatment details used in the experiment.

Sl. No.	Grain protectants/treatments	Part used	Dose
1	*Pongamia pinnata* (Karanja)	Leaf	5% w/w
2	*Murraya koenigii* (curry leaves)	Leaf	5% w/w
3	*Ocimum sanctum* (tulsi)	Leaf	5% w/w
4	*Syzygium aromaticum* (Clove)	Fruit	5% w/w
5	Sesame oil	-	1% v/w
6	Sunflower oil	-	1% v/w
7	Groundnut oil	-	1% v/w
8	Mustard oil	-	1% v/w
9	Castor oil	-	1% v/w
10	Malathion 5% dust	-	1% w/w
11	Untreated control	-	-

Observations recorded

Effect of treatment on oviposition and adult emergence

For the evaluation of oviposition deterrent effects of the plant products, a sample of 25 seeds of chick pea were taken and four pairs of newly emerged *C. chinensis* were introduced into each container. Untreated seeds were used as control. Each treatment was replicated thrice in CRD. After 10 days, number of eggs laid on treated and control seeds were recorded with the help of magnifying glass and the percentage reduction in oviposition was calculated using the formula.

$$\text{Oviposition}(\%) = \frac{\text{No. of eggs laid in control} - \text{No. of eggs laid in treated seeds}}{\text{No. of eggs laid in control}} \times 100$$

After counting the eggs, the container was kept undisturbed and regular observation was done for emergence of adults. As the adult emergence initiates, observations were recorded and adults were removed at a regular interval of 24 hrs until no further emergence occurred for 5 consecutive days. The per cent adult emergence was calculated by using the formula,

$$\text{Per cent adult emergence} = \frac{\text{Number of adult emerged}}{\text{Number of eggs laid}} \times 100$$

Effect of treatment on seed germination

The treated as well as untreated seeds (100g) were kept in separate air tight containers in room condition. After 60 days of storage, seeds were tested for germination. 25 healthy seeds samples were taken at random from each replication of all the treatments. The seeds then were placed in Petri dishes containing moistened filter paper (Whatman No. 1). Healthy untreated seeds were used as control. The number of emerged seedlings from each Petri dish were counted and recorded after 7 days. The percent germination was calculated by using the formula as follows:

$$\text{Percent seed viability} = \frac{\text{No of seeds germinate}}{\text{Total no. of seeds in each petri dish}} \times 100$$

Effect of plant powders and vegetable oils on oviposition and adult emergence of *C. chinensis* on stored chick pea.

The complete data of efficacy of plant powders and vegetable oils on oviposition and adult emergence after storage were tabulated and recorded in the tables 2 and 3 and figures 1 and 2.

Percentage reduction in oviposition

Initially for the evaluation of oviposition deterrent effects of the plant powders and vegetable oils, a sample of 25 seeds from each treatment were taken and 4pairs of the *Callosobruchus chinensis* were released. The data of oviposition was calculated once the pests started laying eggs (approximately 10-15 days). The number of eggs were counted using the magnifying glass. As per the data in table no. 3.1 and figure no. 1, average of three replications of each treatment highest percentage of reduction in oviposition was observed as 100 in the seeds treated with vegetable oils (100.00). The seeds treated with *Murraya koenigii* showed the least percentage reduction of oviposition (8.26) amongst all the treatments.

These findings synchronize with the findings of Verma, B. K and Pandey, G. P (1978) [34] who also reported that oviposition was completely inhibited when groundnut and mustard oils were used. Even findings of Ali, S. I. *et al.* (1983) showed that when neem, coconut, mustard, sesame, palm oils at 1ml per 100 grams of seeds was used, 100% egg mortality and 100% adult mortality was observed. When we observe the findings of Singh, P. K (2003) all the oils proved highly effective in preventing egg laying and controlled population buildup.

Pathania, M and Thakur, A. K (2020) they observed that percentage of oviposition was least when treated with Curry leaf powder than other treatments. Percentage of reduction in oviposition in the seeds treated with *Syzygium aromaticum* showed a percentage of 52.55 which was on par with findings of Gautam *et al*. (2000) who concluded that minimum number of eggs were laid in the seeds treated with clove powder. These findings also coincided with findings of Aslam *et al.* (2002) and Ahmed Zia (2004) where both of them showed that clove powder was effective in reducing the percentage of oviposition. When we observe the seeds treated with *Ocimum sanctum* the percentage of reduction in oviposition was 25.35 these findings shows that seeds treated with *Ocimum sanctum* were found effective next to *Syzygium aromaticum* in reducing the oviposition these findings coincided with the findings of Ratnasekera and Rajapakse (2010) who stated that there was reduction in oviposition when treated with *O. sanctum*. These also coincide with Singh (2011) who observed that the toxicity of plant powders *viz*., black pepper powder, garlic powder, *O. sanctum* and turmeric powder have attributed to reduction in fecundity. 23.64% of reduction in oviposition was observed in the seeds treated with Pongamia pinnata. These findings shows that next to *O. sanctum*, *Pongamia pinnata* was found effective in reducing the oviposition to an extent. These findings were synchronized with the findings of Babu *et al.* (1989) who stated that the treatment with karanja and castor oil effectively reduced oviposition by bruchid. Even Singh, R (2011) also stated that tulsi and karanja leaf extracts at all concentration levels reduced oviposition effectively as compared to control.

Percentage of reduction in oviposition in standard check i.e., Malathion 5% dust was 13.17. These results show that treatment with malathion showed least reduction in oviposition next to *Murraya koenigii* but best than control. These coincide with the findings of Regmi, H *et al.* (2012) stated that when local natural products were used against *Callosobruchus chinensis* in stored chickpea those treatments were found more effective than treatment by Malathion. Those treatments protected seeds in better way than Malathion.

Percentage of adult emergence

The effect of different plant powders and vegetable oils on adult emergence of C. chinensis on stored chickpea was tabulated and recorded in the table no. 3. and the data is depicted in the figure no. 2. The adult emergence was calculated for the 25 seeds taken for the oviposition immediately once the adult emerges from the eggs. The adult emergence will be counted at regular interval of 24hrs for 5 consecutive days until there is no further emergence of adult.

The data collected and recorded indicated that vegetable oils treated seeds where there is no oviposition there is no adult emergence (0.00%). When we observe the plant powder treated seeds, the adult emergence was highly controlled in the seeds treated with *Syzygium aromaticum* (2.25%) followed by *Ocimum sanctum* (2.44%) malathion treated seeds (2.75%) and *Pongamia pinnata* (2.99%). Lowest control i.e., a greater number of adults emergence was observed in control (3.43%) and among all the treatments least reduction in adult emergence was observed in the seeds treated with *Murraya koenigii* (3.17%) but effective than control. These findings coincided with Pathania, M and Thakur, A. K (2020) they observed that number of adult emerged (30.67%) was least in the seeds treated with curry leaf powders than other treatments. Percentage of adult emergence was 2.00% in the seeds treated with *Syzygium aromaticum*. This treatment was found to be best treatment next to treatment by vegetable oils. These findings were on par with the findings of Gautam *et al*. (2000); Aslam *et al*. (2002) and Ahmed Zia (2004) they evaluated some edible plant products against pulse beetle where clove powder was effective in reducing the percentage of adult emergence.

The seeds treated with *Ocimum sanctum* showed percentage of adult emergence of 2.44 which was found effective next to *Syzygium aromaticum* in reducing adult emergence these findings coincided with the findings of Ratnasekera and Rajapakse (2010); Singh (2011) who stated that there was reduction in oviposition with no adult emergence when treated with *O. sanctum*. 2.99% of adult emergence was observed in the seeds treated with *Pongamia pinnata*. These findings shows that next to O. sanctum, Pongamia pinnata was found effective in reducing adult emergence to an extent. These findings were synchronized with the findings of Babu *et al.* (1989) and Singh, R (2011) they stated that the treatment with karanja and castor oil effectively reduced adult emergence of bruchid.

Table 2: Effect of different plant powders and vegetable oils on reduction in oviposition of *C. chinensis* on stored chickpea

Treatments	Reduction in oviposition (%)
Pongamia pinnata @ 5% w/w: (T1)	23.64 (26.97)
Murraya koenigii @ 5% w/w:(T2)	8.26 (12.48)
Ocimum sanctum @ 5% w/w:(T3)	25.35 (30.05)
Syzygium aromaticum@ 5% w/w:(T4)	52.55 (46.47)
Sesame oil @ 1% v/w: (T5)	100.00 (0.05)
Sunflower oil @ 1% v/w: (T6)	100.00 (0.01)
Groundnut oil @ 1% v/w: (T7)	100.00 (0.05)
Mustard oil @ 1% v/w: (T8)	100.00 (0.04)
Castor oil @ 1% v/w: (T9)	100.00 (0.02)
Malathion 5% dust @ 1% w/w: (T10)	22.12 (25.97)
Untreated control: (T0)	0.00 (0.00)
S.Em±	4.59
CD (P=0.05)	13.47

Note: Figures in the table are mean values and those in parenthesis are angular transformed values

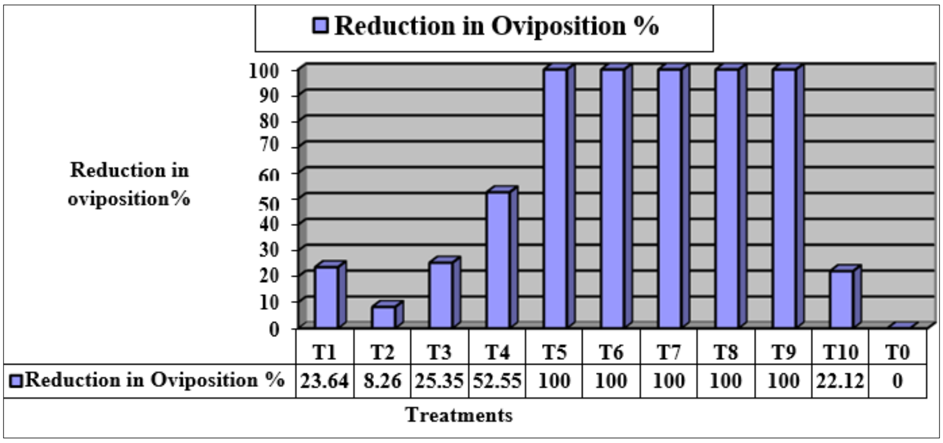

Fig 1: Efficacy of plant powders and vegetable oils on reduction in oviposition of *Callosobruchus chinensis*

T1- *Pongamia pinnata* T2- *Murraya koenigii*
T3- *Ocimum sanctum* T4- *Syzygium aromaticum*
T5- Sesame oil T6- Sunflower oil
T7- Groundnut oil T8- Mustard oil
T9- Castor oil T10- Malathion 5% dust
T0- Untreated control

Table 3: Effect of different plant powders and vegetable oils on adult emergence of *C. chinensis* on stored chickpea

Treatments	Percentage of adult emergence					Mean
	1st day	2nd day	3rd day	4th day	5th day	
Pongamia pinnata @ 5% w/w: (T1)	6.28 (14.05)	1.95 (7.97)	2.09 (8.24)	2.91 (9.76)	1.71 (7.17)	2.99
Murraya koenigii @ 5% w/w:(T2)	6.23 (14.31)	2.19 (8.17)	2.56 (9.10)	2.43 (8.83)	2.44 (8.73)	3.17
Ocimum sanctum @ 5% w/w:(T3)	4.71 (12.37)	1.53 (7.09)	2.60 (9.20)	1.98 (8.02)	1.40 (6.60)	2.44
Syzygium aromaticum @ 5% w/w:(T4)	3.21 (10.31)	2.00 (8.11)	2.82 (9.63)	1.60 (7.22)	1.66 (7.26)	2.26
Sesame oil @ 1% v/w: (T5)	0.00 (0.05)	0.00 (0.05)	0.00 (0.05)	0.00 (0.05)	0.00 (0.05)	0.00
Sunflower oil @ 1% v/w: (T6)	0.00 (0.01)	0.00 (0.01)	0.00 (0.01)	0.00 (0.01)	0.00 (0.01)	0.00
Groundnut oil @ 1% v/w: (T7)	0.00 (0.05)	0.00 (0.05)	0.00 (0.05)	0.00 (0.05)	0.00 (0.05)	0.00
Mustard oil @ 1% v/w: (T8)	0.00 (0.04)	0.00 (0.04)	0.00 (0.04)	0.00 (0.04)	0.00 (0.04)	0.00
Castor oil @ 1% v/w: (T9)	0.00 (0.02)	0.00 (0.02)	0.00 (0.02)	0.00 (0.02)	0.00 (0.02)	0.00
Malathion 5% dust @ 1% w/w: (T10)	5.42 (13.29)	2.45 (8.95)	2.97 (9.92)	2.45 (8.55)	0.45 (3.85)	2.75
Untreated control: (T0)	6.02 (14.07)	2.60 (9.25)	3.04 (9.87)	2.85 (9.70)	2.66 (9.38)	3.43
S.Em±	0.52	0.40	0.44	0.41	0.34	-
CD (P=0.05)	1.52	1.17	1.28	1.19	1.00	-

Note: Figures in the table are mean values and those in parenthesis are angular transformed values

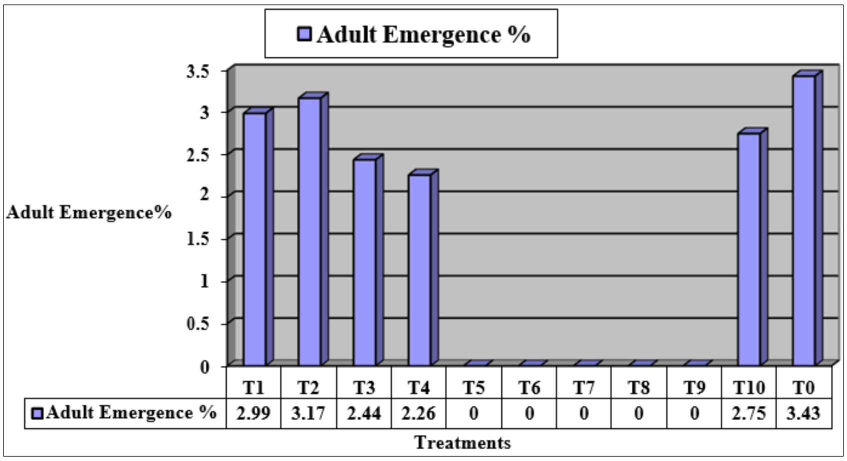

Fig 2: Efficacy of plant powders and vegetable oils on the percentage of adult emergence

T1- *Pongamia pinnata*
T2- *Murraya koenigii*
T3- *Ocimum sanctum*
T4- *Syzygium aromaticum*
T5- Sesame oil
T6- Sunflower oil
T7- Groundnut oil
T8- Mustard oil
T9- Castor oil
T10- Malathion 5% dust
T0- Untreated control

To observe the effect of plant powders and vegetable oils on seed viability

The complete data of efficacy of plant powders and vegetable oils on seed viability for a period of 30, 45, 60 days were tabulated and recorded. The data in the table no. 4 and was depicted in the figure no.3. The data for this objective was collected by taking 25 healthy seeds samples at random from each replication of all the treatments. The seeds were placed in Petri dishes containing moistened filter paper (Whatman No. 1). Healthy untreated seeds were used as control. The number of emerged seedlings from each Petri dish were counted and recorded after 7 days.

From the data collected seed viability percentage was maximum of 88.00 in the seeds treated *with Syzygium aromaticum*, this was followed by 85.33%, 80.00%, 77.33% and 77.33% in seeds treated with Malathion 5% dust, *Ocimum sanctum*, Mustard oil and Sunflower oil. When we observe other treatments 68.00% was obtained in the seeds treated with Sesame oil and Groundnut oil, 62.67% in *Pongamia pinnata* and 54.67% in *Murraya koenigii*. Least percentage of germination was observed in the seeds treated with Castor oil with 52.00. When we observe the untreated control the percentage of seed viability was 78.67.

The findings of Ahmed, J. *et al*. (2016), Swamy, G. S. V. S and Wesley, J. B (2017) and Aslam *et al.* (2002) showed that clove powder was effective in reducing the pest attack and also did not affect the seed viability. While Mohamad, 2012 and Kiradoo and Srivastava, 2010 stated tulsi powder did not affect the germination and Yakanchi,

S. R. and Lendi, G. S. (2019), Babu *et al*. (1989) stated that *Pongamia pinnata* did not affect the germination of seeds when treated. Khaire *et al.* (1992) stated that neem, karanja and mustard oils when used against pulse beetle were safe to use and seed germination was also not affected. Tariq, A. *et al.* (2017) reported that plant powders when used against pulse beetle were found defective in reducing the pest and also effective in seed germination that means plant powders did not affect seed viability.

The percentage of seed germination when treated with vegetable oils was Mustard oil 77.33, Sunflower oil 77.33, Sesame oil and Groundnut oil 68.00 and Castor oil 52.00. These finding synchronized with the data of Inge (2004) who reported that vegetable oils cause the eggs and larvae of pulse beetle to die before they bore into the seeds and also did not affect the germination percentage. Even Singh *et al.* (2006), Kumar, D. B. and Reddy, R. R.

P. (2016) also stated that vegetable oils were not only effective in reducing the pest infestation by *Callosobruchus chinensis* but also seed germination was not affected when treated with vegetable oils. Tripathi *et al*. (2006) they reported that highest percentage of germination was recorded in the seeds treated with Sunflower oil (80), followed by Mustard oil (78), Sesame oil (75) and Ground nut oil (66.67) while lowest germination was recorded in the seeds treated with Castor oil these finding were found similar to the findings of my research carried out.

The next highest seed germination percentage was observed in the seeds treated with Malathion 5% dust

which were coinciding with the findings of Jian and Yadav (1984) and Paramanik and Sardar. They stated that germination was not affected in the seeds treated with Deltamethrin and Malathion. The percentage of germination in untreated plot was recorded as 78.67. from the complete data it was observed that Castor oil and *Murraya koenigii* recorded the least percentage of germination among all the treatments.

Table 4: Effect of different bio-pesticides on percentage of seed viability after 60 days of treatment and 7 days after germination

Treatments	Germination percentage
Pongamia pinnata @ 5% w/w: (T1)	62.67 (52.38)
Murraya koenigii @ 5% w/w:(T2)	54.67 (47.70)
Ocimum sanctum @ 5% w/w:(T3)	80.00 (64.19)
Syzygium aromaticum@ 5% w/w:(T4)	88.00 (70.69)
Sesame oil @ 1% v/w: (T5)	68.00 (55.67)
Sunflower oil @ 1% v/w: (T6)	77.33 (61.99)
Groundnut oil @ 1% v/w: (T7)	68.00 (55.72)
Mustard oil @ 1% v/w: (T8)	52.00 (46.28)
Castor oil @ 1% v/w: (T9)	77.33 (62.03)
Malathion 5% dust @ 1% w/w: (T10)	85.33 (67.99)
Untreated control: (T0)	78.67 (62.58)
S.Em±	4.05
CD (P=0.05)	11.87

Note: DAT = Days after treatment DAG = Days after germination
Figures in the table are mean values and those in parenthesis are angular transformed value

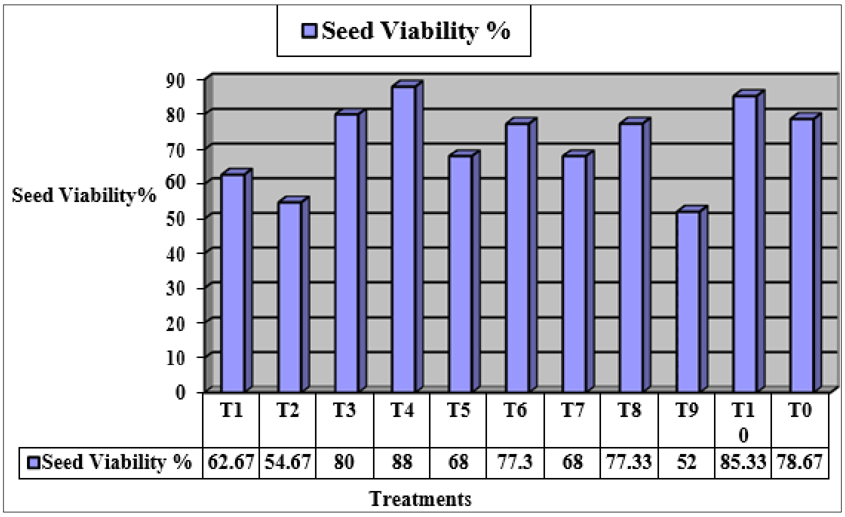

Fig 3: Effect of different bio-pesticides on percentage of seed viability after 60days of treatment and 7 days after germination

T1- *Pongamia pinnata*
T2- *Murraya koenigii*
T3- *Ocimum sanctum*
T4- *Syzygium aromaticum*
T5- Sesame oil
T6- Sunflower oil
T7- Groundnut oil
T8- Mustard oil
T9- Castor oil
T10- Malathion 5% dust
T0- Untreated control

Conclusions

From the investigations it can be concluded that vegetable oils were found highly effective in reducing the oviposition, adult emergence. Other treatments like *Syzygium aromaticum* and *Ocimum sanctum* were also found to be effective in controlling the pulse beetle next to vegetable oils. But the plant powder *Murraya koenigii* was found least effective than untreated control, it was mainly because of the moisture developed in the powder on the treated seeds which made the conditions favourable for the growth of the *Callosobruchus chinensis* (L.). when we observe the seed viability in different treatments castor oil (59%) showed the least germination percentage, it was found that the greasy nature of the oil effected the viability of the seeds when stored for many days. While highest percentage of germination was observed in the seeds treated with *Syzygium aromaticum* (88%). The standard check Malathion 5% dust which was used in this study was found effective in reducing the pest attack by *Callosobruchus chinensis* (L.) and also it didn't affect the seed viability.

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Appendix

ANOVA Table 1: Percentage reduction in oviposition by Callosobruchus chinensis on chickpea seeds after treatments

Source of Variance	Degree of Freedom	Sum of Square	Mean Sum of Square	F Cal	F Tab at 5%	S/NS
Treatment	10	39796.35	3979.64	62.93	2.30	*Significant*
Error	22	1391.17	63.24			
Total	32	41187.53				

ANOVA Table 2(A): Percentage of adults emerged after chickpea seeds were treated with the treatments on 1st day.

Source of Variance	Degree of Freedom	Sum of Square	Mean Sum of Square	F Cal	F Tab at 5%	S/NS
Treatment	10	724.63	72.46	127.39	2.30	Significant
Error	22	12.51	0.57			
Total	32	737.14				

ANOVA Table 2(B): Percentage of adults emerged after chickpea seeds were treated with the plant powders and vegetable oils on 2nd day

Source of Variance	Degree of Freedom	Sum of Square	Mean Sum of Square	F Cal	F Tab at 5%	S/NS
Treatment	10	1467.60	146.76	181.72	2.30	Significant
Error	22	17.77	0.81			
Total	32	1485.37				

ANOVA Table 2(C): Percentage of adults emerged after chickpea seeds were treated with the plant powders and vegetable oils on 3rd day

Source of Variance	Degree of Freedom	Sum of Square	Mean Sum of Square	F Cal	F Tab at 5%	S/NS
Treatment	10	573.67	57.37	120.23	2.30	Significant
Error	22	10.50	0.48			
Total	32	584.17				

ANOVA Table 2(D): Percentage of adults emerged after chickpea seeds were treated with the plant powders and vegetable oils on 4th day

Source of Variance	Degree of Freedom	Sum of Square	Mean Sum of Square	F Cal	F Tab at 5%	S/NS
Treatment	10	644.62	64.46	130.57	2.30	Significant
Error	22	10.86	0.49			
Total	32	655.48				

ANOVA Table 2(E): Percentage of adults emerged after chickpea seeds were treated with the plant powders and vegetable oils on 5th day

Source of Variance	Degree of Freedom	Sum of Square	Mean Sum of Square	F Cal	F Tab at 5%	S/NS
Treatment	10	495.50	49.55	142.79	2.30	Significant
Error	22	7.63	0.35			
Total	32	503.13				

ANOVA Table 2V: Percentage of germination of chickpea seeds after 60 DAT.

Source of Variance	Degree of Freedom	Sum of Square	Mean Sum of Square	F Cal	F Tab at 5%	S/NS
Treatment	10	1890.56	189.06	3.85	2.30	**Significant**
Error	22	1080.55	49.12			
Total	32	2971.11				