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Effect of Cashew Nut Shell Liquid (CNSL) Seed Treatment on Seed Viability and Oviposition of Bruchids in Greengram and Redgram Seeds

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Greengram and redgram seeds are severely affected by the notorious pest called pulse beetle (*Callosobruchus chinensis* L.) or bruchid. Being an internal feeder, it causes heavy damage to the cotyledons and embryos during its short life cycle. Therefore, an attempt was made to use the Cashew Nut Shell Liquid (CNSL) for the control of pulse beetle. The results revealed that the greengram and redgram seeds treated with CNSL have recorded reduced insect infestation in the seeds. Number of eggs, number of insects and damage percentage were nil in seeds treated with 4 ml kg^{-1} of seed at six months of storage compared to other doses. However, more number of eggs, insects and damage percentage were observed in the untreated control seeds. The seed germination was also not affected by the above treatment in both greengram (92%) and redgram (87%) seeds during initial evaluation. If the doses were increased to 20 ml kg^{-1}, it affected the germination by recording 71 per cent in greengram and 81 per cent in redgram seeds, respectively. Further, greengram seeds treated with CNSL @ 4 ml kg ^{1} have maintained better viability with the germination of 82 per cent during 12 months of storage when compared to redgram seeds, which recorded only 27 per cent at 10 months period.

Key words: Pulses, CNSL, Viability, Oviposition deterrence, Bruchid.

Greengram and redgram are important protein rich pulse crops, which are highly affected by the storage pest called pulse beetle or bruchid (*Callosobruchus chinensis* L.). It is estimated that about 40-50% losses are due to this pulse beetle during seed storage (Shaaya *et al.,* 1997). The repeated use of pesticides as seed treating chemical leads to detrimental effect on the seeds and soils. Therefore, use of the organic materials as seed treating compound can minimize the hazardous effect. The cashew nut shell liquid (CNSL) is one such by-product obtained from cashew industry. It is highly viscous with pH 3.0 and deterrent insects. Inspite of its potential, CNSL has not been explored for the control of the pulse beetle in redgram and greengram seeds. Therefore, a study was conducted to investigate its effect on the oviposition of pulse beetle and also on the maintenance of seed viability.

Materials and Methods

CNSL seed treatment for oviposition deterrence

Experiments were conducted to find out the oviposition deterrence effect of CNSL on pulse beetle in greengram and redgram seeds at Department of Seed Science and Technology, Agricultural College and Research Institute, Madurai. Freshly harvested seeds of both crops were treated with the CNSL at different concentrations and the treatments include CNSL @ 1, 2, 3, 4, 6, 8, 10, 15 and 20 ml kg^{-1} separately The adult pulse beetles at the rate of 5 pairs per kg of seed were introduced in separate lots and stored in polythene bags at ambient room temperature (30^{0} C) for deterrence studies. Observations were made at two months intervals after insect release. About 100 seeds were drawn each from treatment and assessed for ovipositioning on seed surface. The seed damage percentage was assessed by observing the presence of exit holes. Multiplication of bruchids was enumerated in each treatment.

CNSL treatment for testing seed viability

Another set of the CNSL treated seeds along with untreated control were packed in the polythene bags and stored under ambient conditions (30^{0} C). Then the samples were drawn out once in two months for the evaluation of the viability and vigour. The germination test was conducted with 400 seeds from each treatment in four replications (ISTA, 1999). Seedling length was measured and vigour index was calculated using the formula, vigour index = germination percentage x seedling length (cm) (Abdul-Baki and Anderson, 1973).

The data collected were subjected to statistical analysis (Panse and Sukhatme, 1967) and the

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critical difference values were calculated at 5 % probability level.

Results and Discussion

CNSL seed treatment on oviposition deterrence in bruchids

The CNSL seed treatment showed significant differences in controlling the bruchid multiplication through reduced number of eggs, number of hatched adults and seed damage percentage in both the seeds. In greengram, the number of eggs seed^{-1} (3.18), number of insects (23.0) and damage percentage (41.0%) were more in the untreated control after two months of storage when compared to seeds treated with CNSL (Fig.1a and b; Fig. 2a and b). Seeds treated with lower doses *viz*., 1 and 2 ml kg^{-1} recorded more number of eggs on the seed, more number of adults and higher seed damage percentage. However, CNSL @ 4 ml kg^{-1} deterred oviposition and recorded no seed damage. Doses higher than this also did not show any damage.

Similarly, redgram seeds treated with CNSL @ 4 ml kg^{-1} of seed recorded no egg laying on the seed and that was the reason for no adults and no seed

Table 1. Effect of CNSL seed treatment on viability and seedling vigour of greengram seeds during storage

Treatments / storage	Seed germination (%)								Vigour index							
	Initial	2 MAS	4 MAS	6MAS	8MAS	10MAS	12 MAS	Mean	Initial	2 MAS	4 MAS	6MAS	8MAS	10 MAS	12 MAS	Mean
T1- Untreated seed	90	86	82	81	78	74	68	80	3070	2706	2282	3321	2655	2570	2493	2728
	(71.6)	(68.1)	(64.9)	(64.2)	(62.0)	(59.3)	(55.3)	(63.6)								
T2- CNSL @ 1 ml kg^{-1}	91	82	81	81	80	77	73	81	3036	2516	2312	3402	2812	2660	2540	2754
	(72.6)	(64.9)	(64.2)	(64.2)	(63.4)	(61.3)	(58.7)	(64.2)								
T3- CNSL @ 2 ml kg^{-1}	94	82	82	80	80	80	80	83	3027	2394	2398	2920	2905	2796	2846	2755
	(76.0)	(64.9)	(64.9)	(63.4)	(63.5)	(63.4)	(63.5)	(65.7)								
T4- CNSL @ 3 ml kg^{-1}	92	86	84	83	82	82	82	84	3063	2713	2581	3087	2911	2866	2860	2868
	(73.6)	(68.0)	(66.6)	(65.7)	(64.9)	(64.9)	(65.0)	(66.9)								
T5- CNSL @ 4 ml kg^{-1}	92	84	84	83	83	82	82	84	2700	2683	2494	2772	2971	2616	2734	2710
	(73.6)	(66.6)	(66.6)	(65.7)	(65.7)	(64.9)	(64.9)	(66.9)								
T6- CNSL @ 6 ml kg^{-1}	82	82	83	80	80	80	80	81	2746	2437	2333	3387	2808	2840	2705	2751
	(64.9)	(65.0)	(65.9)	(63.5)	(63.4)	(63.4)	(63.7)	(64.3)								
T7- CNSL @ 8 ml kg^{-1}	87	83	80	80	80	79	77	81	3120	2519	2319	2868	2779	2748	2656	2715
	(68.9)	(65.7)	(63.4)	(63.4)	(63.4)	(62.7)	(61.5)	(64.2)								
T8-CNSL @10 ml kg^{-1}	85	80	80	79	79	78	75	79	2820	2352	2342	2852	2842	2640	2920	2681
	(67.2)	(63.4)	(63.5)	(62.7)	(62.7)	(62.0)	(60.0)	(63.1)								
T9-CNSL @15 ml kg^{-1}	81	76	73	73	72	71	71	74	2689	1862	2053	2871	2479	2286	2438	2382
	(64.1)	(60.7)	(58.7)	(58.7)	(57.8)	(57.4)	(57.4)	(59.3)								
T10-CNSL@20 ml kg^{-1}	71	69	72	69	68	68	68	69	2285	1659	1956	2449	2245	2270	2389	2179
	(57.6)	(56.2)	(58.0)	(56.2)	(55.3)	(55.6)	(55.6)	(56.3)								
Mean	87	81	80	79	78	77	76		2855	2384	2307	2993	2740	2629	2658	
	(69.2)	(64.3)	(63.7)	(62.8)	(62.2)	(61.5)	(60.6)									
	S	T	SxT						S	T	SxT					
SEd	1.01	1.21	3.21						59.8	71.5	189.2					
CD(P=0.05)	2.02	2.42	NS						119.3	142.6	NS					

(* MAS - Months after storage; S - Storage period; T – Treatments; values in parenthesis indicate transformed arc sine values)

Table 2. Effect of CNSL seed treatment on viability and seedling vigour of redgram seeds during storage

Treatments / storage	Seed germination (%)							Vigour index						
	Initial	2 MAS	4 MAS	6MAS	8MAS	10MAS	Mean	Initial	2 MAS	4 MAS	6MAS	8MAS	10MAS	Mean
T1- Untreated seed	84	83	72	42	0	0	47	2373	2490	2154	1508	0	0	1421
	(66.5)	(65.7)	(57.7)	(40.4)	(2.9)	(2.9)	(39.3)							
T2- CNSL @ 1 ml kg^{-1}	86	84	71	51	0	0	49	2489	2427	1983	1777	0	0	1446
	(68.0)	(66.4)	(57.4)	(45.3)	(2.9)	(2.9)	(40.5)							
T3- CNSL @ 2 ml kg^{-1}	87	86	72	50	27	0	54	2692	3966	2612	1935	890	0	2016
	(68.9)	(68.0)	(58.0)	(45.0)	(31.3)	(2.9)	(45.7)							
T4- CNSL @ 3 ml kg^{-1}	86	86	66	56	31	30	59	2541	3513	2412	1972	992	748	2030
	(68.0)	(68.0)	(54.3)	(48.5)	(33.8)	(33.2)	(50.9)							
T5- CNSL @ 4 ml kg^{-1}	87	85	64	44	29	27	56	2556	3928	2434	1608	1014	795	2056
	(68.4)	(67.3)	(53.1)	(41.5)	(32.3)	(31.3)	(48.8)							
T6- CNSL @ 6 ml kg^{-1}	84	84	62	36	21	21	51	3059	3980	1877	1268	698	792	1946
	(66.4)	(66.6)	(51.9)	(36.8)	(27.3)	(27.3)	(46.1)							
T7- CNSL @ 8 ml kg^{-1}	89	82	61	36	22	19	52	2776	4455	1998	1271	634	662	1966
	(70.6)	(64.9)	(51.4)	(36.8)	(27.9)	(25.8)	(46.3)							
T8- CNSL @ 10 ml kg^{-1}	86	85	60	39	28	26	54	2769	4227	2240	1404	981	698	2053
	(68.0)	(67.2)	(50.8)	(38.6)	(31.7)	(30.6)	(47.8)							
T9- CNSL @ 15 ml kg^{-1}	84	83	64	36	28	26	54	2528	4001	2195	1332	1193	745	1999
	(66.5)	(65.7)	(53.1)	(36.8)	(31.9)	(30.6)	(47.5)							
T10- CNSL @20 ml kg^{-1}	81	81	59	35	16	18	48	2567	4158	1909	1154	654	516	1826
	(64.2)	(64.3)	(50.2)	(36.3)	(23.4)	(25.1)	(43.9)							
Mean	85	84	65	42	20	17	52	2635	3714	2181	1523	706	496	
	(67.6)	(66.4)	(53.8)	(40.6)	(24.5)	(23.6)	(45.7)							
	S	T	SxT					S	T	SxT				
SEd	1.13	1.47	3.60					63.7	82.4	201.7				
CD(P=0.05)	2.28	2.94	7.20					127.5	164.7	403.5				

(* MAS - Months after storage; S - Storage period; T – Treatments; values in parenthesis indicate transformed arc sine values)

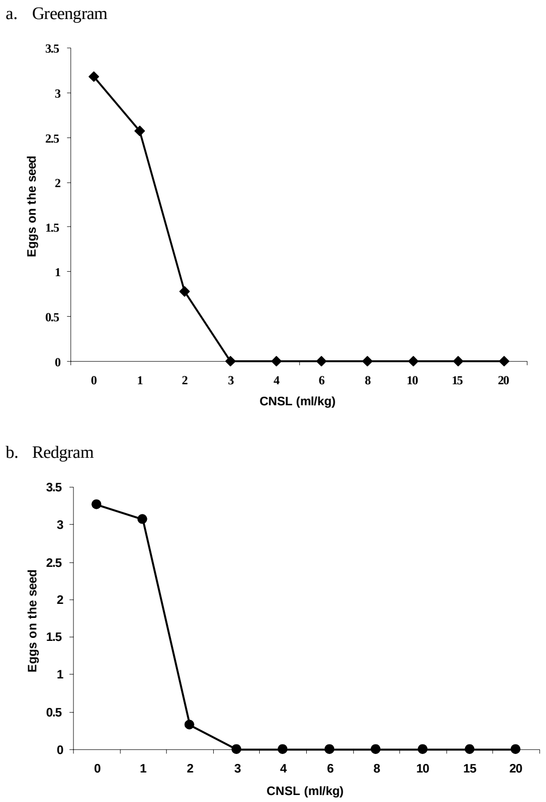

Fig 1. Effect of CNSL seed treatment on oviposition in greengram and redgram seeds (after 2 months of storage)

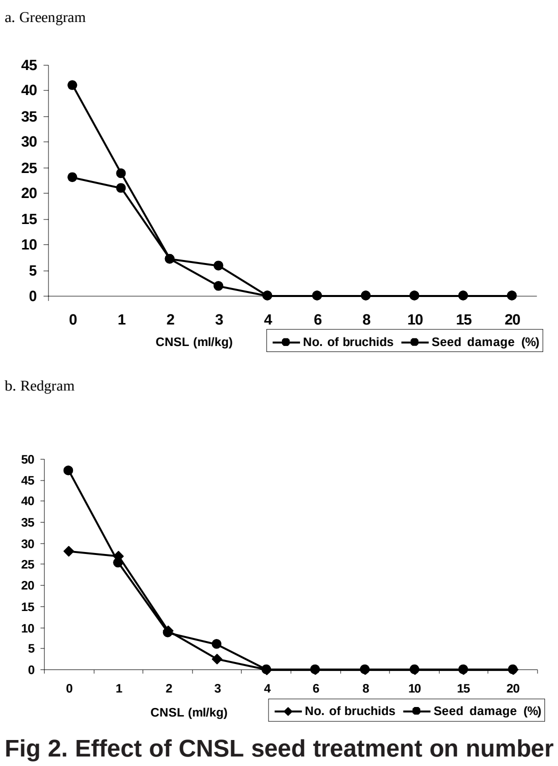

Fig 2. Effect of CNSL seed treatment on number of bruchids and seed damage (%) in greengram and redgram seeds (after 2 months of storage)

damage recorded. However, untreated seeds recorded the maximum number of eggs seed^{-1} (3.27), number of insects (28.0) and seed damage (47.3%) during two months of storage. The seeds treated with higher doses of CNSL (more than 4 ml kg^{-1}) also revealed no insect fecundity and thus, remained undamaged (Fig.1a and b; Fig. 2a and b). Raja (2008) recorded similar trend of low adult emergence, eggs and seed infestation in CNSL treated blackgram seeds. The reduced egg laying might be due to the oily nature or toxic substances or repellent compounds in the CNSL, which might have caused alteration in insect egg laying behaviour. Generally CNSL is bitter, caustic and fumigatory with smokes that irritate and gives off choking fumes (Raja *et al*., 2013). This might have caused the low egg laying on the seed leading to low adult emergence and concomitant seed damage. Mandal (1997) reported that CNSL had consisted of two highly reactive phenolic compounds *viz*., anacardic acid (90%) and cardol (10%), of which cardol showed pronounced insecticidal and fungicidal properties. It has also been reported to be an excellent preservative to timbers, books and stationery especially preventing insect damage. This kind of insecticidal property might have caused lower adult build up and seed infestation.

CNSL seed treatment for testing seed viability

The result on seed germinability showed that greengram seeds treated with lower concentrations of CNSL were not affected. Seeds treated with CNSL at 1 to 4 ml kg^{-1} recorded higher germination (91%, 94%, 92% and 92%, respectively). Whereas, the seeds treated with CNSL more than 4 ml kg^{-1} recorded reduced germination percentage. While, CNSL @ 20 ml kg^{-1} of seed had the lowest germination (71%) (Table 1). Similarly, in redgram seeds, lower doses did not affect the germination. But at higher doses of 15 or 20 ml kg^{-1} of seed, the germination was completely affected (84 and 81%, respectively) (Table 2). In both the crop seeds, the seedling vigour index was not affected by the lower concentrations of CNSL. Raja (2008) found that the germination and seedling vigour of CNSL treated seeds were not affected in blackgram, particularly at lower doses. Similar results of germination and vigour maintenance were observed in legumes and pulses by several workers by using plant oils (Lele and Mustapha, 2000; Marwade *et al.,* 2002; Ramamurthy *et al.,* 2002; Rahman *et al.,* 2010).

The storability of CNSL treated greengram and redgram seeds were found to be affected by storage period. In greengram, maximum mean germination (84 %) was recorded in CSNL treated (@ 3 and 4 ml kg^{-1}) seeds when compared to untreated control (80 %) over a period of 12 months. Also the mean germination (87%) and vigour index (2855) were found to be reduced to 76% and 2658 over the same storage period irrespective of the treatments (Table 1).

In redgram, the mean germination was higher with CNSL treatment @ 3 ml (59 %) and 4 ml kg^{-1} (56 %) compared to control (no germination) during 10 months of storage. Whereas, the untreated and seeds treated with CNSL @ 1 ml and 20 ml kg^{-1} recorded the lowest mean germination (47, 49 and 48 %, respectively). The germination in redgram seeds declined from 85 to 17 %, irrespective of all the treatments during the 10 months of storage. The seedling vigour index revealed similar trends of reduction (2635 to 496) (Table 2). This might be due to the ageing phenomenon of seed would have caused the germination and vigour reduction in both the seeds. However, the greengram seeds could be stored better with higher germination (82%) during 12 months of storage when compared to redgram seeds, which recorded only 27 per cent over 10 months period (Table 2).

It is concluded that ovipositioning and adult emergence of pulse beetle (*Callosobruchus chinensis*) can be effectively controlled by cashew nut shell liquid (CNSL) seed treatment @ 4 ml kg^{-1} in greengram and redgram. However, the seed germination and seedling vigour were found to be affected at higher doses when the treated seeds were stored for long term. But the greengram seeds treated with CNSL @ 4 ml kg^{-1} were found to be stored better over 12 months storage when compared to redgram seeds.

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