

Neem formulations – safer seed protectants for long term storage of red gram against *Callosobruchus chinensis*

Rajasri Mandali and K. Dharma Reddy

ABSTRACT

The efficacy of indigenous neem products like neem seed kernel powder, neem cake, neem 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 redgram. These were compared with deltamethrin treatment as a chemical check. The red gram seed was treated with the neem formulations and stored under ambient conditions for storability studies. Observations on oviposition, insect damage, germination and seedling vigor index were recorded at three months interval. All the three commercially available neem formulations viz., Neemazal, Econeem plus, Neem india recorded less insect damage (<1 %) on par with neem oil (1%) and deltamethrin (0.8%) but found significantly superior to other neem products (1.2 to 1.4 %) and untreated control (1.8%) during three months of storage. Econeem plus proved to be superior over other neem formulations with lowest insect damage (1.28%) on par with Neemindia (3.79%) and deltamethrin (3.07%) compared to high insect damage recorded with untreated control (49.04%) at six months of storage. All the three commercially available neem formulations viz., Econeem plus, Neem india and Neemazal recorded less insect damage (6.9, 7.3 and 7.5 % respectively) on par with deltamethrin (7.3%) and neemoil (8.7%) and deltamethrin (0.8%) but found significantly superior to other neem products (> 40 %) and untreated control (64.2%) up to nine months of storage. The results indicated that the neem formulations viz., Econeem plus, Neemazal and Neemindia were found to be very effective against *C. chinensis* by recording less oviposition, less adult emergence and less insect damage in stored red gram and also maintained high viability (>80%) and vigour of seed up to nine months of storage.

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INTRODUCTION

Red gram is an important pulse crop in India which is the major source of dietary protein for most of the vegetarian population of India. Post harvest losses during red gram storage are severe due to pulse beetle, *Callosobruchus chinensis* (F.) (Coleoptera: Bruchidae). It causes 30- 55 % grain losses in terms of both qualitative and quantitative constituents. *C. chinensis* is a serious cosmopolitan and polyphagous pest of stored pulses such as green gram, black gram, red gram, bean, cowpea, lentil, chickpea or other legumes. In the recent past, the preservation of pulses has relied heavily upon the insecticides to control the storage pests. But the increasing problems of resistance and residues of pesticides and contamination of biosphere have led

the need for safer and eco friendly biodegradable pesticides.

The present trend is towards the use of alternative environmental friendly and non-toxic control methods that pose no threat to the health of operator or consumer. It is demanding to develop the alternative methods that are economically feasible and ecologically safer to control the storage grain insects (Moreno-Martinez *et al.*, 2000). The use of botanical pesticides is considered as one of the alternative substitute to hazardous chemicals. Among the botanicals, Neem is visualized as an eco-friendly pesticide having rich source of bioactive chemicals with a greater potential for use as successful pest control agent which can affect insects in several ways: they may disrupt major

metabolic pathways and cause rapid death, act as attractants, deterrents, phago-stimulants, anti-feedants or ovipositional deterrents, also retard or accelerate development or interfere with the life cycle of the insects. Hence, the present study was conducted to evaluate the efficacy of neem formulations against pulse beetle, *C. chinensis* infesting red gram and its effect on the long term storability and quality parameters of red gram.

MATERIALS AND METHODS

The laboratory studies were conducted during 2010 and 2011 at Seed Entomology Laboratory, Seed Research and Technology Centre (S.R.T.C), Acharya N. G. Ranga Agricultural University (A.N.G.R.A.U), Rajendranagar, Hyderabad Andhra Pradesh. Freshly harvested, insect free and clean red gram variety 'LRG-30' obtained from Breeder seed production unit of S.R.T.C, Rajendranagar, Hyderabad was used for experimental purpose. The moisture content of red gram seed was determined by Dickey John Moisture meter and it was 10%. Four indigenous neem products viz., Neem Seed Kernel (NSK) powder, Neem cake, Neem leaf powder, 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 Ltd, India) along with chemical check deltamethrin were evaluated against pulse beetle in red gram seed. 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 $27\pm 5^{\circ}$ C temperature and $65\pm 5\%$ RH for natural infestation. The data recording was initiated after three months of storage and continued up to nine months of storage at three months interval. Observations on oviposition, adult emergence, insect damage of pulse beetle, seed germination and seedling vigor index were recorded at different storage intervals. Germination test using paper towel technique was carried out as per the procedure given by ISTA (1999). 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 10 seedlings were measured in centimeters and total length of the seedling was calculated. The seedling vigor index was calculated by using the following formula (Abdul-Baki and Anderson, 1973). The data were statistically analyzed using MSTAT statistical package.

RESULTS AND DISCUSSION

Neem formulations on oviposition of pulse beetle

The efficacy of different neem formulations on the fecundity of *C. chinensis* on redgram is depicted in Fig.1. All the commercially available neem formulations viz., Econeem plus, Neemazal, NeemIndia and neem oil were found to be superior and recorded less number of eggs on treated seeds on par with chemical check deltamethrin compared to other neem products and untreated control (Table 1). There were only few reports on the ovipositional deterrent action of neem products against the pulse beetle. Khaire *et al.* (1993) reported that treating pigeon pea seeds with neem oil showed significant repellent action against egg laying by adult *C. chinensis* beetles for up to 100 days after treatment. Pandey *et al.* (1986) also found that plant extracts of neem leaves and twigs gave a high repellent action against *C. chinensis*.

Adult emergence of pulse beetle

Among the different neem formulations, seeds treated with Econeem plus registered lowest number of adults followed by deltamethrin, neem oil, neemindia and Neemazal compared to untreated control. All the indigenous neem products viz., NSK powder, neem cake and neem leaf powder recorded more number of pulse beetle adults compared to commercial neem formulations. Neem leaf powder was found to be inferior by recording highest number of pulse beetles and on par with untreated control (Table 1).

Pulse beetle damage

Significant differences in pulse beetle damage was observed with in red gram seed treated with neem formulations at different storage intervals (Table 1). All the three commercially available neem formulations viz., Neemazal, Econeem plus and Neem india recorded less insect damage and on par

Table 1. Effect of neem formulations on the oviposition, adult emergence and insect damage of pulse beetle on red gram at different storage intervals

Treatments (ml/kg seed)	No. eggs/ 100 seeds	No. Adults emerged /kg seed	Insect damage (%) * (months after storage)		
			3	6	9
NSK powder @ 5 g	36	676	1.4	31.5	42.2
Neem cake @ 5 g	29	1013	1.2	29.2	39.7
Neem dry leaf powder -5g	17	2336	1.4	36.7	40.6
Neem oil @ 5ml	4	117	1.0	4.49	8.7
Neemindia @ 5 ml	9	258	0.7	6.25	7.3
Econeemplus @ 5 ml	2	44	0.6	1.28	6.9
Neemazal @ 1.5 ml	6	344	0.4	3.79	7.5
Deltamethrin @ 40 mg	4	67	0.8	3.07	7.3
Untreated control	39	2533	1.8	49.04	64.2
CD @ 5 %			0.15	2.67	3.45

with neem oil and deltamethrin but found significantly superior to other neem products and untreated control up to three months of storage. Econeem plus proved to be superior to other neem formulations with lowest insect damage on par with Neemindia and deltamethrin compared to high infestation recorded with untreated control while Neem oil and Neemazal showed moderate efficacy against pulse beetle with 4.49 % and 6.25 % seed damage respectively. Whereas indigenous neem based products *viz.*, NSK powder, neem leaf powder and neem cake proved ineffective against pulse beetle in red gram and recorded high insect infestation.

The present research findings are in agreement with the findings of earlier researchers who have reported the efficacy of neem products on pulse beetle damage in stored pulses (Yadav 1985, Sujatha and Punnaiah 1985, Das and Karim, 1986). Studies on the residual effect of neem against *C. chinensis* conducted by Choudhary (1990) showed that the damage by the pulse beetle was reduced on neem oil treated chickpea. Jacob and Sheila (1990) reported that the effectiveness of neem oil against *C. chinensis* on green gram which gave 60% mortality of the bruchid after 3 days. Studies conducted by Pandey and Singh (1995) showed that neem leaf powder could effectively protect black gram seed from damage of *C. chinensis*. They also found that neem bark powder was effective in reducing the

damage. Mansour (1997) tested NeemAzal-S against *C. chinensis* in the laboratory and found that 0.5% NeemAzal-S gave 100% mortality of different stages of the pest up to three months.

Toxicity of neem based formulations have also been reported by earlier workers with various neem extracts which have repellent, antifeedant and toxic effects against a number of stored grain insect pests (Nazli *et al.* 2003). Ahmed *et al.* (2000) reported the efficacy of neem extracts compared cypermethrin and methyl parathion against the stored grain insect pests and observed that neem extracts gave highest mortality of *T. castaneum*, this supports our results of neem formulations especially which gave less insect damage and oviposition of the beetles. Zahid *et al.* (2000) reported high (63%) mortality by neem oil on par with actellic and malathion. The present results receive support from El-Lakwah and El-Kashlan (1999) who reported that Neemazal - W (a powder formulation) gave good mortality and reduction in progeny of five major pests of stored grains including *T. castaneum*.

Seed germination of red gram

All the neem formulations except neem oil maintained the seed germination above seed certification standards on par with deltamethrin compared to untreated control up to six months of storage. Among the different formulations, Econeem plus registered the highest seed

Table 2. Effect of neem formulations on the germination and seedling vigour of red gram

Treatments (per kg seed)	Germination (%)			Seedling vigour index (months after storage)		
	3M	6M	9M	3M	6M	9M
NSK powder @ 5.0 g	92	88	35	1825	993	256
Neem cake @ 5.0 g	90	86	23	1506	1054	150
Neem dry leaf powder @5.0g	90	87	63	1571	981	727
Neem oil @ 5.0ml	85	78	60	1676	1053	752
Neemindia @ 5.0 ml	90	80	75	1413	1166	828
Econeemplus @ 5.0 ml	96	90	82	1898	1185	1020
Neemazal @ 1.5 ml	91	90	80	1704	1121	816
Deltamethrin @ 40 mg	90	88	81	1661	992	895
Untreated control	79	67	19	1508	949	221
CD @ 5 %	8.47	8.59	8.38	183.7	179.9	261.25

germination (Table 2). Vijayalakshmi and Goswami (1986) reported reduced germination of pulse seeds due to neem oil treatment.

Seedling vigor index

The studies on seedling vigor index of red gram seed at different storage intervals indicated that the vigor of seedlings decreased with increase in storage period. All the neem formulations except crude neem were safer to the red gram seeds and maintained the germination of seeds above certification standards up to six months of storage. Econeem plus and neemazal maintained high seedling vigour on par with deltamethrin compared to untreated control up to six months of storage. The potential of commercial neem formulations like Neemazal, Neemindia and Econeem plus can be used in the storage of pulses as an alternatives to conventional insecticides like deltamethrin for long term safe storage of red gram seed. These neem products not only effectively controlled the pulse beetle, *C. chinensis* damage but also maintained the germination, seedling vigor and quality of red gram seed up to nine months of storage. Hence, these eco friendly neem formulations can be used as safer alternatives to chemicals for long term storage and sustainable pest management of stored pulses.

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¹Rajasri Mandali and ²K. Dharma Reddy

¹Regional Agricultural Research Station, Palem, Mahaboobnagar, A.P, India .

²Acharya N.G. Ranga Agri. University

Email: nihariraj@yahoo.co.in