

An Eco-Friendly Management of Pulse Beetle, *Callosobruchus chinensis* using Neem Formulations in Black Gram

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Abstract: The efficacy of different neem products like neem seed powder, neem cake, neem dry leaf powder, neem oil and commercially available neem formulations viz., Econeem plus®, Neemindia® and Neemazal® were evaluated in the laboratory for the control of pulse beetle, *C. chinensis* in stored black gram. The black gram seed was treated with the neem products were stored under ambient conditions and the data was recorded at three months interval on germinability, seedling vigour index and insect damage. All the neem formulations were found to be effective against *C. chinensis* in stored black gram up to 15 months of storage. Neem oil @ 5 ml/kg seed affected badly the germinability and seedling vigour of black gram seed under storage. The neem formulations viz., Neemazal, Econeem plus and neem cake were on par with deltamethrin found to be very effective against pulse beetle and improved the storability and quality of black gram seed. These neem products are safe, cheap, residue free and eco-friendly seed protectants that can fit into the IPM package of stored grain pests of black gram.

Keywords: Blackgram, *Callosobruchus chinensis*, germination, neem formulations, seedling vigour, storage pests

1. Introduction

Black gram (*Vigna mungo*) is an important pulse crop in India and is the main source of protein for the predominantly vegetarian population of country. It is also a rich source of energy, minerals, vitamins and plays a major role in correcting malnutrition. The pulse beetle, *Callosobruchus chinensis* Linn (Coleoptera, Bruchidae) is one of the most destructive pests infesting stored pulses in India. Due to short life cycle and high degree of reproductive capacity, losses caused by this beetle to the pulses have been estimated to the tune of 30 - 40% in storage [12]. Hence, the management of pulse beetle is vital for successful and long term storage of the pulses. At present, the pest control measures in storage rely on the use of synthetic insecticides, however their injudicious and repeated use have created several problems such as insect resistance and toxic residues in food grains. The growing awareness of hazards of excessive use of pesticides globally had led researchers for safer and more environment friendly alternatives for pest control under storage. One of such methods is the use of plant products to protect the stored grains, as these are cheap, easily available, target specific and safe to environment and human beings. In view of this, the present studies were undertaken to evaluate the insecticidal efficacy of certain commercially available neem formulations against pulse beetle as an alternative to chemical control in stored black gram.

2. Materials and Methods

Laboratory and storage studies were conducted at Seed Entomology Laboratory, Seed Research and Technology Centre, Acharya N G Ranga Agricultural University, Hyderabad, India. Untreated, freshly harvested, insect free and clean black gram seed with little dockage was used for experimental purpose. Four indigenously available neem products viz., neem seed kernel powder, neem cake, neem dry leaf powder and crude neem oil and three commercially

available neem formulations viz., Econeem plus® (Margo Bio-Controls Private Ltd., Bangalore, India) Neemindia® (ITC Ltd., India) and Neemazal® (EID Parry India Limited) were tested against pulse beetle in black gram seed. Deltamethrin @ 40 mg/kg seed was used as standard chemical check for comparison. One kg of freshly harvested certified seed with high germination (> 90%) and low moisture content (10%) was used for experimentation. Required quantity of neem formulation was added and mixed thoroughly for proper coating on the seed. The seeds were packed in gunny bags of 2 kg capacity and kept in laboratory under ambient conditions of 27±5^o C temperature and 65±5% RH. The data recording was initiated after three months of storage and continued up to 18 months of storage at three months interval. Observations on oviposition of pulse beetle, adult emergence, seed germination, seedling vigour index and pulse beetle damage were recorded. To test the viability of seed, germination test using paper towel technique was carried out as per the procedure given by [7]. Germinated seeds were counted on 10th day and ten germinated seedlings were selected from each replication of the treatment for calculating the seedling vigor index. The shoot and root length of each of the ten seedlings were measured in centimeters and total length of the seedling was calculated. The seedling vigor index was calculated by using the following formulas [1]. Seedling vigour index (SVI) = Germination (%) x Total seedling length (cm). The data were statistically analyzed using MSTAT statistical package.

3. Results and Discussion

The pooled results of the two years were combined and presented as detailed below.

Effect of neem formulations on oviposition of *C. chinensis*: Significant reduction in egg laying was observed in all the neem formulations treated seeds compared to the untreated control (Fig.1). Among the seven treatments, Neemazal, Econeem plus and neem seed kernel powder were found to

be superior with no egg laying on treated seeds compared to deposited for 50 seeds. untreated control where a mean number of 135 eggs were

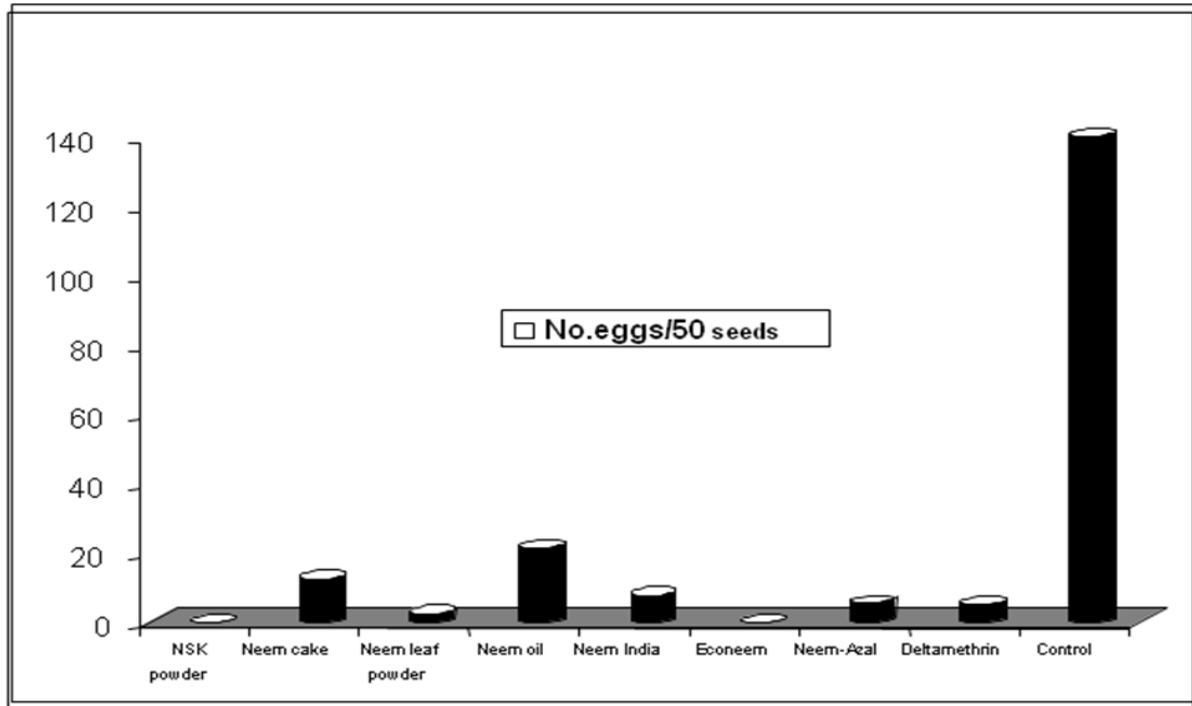


Figure 1: Effect of neem formulations on oviposition of pulse beetle on treated black gram seed

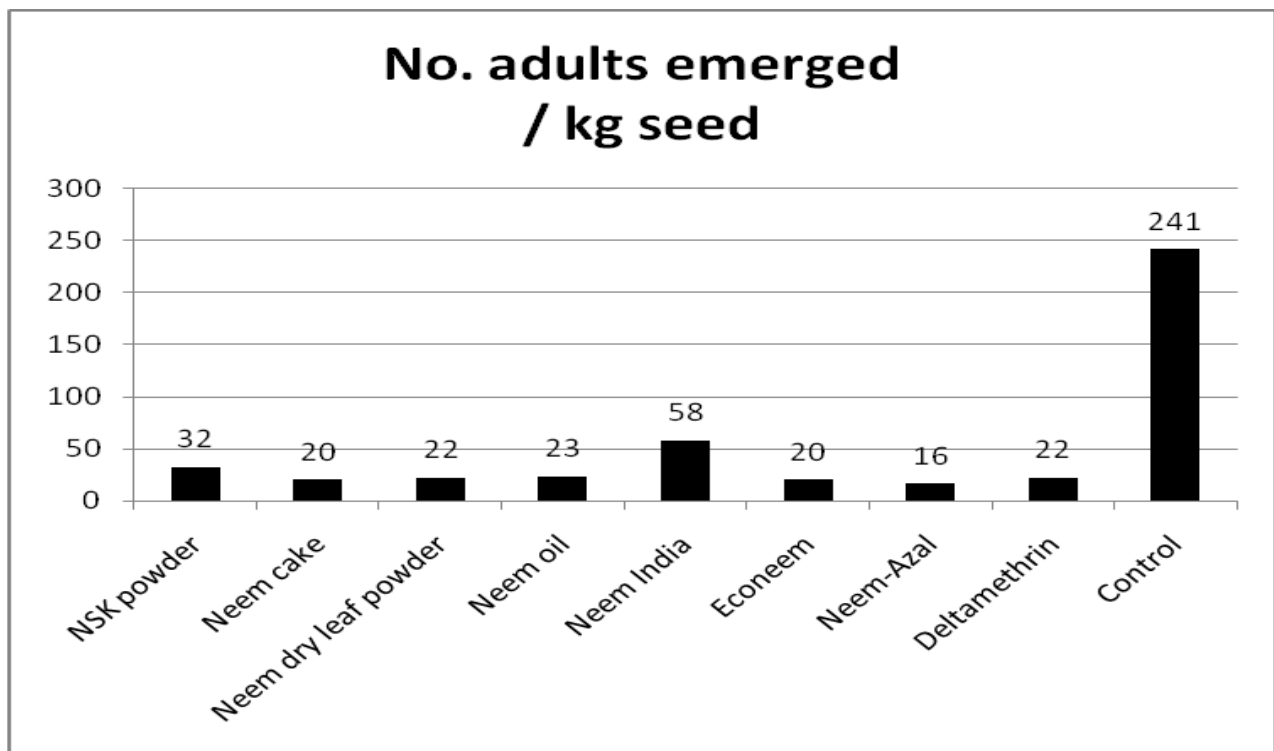


Figure 2: Effect of neem formulations on adult emergence of pulse beetle in black gram

The reduced oviposition rate due to neem formulations was also reported by many workers. [14] observed that ovicidal and oviposition inhibition properties of neem oil. Similarly, [10] and [11] reported a significant reduction in egg laying and adult emergence in *C. maculatus* treated with neem seed oil. [18] reported that the neem oil (5 ml/kg) was most effective as oviposition deterrent and also increased the

developmental period resulting in minimum growth indices of the *C. chinensis*.

Effect of neem formulations on pulse beetle emergence:

The mean number of adults emerged was significantly less with all the neem treatments (16 to 58 insects) compared to control (241 insects / kg seed) as indicated in (Fig.2). Neemazal recorded lowest number of adult emergence (16

insects) followed by Econeem plus, neem cake (20 insects) and found superior to chemical check deltamethrin (22 insects). Neem oil treatment also reduced oviposition, inhibited adult emergence and development of *C. maculatus*, *C. chinensis* and *C. analis* [21], [17], [2]. [15] found that neem oil did not allow adult emergence along with reduced oviposition and also prevented insect development against pulse beetle attack in *Vigna radiata*.

Effect of neem formulations on pulse beetle damage: The per cent damage in black gram seeds treated with different neem formulations at different storage intervals was found to be significant (Table 1 and Fig.3). All the neem products provided excellent control over pulse beetle damage with no insect infestation on par with deltamethrin up to 12 months of storage as against 10.5 % insect damage recorded with untreated control. Fifteen months after storage, Neemazal,

NSK powder and neem cake proved to be superior seed protectants with no insect damage followed by Econeem plus and neem-India (< 1%) compared to high insect damage of 22.2% in untreated control. Neemazal protected the black gram seed against *C. chinensis* damage (1.26 %) better than the local neem products, which in turn provided far better protection against the pulse beetle compared to 37.21% in untreated control up to 18 months in stored black gram. The overall mean insect damage indicated that Neemazal, Econeem plus, Neemcake and neem oil proved to be better protectants of stored black gram seed (< 1%) and on par with deltamethrin (0%) compared to untreated control (12.1%). The present research findings are in agreement with the earlier researchers who have reported the efficacy of neem products on pulse beetle damage in stored pulses [21], [17], [3].

Table 1: Effect of neem formulations on pulse beetle incidence in black gram during storage

Treatments	Months after storage						
	Insect damage (%) *						
	3	6	9	12	15	18	Mean
NSK powder	0	0(0.7)	0(0.7)	0(0.7)	0(0.7)	15.2(22.9)	2.5(8.9)
Neem cake	0	0(0.7)	0(0.7)	0(0.7)	0(0.7)	3.92(11.4)	0.7(4.7)
Neem dry leaf powder	0	0(0.7)	0(0.7)	0(0.7)	14.2(22.1)	26.6(31.0)	6.8(15.0)
Neem oil	0	0(0.7)	0(0.7)	0(0.7)	2.59(8.7)	2.92(9.7)	0.9(4.5)
Neemindia®	0	0(0.7)	0(0.7)	0(0.7)	1.1(5.4)	6.74(15.0)	1.3(6.1)
Econeem plus®	0	0(0.7)	0(0.7)	0(0.7)	0.9(1.8)	3.68(10.9)	0.8(4.3)
Neemazal®	0	0(0.7)	0(0.7)	0(0.7)	0(0.7)	1.26(6.4)	0.2(2.1)
Deltamethrin	0	0(0.7)	0(0.7)	0(0.7)	0(0.7)	0.0(0.7)	0.0(0.7)
Control	0	1.0(4.6)	4.5(12.4)	10.5(18.9)	22.2(28.1)	37.21(37.6)	12.1(20.3)
CD @ 5%	NS	2.4	2.0	1.1	3.2	3.9	2.3

*Figures in parentheses are arcsine transformed values

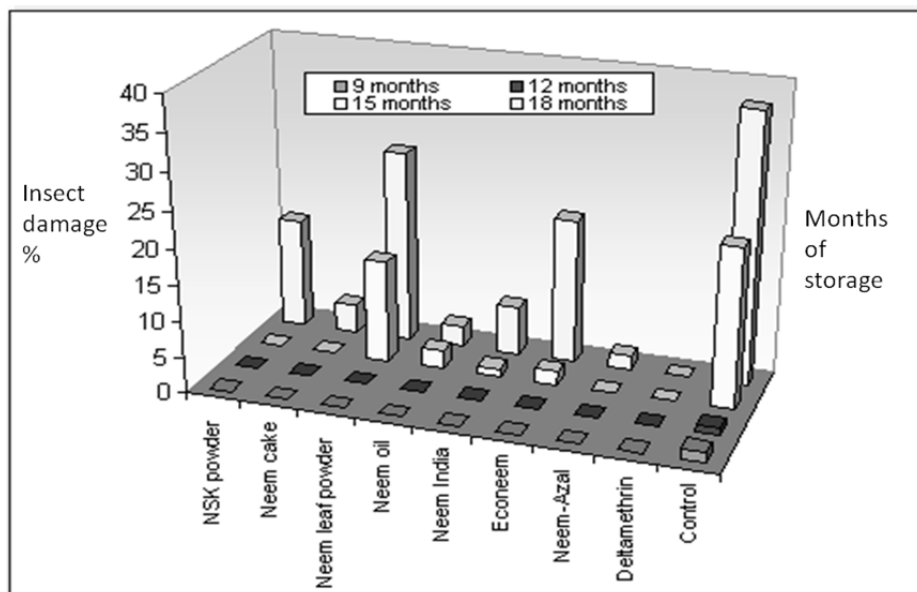


Figure 3: Effect of neem formulations on the pulse beetle damage of black gram seed at different storage intervals

Table 2: Effect of neem formulations on the germinability and seedling vigour index of black gram during storage

Treatments	Months after storage													
	Germination (%)*							Seedling vigor index **						
	3	6	9	12	15	18	Mean	3	6	9	12	15	18	Mean
NSK powder @ 5g/kg seed	90.6 (75.3)	88.0 (73.9)	86.66 (73.2)	86.0 (72.8)	80.6 (70.3)	75.33 (60.5)	84.5 (66.8)	2100 (45.8)	1736 (41.6)	1632 (40.4)	1432 (37.8)	1124 (33.5)	922 (30.3)	1491 (38.6)
Neem cake @ 5g/kg seed	90.0 (75.0)	87.0 (70.08)	86.0 (69.05)	84.0 (67.2)	84.0 (67.2)	82.0 (65.5)	85.5 (67.6)	2249 (47.4)	1933 (43.9)	1732 (41.6)	1589 (39.8)	1218 (34.9)	977 (31.2)	1616 (40.2)
Neem leaf powder @ 5g/kg seed	89.0 (72.5)	86.0 (69.05)	76.33 (61.0)	76.3 (61.2)	73.0 (58.9)	70.33 (57.2)	78.5 (62.4)	2159 (46.4)	1804 (42.4)	1655 (40.6)	965 (30.9)	927 (30.5)	851 (29.2)	1394 (37.3)
Neem oil @ 5ml/kg seed	61.6 (51.8)	60.0 (50.85)	58.0 (49.7)	57.0 (49.1)	57.0 (49.1)	56.6 (48.8)	58.4 (49.8)	1817 (42.6)	1754 (41.8)	1206 (34.6)	1115 (33.3)	711 (26.7)	576 (24.0)	1197 (34.5)
Neemindia@ @ 5ml/kg seed	92.3 (76.3)	90.0 (75.0)	83.6 (71.7)	79.6 (69.9)	61.66 (62.5)	53.6 (59.4)	76.8 (61.2)	1875 (43.3)	1758 (41.8)	1155 (33.9)	1029 (31.9)	953 (30.9)	861 (29.3)	1272 (35.6)
Econeem plus@ @ 5ml/kg seed	91.0 (75.6)	89.0 (74.5)	88.3 (74.1)	83.3 (71.6)	82.66 (71.3)	80.0 (63.9)	85.7 (67.8)	2119 (46.0)	1752 (41.8)	1727 (41.5)	1218 (34.8)	926 (30.4)	889 (29.8)	1439 (37.9)
Neemazal@ @ 1.5ml/kg seed	90.3 (75.2)	90.0 (75.0)	90.0 (75.0)	90.0 (75.0)	90.0 (75.0)	89.6 (74.8)	90.0 (75.0)	2275 (47.7)	1808 (42.4)	1760 (41.9)	1279 (35.6)	1271 (35.7)	1000 (31.6)	1566 (39.5)
Deltamethrin @ 40 mg /kg seed	92.0 (76.1)	90.0 (75.0)	89.0 (74.5)	88.6 (74.2)	87.66 (73.7)	86.3 (69.4)	88.9 (74.5)	2275 (47.7)	2167 (46.5)	1663 (40.7)	1252 (35.3)	1112 (33.4)	970 (31.2)	1573 (39.6)
Control	89.3 (73.0)	83.0 (66.3)	76.66 (61.4)	69.0 (56.4)	62.00 (52.0)	50.0 (45.0)	73.2 (58.8)	1796 (42.3)	1714 (41.4)	1615 (40.19)	1256 (35.4)	1095 (33.1)	915 (30.3)	1399 (37.3)
CD @ 5%	4.33	5.76	7.36	8.52	11.3	12.0	0.44	0.19	0.15	0.37	0.39	0.52	0.52	0.24

* Figures in parenthesis are arcsine transformed values ** Figures in parenthesis are square root transformed values

Effect of neem formulations on seed germination and seedling vigour: Among the different neem formulations, seeds treated with Neemazal registered highest seed germination (90%) up to 15 months of storage of black gram seed (Table 2.). Except crude neem oil, all other neem products maintained germinability of black gram seed above seed certification standards (>80%) upto six months of storage but the germination of neem oil treated seeds was dropped to 61.6 % within three months of storage which is less than the germination of untreated seeds (89.3%). The pooled mean data of 18 months of storage indicated that neem formulations viz., Neemazal (90%), Econeem plus (85.7%), neem cake (85.5%) and NSK powder (84.5%) recorded high germination and on par with chemical check deltamethrin (88.9%) compared to low germination recorded with crude neem oil (58.4%) and untreated check (73.2%). Hence, commercial neem formulation, Neemazal was proved superior to the local neem products in grain protection against germination loss and on par with chemical check deltamethrin, with crude neem oil being the least effective (58%). Similar reports of reduced germination of pulse seeds due to neem oil treatment was reported by [20]. In contrary, [13] in green gram and [19] in cow pea reported that neem oil at 0.5 % maintained higher germination and seed vigour during storage.

The studies on seedling vigour index of black gram seed at different storage intervals indicated that the vigour of seedlings decreased with the increase of storage period. The pooled mean data of 18 months of seed storage indicated significant differences in seedling vigour index of treated seeds at different storage intervals (Table 2). Neem cake, Neemazal followed by Econeem plus proved superior to all other neem formulations with highest seedling vigour (1616, 1566 and 1439, respectively) throughout the storage period of 18 months compared to chemical check deltamethrin

(1578) and untreated control (1399) . Crude neem oil treatment to black gram seed resulted in not only poor germination but also less vigour of the seedling.

Toxicity of neem based formulations have also been reported elsewhere [16], [6], [9], [4], [8]. The present results receive support from [5] who reported that Neemazal-W (a powder formulation) gave mortality and reduction in progeny of five major pests of stored grains including *T. castaneum*.

The results of present study emphasized the potential of indigenous and biological neem based products like Neem cake, NSK powder and commercially available neem formulations like Neemazal and Econeem plus in the storage of pulses and can be used as alternatives to conventional insecticides like deltamethrin for long term safe storage of pulses . These neem products are safe, cheap, residue free and eco-friendly materials that can fit into the IPM package of stored grain pests of pulses.

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