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Full Length Research Paper

Euphorbiaceous Plant Formulations *vis-a-vis* Rate of development of the Bruchid *Callosobruchus chinensis* Linn.

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Abstract
Pulses constitute major source of protein in the diet of people of developing countries and play an important role in Indian economy and are traditionally recognized as an indispensable constituent of Indian food. The genus *Callosobruchus* attacks grain legumes during both pre and post harvest stages all over the world. Efficient control of stored grain pests has long been the aim of entomologists and the present work was carried out to screen certain formulations against the pulse beetle *Callosobruchus chinensis* Linn. raised on grains of *Vigna radiata*. The plants selected for the study includes *Euphorbia hirta*, *Phyllanthus amarus* and *Jatropha gossypiifolia* all belonging to family Euphorbiaceae. Different formulations using leaf of the plants were employed in the form of crude extract, aqueous suspension, aqueous extract, ethanol extract and diethyl ether extract. The treatments were made using different dose concentrations of 1, 5, 10 and 25% and rate of development was documented. It could be concluded from the study that plants belonging to family Euphorbiaceae do possess chemicals, which are toxic to insects and therefore have a potential to be used against the pest *C. chinensis*. Although, the three select plants showed varied degree of effect on rate of development, *P. amarus* seemed to be the most effective.

Key words: *Callosobruchus chinensis*, Euphorbiaceae, *Euphorbia hirta*, *Phyllanthus amarus, Jatropha gossypiifolia*, Plant formulations, Rate of development.

Introduction

In India, where the population is predominantly vegetarian, pulses are the most important and rich source of protein and several amino acids. Besides, these also provide energy, minerals and certain vitamins. Pulses contain 20-30% of protein which is almost three times higher than cereals (Doharey et al., 1990). According to reports available, in India, over 200 species of insects have been recorded infesting various pulses (CABI, 2007). Of these, 17 species of bruchids belonging to 11 genera have been recorded infesting different pulses (Arora, 1977). The genus *Callosobruchus* attacks grain legumes during both pre and post harvest stages all over the world; but in India, *C.maculatus*, *C. analis* and *C. chinensis* are the predominant pest species of the genera (Dias, 1988). The bruchid infestation also affects seed quality, market value and can reduce cowpea seed viability to 2% after months of storage (Caswell, 1980).

Efficient control of stored grain pests has long been the aim of entomologists throughout the world and synthetic chemical pesticides have been used for many years to control stored grain pests (Salem et al., 2007; Ani, 2010; Bhalla et al., 2008). However, the persistent use of these insecticides in granaries of small-scale farmers has led to a number of problems such as killing of non-target species, user hazards, toxic residues in food, development of genetic resistance in the treated pest, increased cost of application and the destruction of the balance of the ecosystem (Shaheen & Khaliq, 2005; Boateng & Kusi, 2008). Historical usage of nicotine and pyrethrum has encouraged scientists to focus their attention on alkaloids, flavonoids, terpenoids and other secondary compounds to be used as pest control agents (Rajapakse & Ratnasekera, 2008) and are working for the development and establishment of plant based pesticides. Over 200 plant species have been reported to have insecticidal properties capable of controlling insects (Golob & Webley 1980). Various works screening different plants against stored grain pests include those by Negi et al. (1997), Srivastava & Mann (2002a), Srivastava & Mann (2002b), Kaur & Srivastava (2004), Srivastava & Gupta (2007), Srivastava & Ghei (2007), Gupta & Srivastava (2008), Kiradoo & Srivastava (2010), Kiradoo & Srivastava (2011), Rawat & Srivastava(2011), Rawat & Srivastava (2012), Mann & Srivastava (2013a, b, c, d,e,f), Kosar & Srivastava (2013), Mann & Srivastava (2014).

Callosobruchus chinensis shows clear sexual dimorphism. The female beetle lays eggs on the healthy seed surface and the larva immediately after hatching bores into the seed. By the time it reaches the adult stage it consumes the seed cotyledons. The adult emerges out leaving behind holed grains.

The plant family Euphorbiaceae is a large family of flowering plants with 300 genera and around 7,500 species. A number of plants of this family are of considerable economic importance. Some members of Euphorbiaceae have medicinal properties in

these plants *P. amarus*, *P. nirurim*, *E. hirta*, *J. curcas* and *J. gossipifolia* are included. There plants are also reported to possess insecticidal activity. Among the many plant species that have been used to control stored product pests is the physic nut, *Jatropha curcas* L. plant. The efficacy of *Jatropha* seed oil against insect has been reported by Huis (1991), Adabie- Gomez et al. (2006) and Henning (2007). Aqueous leaf extract of *Ricinus communis* L (Euphorbiaceae), a cultivated plant in tropical countries, showed excellent insecticidal activity against *Callosobruchus chinensis* L (Coleoptera: Bruchidae) as documented by Upasani et al. (2003). Repellency of hydroethanolic extracts of *Ricinus communis* to *Scyphophorus acupunctatus* in the laboratory was studied by Cinthia et al. (2012).

The present work was therefore carried out to screen *Euphorbia hirta*, *Phyllanthus amarus* and *Jatropha gossypiifolia* all belonging to family Euphorbiaceae formulations against the pulse beetle *Callosobruchus chinensis* Linn. and document the rate of development (days) of the pest insect.

Materials and Methods

The test insect selected for the investigation pulse beetle *Callosobruchus chinensis* L. was raised on green gram *Vigna radiata* maintained at 28±2ºC temperature and 70% relative humidity. The three plants viz., *Euphorbia hirta* Linn.**,** *Phyllanthus amarus* Linn. and *Jatropha gossypiifolia* Linn. used for the study were collected from in and around Bikaner city (27º11' & 20º 03' North latitude and 71º54' & 74º12' East longitude). The plant part used was leaves which were picked and washed. For crude extracts fresh leaves were taken while, for rest of the formulations they were shade dried for 10-15 days and were ground separately in electric grinder and kept in airtight plastic container for further use. Formulations of 1, 5, 10 and 25% concentrations were prepared. These included aqueous suspension, aqueous extract, ethanol extract and diethyl ether extract. Normal, control and five experimental sets were laid out. Each set comprised of three replicas. To document the aspect selected, time taken for the development of adult from the day of egg laying, up to the emergence, was recorded in days and expressed as rate of development. The data obtained was subjected to analysis of variance (ANOVA) using MS-Excel software. The critical difference at 1 and 5% level of significance was worked out.

Results

The mean rate of development (days) by the bruchid *C. chinensis* under different treatments of various plants studied has been presented in Table 1a and ANOVA has been presented in Tables 1b to 1n.

During the present study mean rate of development (days) by *C. chinensis* in normal sets it was observed to be 27 (days), while in control sets treated with GDW it was noted to be 29 and in sets treated with ethanol as well as DEE extracts it was observed to be 35 days. Highest rate of development (120 days) was observed in experimental sets treated with crude extract of all concentrations of *P. amarus*. Over all, besides crude extract, aqueous suspension of the same plant was also found to significantly increase the rate of development of the pest insect.

For comparing the effect of different formulations, ANOVA was applied and has been presented in Table 1b. Further, based on this analysis Tables 1c to 1n were constructed. The perusal of the number of days taken to develop by the pest insect was significantly increased in various experimental sets.

Table 1b clearly indicates that the results of rate of development (days) taken by the beetle, pertaining to efficacy of plants (A), extracts (B), concentration, (C) treatments (D) and plants extracts (AXB), plants and concentrations (AXC), plants and treatments (AXD), extracts and concentrations (BXC), extracts and treatments (BXD), concentrations and treatments (CXD), plants, extracts and concentrations (AXBXC), plants, extracts and treatments (AXBXD), plants, concentrations and treatments (AXCXD), extracts, concentrations and treatments (BXCXD) and plants, extracts, concentrations and treatments (AXBXCXD) were highly significant ($p<0.01$). When comparisons were made on the basis of ANOVA (Table 1c) with respect to the efficacy of the three plants studied on the rate of development of the bruchid, it was found that only treatments of *P. amarus* significantly ($p<0.05$) increased the development of bruchid and this treatment significantly differed from treatments of *J. gossypiifolia* and *E. hirta.*

On the basis of ANOVA (Table 1c) it could further be inferred that various other treatments were also effective in increasing the time taken for development of *C. chinensis*. In crude extract rate of development was observed to be significantly ($p<0.05$) higher from rest of the formulations, viz., aqueous suspension, aqueous extract, ethanol and DEE extracts.

When the effect of different concentrations on the rate of development of the pest was compared, it was noted that only 25% extracts resulted in significantly ($p<0.05$) more time taken by the bruchid for development. While comparing the effect of plants and extract, it was observed that a significantly ($p<0.05$) higher rate of development was found in experimental sets treated with crude extracts of *P. amarus* as compared to rest of the plant formulations (Table 1d).

While comparing the effect of plants and their different concentrations it was observed that a significantly ($p<0.05$) higher rate of development of the bruchid was found in experimental sets treated with 25% concentration of *P. amarus* as compared to rest of the plant formulations (Table 1c).
Further, when the effect of plants and treatments on the rate of development of the bruchid was observed it was found that all the treatments resulted in significantly ($p<.05$) increased rate of development (Table 1f).

Table 1a. Mean rate of development (days) of *C. chinensis* under different formulations of leaves of select three plants

Treatments	Plants → / Conc. ↓	*Euphorbia hirta*	*Phyllanthus amarus*	*Jatropha gossypiifolia*
Crude extract	***Normal***	27.00 ± 0.00	27.00 ± 0.00	27.00 ± 0.00
	Control	29.00 ± 0.00	29.00 ± 0.00	29.00 ± 0.00
	1%	31.20 ± 1.92	120.00 ± 0.00	60.00 ± 0.00
	5%	31.60 ± 0.55	120.00 ± 0.00	58.00 ± 2.74
	10%	31.00 ± 1.00	120.00 ± 0.00	58.00 ± 2.74
	25%	30.40 ± 0.55	119.20 ± 1.10	58.00 ± 2.74
Aqueous suspension	***Normal***	27.00 ± 0.00	27.00 ± 0.00	27.00 ± 0.00
	Control	29.00 ± 0.00	29.00 ± 0.00	29.00 ± 0.00
	1%	31.40 ± 0.89	106.00 ± 5.48	38.60 ± 2.88
	5%	30.60 ± 0.89	106.00 ± 5.48	38.40 ± 3.13
	10%	30.40 ± 0.89	106.00 ± 5.48	38.80 ± 2.68
	25%	29.40 ± 0.89	106.00 ± 5.48	38.60 ± 2.97
Aqueous extract	***Normal***	27.00 ± 0.00	27.00 ± 0.00	27.00 ± 0.00
	Control	29.00 ± 0.00	29.00 ± 0.00	29.00 ± 0.00
	1%	30.20 ± 0.45	81.00 ± 2.24	29.60 ± 2.07
	5%	30.20 ± 1.79	83.00 ± 2.74	29.40 ± 1.95
	10%	30.00 ± 1.41	83.00 ± 2.74	29.60 ± 2.07
	25%	29.20 ± 1.79	81.00 ± 2.24	29.20 ± 2.17
Ethanol extract	***Normal***	27.00 ± 0.00	27.00 ± 0.00	27.00 ± 0.00
	Control	35.00 ± 0.00	35.00 ± 0.00	35.00 ± 0.00
	1%	31.60 ± 0.55	40.00 ± 0.00	32.40 ± 1.52
	5%	31.40 ± 0.55	40.00 ± 0.00	32.20 ± 1.64
	10%	30.60 ± 0.55	39.00 ± 2.24	31.80 ± 1.48
	25%	28.80 ± 0.84	38.00 ± 2.74	31.80 ± 0.45
***Di-ethyl ether* extract**	***Normal***	27.00 ± 0.00	27.00 ± 0.00	27.00 ± 0.00
	Control	35.00 ± 0.00	35.00 ± 0.00	35.00 ± 0.00
	1%	31.20 ± 0.45	40.60 ± 0.89	34.00 ± 6.56
	5%	31.20 ± 0.84	40.00 ± 2.92	34.00 ± 6.56
	10%	30.00 ± 1.41	40.60 ± 6.19	34.00 ± 6.56
	25%	28.80 ± 0.45	39.80 ± 2.77	34.00 ± 6.60

Values given are mean ± SD

Table 1b. ANOVA for rate of development showing different interactions and level of significance

Source of Variations	df	SS	MSS	F-cal	S/NS	S.Em.	CD 5%	CD 1%
A	2	51808.03	25904.01	3183.97	**	0.16	0.46	0.60
B	4	12649.05	3162.26	388.69	**	0.21	0.59	0.78
C	3	243.59	81.20	9.98	**	0.19	0.53	0.69
D	3	90512.75	30170.92	3708.43	**	0.16	0.46	0.60
A x B	8	17907.18	2238.40	275.13	**	0.37	1.02	1.35
A x C	6	815.10	135.85	16.70	**	0.33	0.91	1.20
A x D	6	93682.19	15613.70	1919.14	**	0.29	0.79	1.04
B x C	12	593.48	49.46	6.08	**	0.43	1.18	1.55
B x D	12	39611.96	3301.00	405.74	**	0.37	1.02	1.35
C x D	9	487.18	54.13	6.65	**	0.33	0.91	1.20
A x B x C	24	1322.40	55.10	6.77	**	0.74	2.05	2.69
A x B x D	24	38588.90	1607.87	197.63	**	0.64	1.77	2.33
A x C x D	18	1630.20	90.57	11.13	**	0.57	1.58	2.08
B x C x D	36	1186.95	32.97	4.05	**	0.74	2.05	2.69
A x B x C x D	72	2644.80	36.73	4.52	**	1.28	3.54	4.66
Error	660	5369.60	8.14					
Mean	899	359053.36						

** 5% level of significance*
*** 1% level of significance*
S.Em.- standard error of mean
C.D.- Critical difference
MSS- Mean sum of square
SS- Sum of square
A- Plants
B- Extracts
C- Concentrations
D- All Treatments

Table 1c. Comparison of different formulations with respect to overall mean of rate of development (ANOVA) and critical difference

A1	46.59
A2	29.10
A3	32.39
S.Em±	0.16
CD (5%)	0.46
CD (1%)	0.60
B1	42.04
B2	38.23
B3	35.32
B4	32.82
B5	31.73
S.Em±	0.21
CD (5%)	0.59
CD (1%)	0.78
C1	36.92
C2	35.59
C3	35.80
C4	35.80
S.Em±	0.19
CD (5%)	0.53
CD (1%)	0.69
D1	27.00
D2	31.07
D3	50.01
S.Em±	0.33
CD (5%)	0.91
CD (1%)	1.20

A1- P. amarus *A2- E. hirta* *A3- J. gossypiifolia*
B1- Crude extract *B2- Aqueous suspension* *B3- Aqueous extract*
B4- Ethanol extract *B5- DEE*
C1- 25% *C2- 10%* *C3- 5%*
C4- 1%
D1- Normal *D2- Control* *D3- Treatments*

Table 1d. Comparison of rate of development of *C. chinensis* with respect to plants and extracts (A x B)

	B1	**B2**	**B3**	**B4**	**B5**	**Mean**
A1	58.93	54.33	48.42	37.17	34.08	46.59
A2	29.02	28.82	28.63	29.93	29.10	29.10
A3	38.17	31.53	28.92	31.35	32.00	32.39
Mean	42.04	38.23	35.32	32.82	31.73	
S.Em.±	0.37					
C.D. (5%)	1.02					
C.D. (1%)	1.35					

Table 1e. Comparison of rate of development of *C. chinensis* with respect to plants and concentrations (A x C)

	C1	**C2**	**C3**	**C4**	**Mean**
A1	49.80	45.37	45.53	45.64	46.59
A2	28.71	29.12	29.27	29.31	29.10
A3	32.24	32.28	32.61	32.44	32.39
Mean	36.92	35.59	35.80	35.80	
S.Em.±	0.33				
C.D. (5%)	0.91				
C.D. (1%)	1.20				

Table 1f. Comparison of rate of development of *C. chinensis* with respect to plants and treatments (A x D)

	A1	A2	A3	Mean
D1	27.00	27.00	27.00	27.00
D2.	32.00	29.80	31.40	31.07
D3	80.76	30.50	38.78	50.01
Mean	46.59	29.10	32.39	
S.Em.±	0.29			
C.D. (5%)	0.79			
C.D. (1%)	1.04			

Table 1g. Comparison of rate of development of *C. chinensis* with respect to extracts and concentrations (B x C)

	B1	B2	B3	B4	B5	Mean
C1	41.84	38.11	37.04	36.07	31.51	36.92
C2	42.00	38.24	34.40	31.58	31.73	35.59
C3	42.07	38.22	35.20	31.73	31.80	35.80
C4	42.24	38.33	34.64	31.89	31.87	35.80
Mean	42.04	38.23	35.32	32.82	31.73	
S.Em.±	0.43					
C.D. (5%)	1.18					
C.D. (1%)	1.55					

Table 1h. Comparison of rate of development of *C. chinensis* with respect to extracts and treatments (B x D)

	B1	B2	B3	B4	B5	Mean
D1	27.00	27.00	27.00	27.00	27.00	27.00
D2	29.33	29.33	29.33	34.00	33.33	31.07
D3	69.78	58.35	49.63	37.45	34.85	50.01
Mean	42.04	38.23	35.32	32.82	31.73	
S.Em.±	0.37					
C.D. (5%)	1.02					
C.D. (1%)	1.35					

Table 1i. Comparison of rate of development of *C. chinensis* with respect to concentrations and treatments (C x D)

	C1	C2	C3	C4	Mean
C1	27.00	27.00	27.00	27.00	27.00
C2	31.07	31.07	31.07	31.07	31.07
C3	52.68	48.71	49.35	49.32	50.01
Mean	36.92	35.59	35.80	35.80	
S.Em.±	0.33				
C.D. (5%)	0.91				
C.D. (1%)	1.20				

Table 1j. Comparison of rate of development of *C. chinensis* with respect to plants, extracts and concentrations (A x B x C)

		C1	C2	C3	C4	Mean
A1	B1	58.73	59.00	59.00	59.00	58.93
	B2	54.33	54.33	54.33	54.33	54.33
	B3	54.33	46.00	46.67	46.67	48.42
	B4	47.67	33.33	33.67	34.00	37.17
	B5	33.93	34.20	34.00	34.20	34.08
A2	B1	28.80	29.00	29.20	29.07	29.02
	B2	28.47	28.80	28.87	29.13	28.82
	B3	28.40	28.67	28.73	28.73	28.63
	B4	29.27	30.13	30.13	30.20	29.93
	B5	28.60	29.00	29.40	29.40	29.10
A3	B1	38.00	38.00	38.00	38.67	38.17
	B2	31.53	31.60	31.47	31.53	31.53
	B3	28.40	28.53	30.20	28.53	28.92

Table 1j continued in Page 44……

	B4	31.27	31.27	31.40	31.47	31.35
	B5	32.00	32.00	32.00	32.00	32.00
	mean	36.92	35.59	35.80	35.80	
S.Em.±	0.74					
C.D. (5%)	2.05					
C.D. (1%)	2.69					

Table 1k. Comparison of rate of development of *C. chinensis* with respect to plants, extracts and treatments (A x B x D)

		D1	**D2**	**D3**	**Mean**
A1	B1	27.00	30.00	119.80	58.93
	B2	27.00	30.00	106.00	54.33
	B3	27.00	30.00	88.25	48.42
	B4	27.00	35.00	49.50	37.17
	B5	27.00	35.00	40.25	34.08
A2	B1	27.00	29.00	31.05	29.02
	B2	27.00	29.00	30.45	28.82
	B3	27.00	29.00	29.90	28.63
	B4	27.00	32.00	30.80	29.93
	B5	27.00	30.00	30.30	29.10
A3	B1	27.00	29.00	58.50	38.17
	B2	27.00	29.00	38.60	31.53
	B3	27.00	29.00	30.75	28.92
	B4	27.00	35.00	32.05	31.35
	B5	27.00	35.00	34.00	32.00
	Mean	27.00	31.07	50.01	
S.Em.±	0.64				
C.D. (5%)	1.77				
C.D. (1%)	2.33				

Table 1l. Comparison of rate of development of *C. chinensis* with respect to plants, concentrations and treatments (A x C x D)

		D1	**D2**	**D3**	**Mean**
A1	C1	27.00	32.00	90.40	49.80
	C2	27.00	32.00	77.12	45.37
	C3	27.00	32.00	77.60	45.53
	C4	27.00	32.00	77.92	45.64
A2	C1	27.00	29.80	29.32	28.71
	C2	27.00	29.80	30.56	29.12
	C3	27.00	29.80	31.00	29.27
	C4	27.00	29.80	31.12	29.31
A3	C1	27.00	31.40	38.32	32.24
	C2	27.00	31.40	38.44	32.28
	C3	27.00	31.40	39.44	32.61
	C4	27.00	31.40	38.92	32.44
	Mean	27.00	31.07	50.01	
S.Em.±	0.57				
C.D. (5%)	1.58				
C.D. (1%)	2.08				

Table 1m. Comparison of rate of development of *C. chinensis* with respect to extracts, concentrations and treatments (B x C x D)

		D1	**D2**	**D3**	**Mean**
B1	C1	27.00	29.33	69.20	41.84
	C2	27.00	29.33	69.67	42.00
	C3	27.00	29.33	69.87	42.07
	C4	27.00	29.33	70.40	42.24
B2	C1	27.00	29.33	58.00	38.11
	C2	27.00	29.33	58.40	38.24

Table 1m continued in Page 45……

	C3	27.00	29.33	58.33	38.22
	C4	27.00	29.33	58.67	38.33
B3	C1	27.00	29.33	54.80	37.04
	C2	27.00	29.33	46.87	34.40
	C3	27.00	29.33	49.27	35.20
	C4	27.00	29.33	47.60	34.64
B4	C1	27.00	34.00	47.20	36.07
	C2	27.00	34.00	33.73	31.58
	C3	27.00	34.00	34.20	31.73
	C4	27.00	34.00	34.67	31.89
B5	C1	27.00	33.33	34.20	31.51
	C2	27.00	33.33	34.87	31.73
	C3	27.00	33.33	35.07	31.80
	C4	27.00	33.33	35.27	31.87
	Mean	27.00	31.07	50.01	
S.Em.±	0.74				
C.D. (5%)	2.05				
C.D. (1%)	2.69				

Table 1n. Comparison of rate of development of *C. chinensis* with respect to plants, extracts, concentrations and treatments (A x B x C x D)

			D1	**D2**	**D3**	**Mean**
A1	**B1**	C1	27.00	30.00	119.20	58.73
		C2	27.00	30.00	120.00	59.00
		C3	27.00	30.00	120.00	59.00
		C4	27.00	30.00	120.00	59.00
	B2	C1	27.00	30.00	106.00	54.33
		C2	27.00	30.00	106.00	54.33
		C3	27.00	30.00	106.00	54.33
		C4	27.00	30.00	106.00	54.33
	B3	C1	27.00	30.00	106.00	54.33
		C2	27.00	30.00	81.00	46.00
		C3	27.00	30.00	83.00	46.67
		C4	27.00	30.00	83.00	46.67
	B4	C1	27.00	35.00	81.00	47.67
		C2	27.00	35.00	38.00	33.33
		C3	27.00	35.00	39.00	33.67
		C4	27.00	35.00	40.00	34.00
	B5	C1	27.00	35.00	39.80	33.93
		C2	27.00	35.00	40.60	34.20
		C3	27.00	35.00	40.00	34.00
		C4	27.00	35.00	40.60	34.20
A2	**B1**	C1	27.00	29.00	30.40	28.80
		C2	27.00	29.00	31.00	29.00
		C3	27.00	29.00	31.60	29.20
		C4	27.00	29.00	31.20	29.07
	B2	C1	27.00	29.00	29.40	28.47
		C2	27.00	29.00	30.40	28.80
		C3	27.00	29.00	30.60	28.87
		C4	27.00	29.00	31.40	29.13
	B3	C1	27.00	29.00	29.20	28.40
		C2	27.00	29.00	30.00	28.67
		C3	27.00	29.00	30.20	28.73
		C4	27.00	29.00	30.20	28.73
	B4	C1	27.00	32.00	28.80	29.27
		C2	27.00	32.00	31.40	30.13

Table 1n continued in Page 46……

		C3	27.00	32.00	31.40	30.13
		C4	27.00	32.00	31.60	30.20
	B5	C1	27.00	30.00	28.80	28.60
		C2	27.00	30.00	30.00	29.00
		C3	27.00	30.00	31.20	29.40
		C4	27.00	30.00	31.20	29.40
A3	**B1**	C1	27.00	29.00	58.00	38.00
		C2	27.00	29.00	58.00	38.00
		C3	27.00	29.00	58.00	38.00
		C4	27.00	29.00	60.00	38.67
	B2	C1	27.00	29.00	38.60	31.53
		C2	27.00	29.00	38.80	31.60
		C3	27.00	29.00	38.40	31.47
		C4	27.00	29.00	38.60	31.53
	B3	C1	27.00	29.00	29.20	28.40
		C2	27.00	29.00	29.60	28.53
		C3	27.00	29.00	34.60	30.20
		C4	27.00	29.00	29.60	28.53
	B4	C1	27.00	35.00	31.80	31.27
		C2	27.00	35.00	31.80	31.27
		C3	27.00	35.00	32.20	31.40
		C4	27.00	35.00	32.40	31.47
	B5	C1	27.00	35.00	34.00	32.00
		C2	27.00	35.00	34.00	32.00
		C3	27.00	35.00	34.00	32.00
		C4	27.00	35.00	34.00	32.00
		Mean	27.00	31.07	50.01	
	S.Em.±	1.28				
	C.D. (5%)	3.54				
	C.D. (1%)	4.66				

Discussion

The average number of days taken by *C. chinensis* to develop from egg and emerge out as adult has been considered as rate of development during the present study. Highest rate of development was observed in experimental sets treated with extracts of *P. amarus*. Bashir & El Shafie (2013), suggested *Jatropha* oil at 10% concentration resulted in delay of the development time of nymphal instar of *S. gregaria* from 5th to 6th nymphal instar by 5 days. Earlier Kiradoo (2009) found that treatments of *M. spicata* enhanced the time taken for development by *C. chinensis*. Kathuria & Kaushik (2006) also reported that the leaves of *O. sanctum L. adversely* affected the larval development, number of days to pupation and percentage normal pupation. Pandey et al. (1985) observed development period of *C. cephalonica* to range from 45.33-48.08 days in control as compared to 46-65.08 days when treated with neem oil, powder of kernel, cakes, leaves, flower and babul gum. Negi (2007) observed the time taken by *C. chinensis* to develop and emerge out as adults to go up to 40 days as compared to 26–28 days in normal and control sets when treated with *P. juliflora* bark + *P. cineraria* fruit. Ghei (2001) also observed the treatments of plants *Trigonella* to significantly increase the time taken for the development by the bruchid. Certain Solanaceous plants were employed by Gupta (2004), who also reached to a similar conclusion when extracts of *S. surattense* were used. Modgil & Essential oils of four species of *Mentha* were found to be effective against stored product insects by Tripathi et al. (2001). All these reports support the present findings. Morallo-Rejaesus et al. (1990) observed retardation in development of *C. chinensis* when treated with fruit of *C. frutescens*; Juneja & Patel (1994) observed no population build up of *C. analis* up to four months of storage of green gram when treated with seed powder of custard apple, black pepper, peel of orange and leaves of mint; Gupta (2004) found fruit formulation of certain Solanaceous plants to increase the time taken for development; Ghei (2001) observed extracts of *Trigonella* to significantly increase rate of development of *C. chinensis*, all these reports corroborate the present study. Similar effects have also been evinced by Schumutterer & Rembold (1980) and Mathur et al. (1989), who noted seeds of *A. indica* to act as growth disruptors.

Different formulations employed during the present study were found to affect the rate of development. Over all, besides crude extract, aqueous suspension also effectively enhanced the time taken by the beetle to develop and emerge as adult. These findings are in close proximity with those of Mann (1997), who observed powder suspension of stem, root and fruit and ether extract of stem of *P. harmala* to significantly lengthen the time taken for development by the bruchid; Ghei (2001), who found ether extracts of roots and leaves, aqueous extract of pods of certain leguminous plants to effect the rate of development of *C. chinensis*; Gupta (2004), who also found ether extract to be most effective in retarding the development of *C. chinensis*, while, Chiranjeevi & Sudhakar (1996) who suggested *A. indica* and *L. camara* to effect the development of pulse beetle only moderately.

During the present study, the rate of development was also found to be significantly affected by the extract concentration and, the time taken for development by the bruchid was particularly enhanced in sets treated with 25% extract. The present findings are in agreement with earlier reports of Mann (1997), Ghei (2001), Gupta (2004) and Negi (2007), who all observed an increase in the time taken by the pest insect to emerge as adult with an increase in dose concentration of different plant extracts. The efficacy of different concentration of commercial neem based insecticides 'Nimbicidine' was evaluated against C. *castaneum* by Das et al. (2006), who observed significant reduction in growth with lengthened developmental period. Khan & Borle (1985) documented clay and powdered rhizome of *A. calamus* at 0.1 and 0.5% concentrations to be most effective in arresting the development of *C. chinensis*.

Conclusion

It could therefore be concluded that, plants belonging to family Euphorbiaceae do possess chemicals, which are toxic to insects and therefore have a potential to be used against the pest *C. chinensis*. Although, the three select plants showed varied degree of effect on rate of development, *P. amarus* seemed to be the most effective.

References

Arora, G.L. 1977. Taxonomy of the Bruchidae (Coleoptera) of North-West India, Part I Adults, *Oriental Insects* supplement, No 7:1-32.

Ani Dialoke 2010. Screening of some Biopesticides for the contral of *Callosobruchus chinensis* in stored black beans (*Vigna mango*) in Imo state.. *Journal of American Science*; 6(5).

Adabie- Gomez, D.A., Monford, K.G., Agyir-Yawson, A., Owusu Biney, A. and osae, M. 2006. Evaluation of four local plant species for insecticidal activity against *Sitophilus Zeamais* Mots (Coleoptera: Curculionidae) and *Callosobruchus Maculatus* (F) (Coleoptera: Bruchidae). *Chana J. Agric. Sci*. 39: 147-154.

Bashir, A. & El Shafie 2013. Insecticidal and antifeedant efficacy of Jatropha oil extract against the desert locust *Schistocerca gregaria* (Forskel) (Orthoptera: Acrididae). *Agriculture and Biology Journal of North America*. 4(3):260-267.

Bhalla, S., Gupta, K., Lal, B., Kapur, M.L., Khetarpal, R.K. 2008. Efficacy of various non-chemical method against pulse beetle, *Callosobruchus maculatus* Fab. ENDURE International Conference, Diversifying Crop Protection, October 12-15, France, p. 4.

Boateng, B. A. & Kusi, F. 2008. Toxicity of *Jatropha* seed oil to *Callosobructus maculatus* (Coleoptera ; Bruchidae) and its Parasitoid, *Dinarmus busilis* (Hymenoptera ; Pteromalidae) *Journal of Applied Science Research*, 4 (8) : 945–951.

CAB International 2007. Crop Protection compendium. Walling ford, UK: CAB International.

Caswell, G.H. 1980. A review of the work done in the entomology section. Institute Agricultural Research. *Pests of stored grain. Samaru Miscellan*. 99:12.

Chiranjeevi, C. & Sudhakar, T. R. 1996. Effects of indigenous plant materials on the fecundity, adult emergence and development of pulse beetle, *Callosobruchus chinensis* (L.) in black gram. *Journal of Research, APAU,* 24: 57- 61.

Cinthia Pacheo-Sanchez, Patricia Villa- Ayala, Roberto Montes-Belmont, Rodolfo Figueroa Brito, Alfredo Jimencz- Percz. 2012, Effect of *Ricinus communis* extracts on weight and Mortality of *Scyphophorus acupunctatus* (Colcoptera: Curculionidae) *International Journal of Applied Science and Technology,* 2(1):83-94.

Das, D.R., Selina, P. and Faruki, S.I. 2006. Efficacy of commercial neem-based insecticide, Nimbicidine against eggs of the red flour beetle *Tribolium castaneum* (Herbst). *Univ.J.Zool.* Rajshahi Univ. 25 : 51–55.

Dias, C.A.R. and Yadav, T.D. 1988. incidence of pulse beetle in different ligume seeds. *Indian Journal of Entomology,* 50(4): 457-461.

Doharey, R. B., Katiyar, R. N. and Singh, K. M. 1990. Comparative efficacy of some edible oils for the protection of green gram (*Vigna radiata* L.) Wilczek against pulse beetle *Callosobruchus chinensis* (L.) and *Callosobruchus maculatus* (E). *Bull Grain Tech.,* 28 (2): 116-119.

Ghei, Meenakshi. 2001. Screening of certain leguminous plants for their insecticidal efficacy against pulse beetle *Callosobruchus chinensis* Linn. (Coleoptera: Bruchidae) Ph. D, Thesis, M.D. S. University, Ajmer (India), p. 146.

Golob, P. & Webley, D. J. 1980. The use of plants and minerals as traditional protectants of stored products. *Tropical products Institute,* London, pp. 32.

Gupta, Latila, 2004. Management of pulse beetle *Callosobruchus chinensis* employing extracts of some solanaceous plants. Ph.D. Thesis, MDS University, Ajmer (India).

Huis, A. Van 1991. Biological Methods of bruchid control in the tropics: A review. *Insect Science and its application*, 12(1-2-3): 87-102. 12(1/2/3): 87-102.

Henning, R.K., 2007. *Jatopha curcas* L. [Internet] Record from protabase. Van der vossen, H.A.M and Mkamilo, G.S. (Eds.) PROTA.

Juneja, R. P. & Patel, J. R. 1994. Botanical materials as protectant of green gram, *Vigna radiata* (L.) Wilczek against pulse beetle, *Callosobruchus analis* Fabricius. *Gujrat Agricultural University Research Journal,* 20: 84-87.

Kathuria, V. & Kaushik, N. 2006. Evaluation of insecticidal property of some plant species against *Helicoverpa armigera*. *Indian Journal of Agricultural Science*, 76 (10) : 617–617.

Kaur, Amandeep & Srivastava, Meera. 2004. Comparative toxicity of certain plant formulations against stored grain pests. *Indian J. Appl. Ent.,* 18 (2) : 94–100.

Khan.M. I. & Borle, M.N. 1985. Efficacy of some safer grain protectants against the pulse beetle *Callosobruchus chinetisis* L. infesting stored Bengal gram (*Cicer arietinum* L.). *Punjabrao Krishi Vidyapeeth Res. J*. 9 (1): 53-55.

Kiradoo, Murli Manohar & Srivastava, Meera 2010. A comparative study on the efficacy of two Lamiaceae plants on egg-laying performance by the pulse beetle *Callosobruchus chinensis* Linn. (Coleoptera:Bruchidae). *Journal of Biopesticides,* 3 (3): 590 – 595.

Kiradoo, M.M.& Srivastava, Meera 2011. Insecticidal efficacy of some Lamiaceae plant extracts against *Callosobruchus chinensis* Linn. (Coleoptera: Bruchidae). *Asian J.Agric. Sci*. 3 (2): 100-103.

Kosar, Hina & Meera Srivastava 2013. A study on mortality of *Callosobruchus chinensis* L. (Coleoptera: Bruchidae) when treated with various formulations of plant *Phyllanthus amarus* (Euphorbiaceae). *International Journal of Chemical, Environmental & Biological Sciences*, 1(1):177-179.

Mann, Amandeep Kaur 1997. Evaluation of pesticidal efficacy of certain desert plants against some stored grain pests. Ph. D. Thesis, M. D. S. University, Ajmer (India), p. 197.

Mann, Amandeep Kaur & Meera Srivastava 2013a. Effect of smoke treatment of plant *Aerva tomentosa* on the mortality of pest *Rhizopertha dominica* (Fab.) (Coleoptera: Bostrichiadae). *Indian Journal of Applied Research*, 3(7):650-651.

Mann, Amandeep Kaur & Meera Srivastava 2013b. Efficacy of plant *Peganum harmala* on the percentage of damaged grains infested by pulse beetle *Callosobruchus chinensis* Linn. *International Journal of Scientific Research*, 2(8): 512-513.

Mann, Amandeep Kaur & Meera Srivastava 2013c. Study on biopesticidal potential of some desert plants. *Journal of Entomology and Zoology Studies*, 1(3): 79-82.

Mann, Amandeep Kaur & Meera Srivastava 2013d. Efficacy of plant *Fagonia cretica* on the percentage of damaged grains of *Triticum vulgare* infested by beetle *Tribolium castaneum*. *Int. J. Scientific Res*. 2(11): 62-63.

Mann, Amandeep Kaur & Meera Srivastava 2013e. Efficacy of plant *Tribulus terrestris* on the percentage of damaged grains of *Triticum vulgare* infested by beetle *Tribolium castaneum*. *Int. J. Scientific Res*. 2(12): 562-563.

Mann, Amandeep Kaur Mann & Meera Srivastava 2013f. Effect of smoke treatment of plant *Peganum harmala* on the mortality of pest *Rhizopertha dominica* (Fab.) (Coleoptera: Bostrichidae). *Int. J. Scientific Res*. 2(12): 564-65.

Mann, Amandeep Kaur & Meera Srivastava 2014. Pesticidal effect of plant *Peganum harmala* against stored grain pest *Tribolium castaneum* (Coleoptera: Tenebrionidae). *Indian J. Applied Res*. 4(7): 544-45.

Mathur, N. M., Sharma, M. M. and Srivastava, R. P 1989. Effectiveness of neem kernel powder against lesser grain borer. *Rhyzopertha dominica* Fab. and rice weevil. *Sitophilus oryzae* Linn. *Ind. J. Appl. Ent.,* 3: 59-60.

Modgil. R., Samuels, R. 1998. Efficacy of mint and eucalyputs leaves on the physico-chemical characteristics of stored wheat against insect infestation. Food, 42 (5) : 304 – 308.

Morallo-Rajesus, B. Maini, H. A, Ohsawa, K. and Yamamoto, I. 1990. Insecticidal actions of several plants to *Callosobruchus chinensis* L. In: Fujii K... Gatehouse A. M. R.. Johson, C. D. Mitchel, R. and Yoshida, T. (Eds.). Bruchids and Legumes: Economics, Ecology and Coevolution. *Proceedings of the Second International Symposium on Bruchids and legumes,* Okayma, Japan, pp. 91-100.

Negi, R.S., Srivastava, Meera and Saxena, M.M. 1997. Egg. Laying and adult emergence of *Callosobruchus chinensis* on green gram (*Vigna radiata*) treated with pongam oil. *Indian J. Ent*., 59(2): 170-172.

Pandey, N. D., Pal, Krishna., Pandey, Sanjeev., Tripathi, R. A. and Singh, Y. P. 1985. Use of neem, *Azadirachta indica A.* Juss. as seed protectant against rice moth. *Coreyra cephalonica* stain. I. Effect on the development and damage. *Bull. Grain. Tech.,* 23(2): 147-153.

Rajapkse, R.H.S. & Ratnasekera, D. 2008. Pesticidal potential of some selected tropical plants against *Callosobruchus maculatus* (F) and *Callosobruchus chinensis* (L) (Coleoptera:Brucidae). *Trop. Agr. Res. Extension*, 11:69-71.

Rawat, Shailja & Srivastava, Meera 2011. Evaluation of qualitative and quantitative losses caused by *Callosobruchus chinensis* to some pulses. *J. ent. Res*. 35(2): 117-120.

Rawat, Shailja & Srivastava, Meera 2012. Evaluation of efficacy of formulations of plant *Prosopis juliflora* against *Callosobruchus chinensis* Linn. *Global J. Sci. Front. Res. Agric. Bio.* 12 (4): 29-31.

Salem S, Abou-Ela MM, Elkholy M 2007. Entomocidal effect of Brassica hapus extracts on two store pests, *Sitophilus oryzae* (L.) and *Rhyzopertha dominica* (Fab.) (Coleoptera) *J. Appl. Sci. Res.* 3:317-322.

Schmutterer, H. & Rembold, H. 1980. Effect of some pure fractions from seeds of *Azadirachta indica* on feeding activity and metamorphoses of *Epilachna varivestis* (Coleoptera: Coccinellidae). Z. *ang. Bit.,* 89 (2): 179-180.

Shaheen FA, Khaliq A 2005. Mangement of pulse Beetle, Callosobruchus chinensis L. (Coleptera: Bruchidae) in stored chickpea using ashes, red soil powder and two pentine oil. *Pak. Entomol*. 27:19-24.

Srivastava, Meera and Mann, Amandeep Kaur 2002a. An evaluation of efficacy of extracts of plant *Peganum harmala* (Zygophyllaceae) against pulse beetle *Callosobruchus chinensis* Linn. (Coleoptera: Bruchidae). *Indian J. Entomology*, 64(2): 138-147.

Srivastava, Meera & Mann, Amandeep Kaur 2002b. An effect of smoke treatment on the mortality of *Callosobruchus chinensis* Linn. *Insect Environment* 8(3): 108-109.

Srivastava, Meera & Gupta, Lalita 2007. Effect of formulations of *Solanum surratense* (Family: Solanaceae) an Indian desert plant on oviposition by the pulse beetle *Callosobruchus chinensis* Linn. *African Journal of Agricultural Research*, 2(10): 552-554.

Srivastava, Meera & Ghei ,Meenakshi 2007. Studies on the efficacy of extracts of *Trigonella foenum-graecum* on mortality and oviposition of *Callosobruchus chinensis* Linn. *Ind.J.Appl.Entom*. 21(2): 49-52.

Tripathi, A. K., Verma, Neetu, Prajapati, Veena, Khanuja, S. P. S. and Kumar, Sushil 2001. Toxic and feeding-deterrent activities of essential oil of *Citrus reticulata* peel towards certain insect pests of stored grain and agriculture. *Proc. NCPP,* Udaipur. p. 37.

Upasani S.M. Kotkar, H.M. Mendki, P.S & Maheshwari V.L. 2003. Partial Characterization and insecticidal properties of *Ricinus communis* L. Foliage flavanoids. Pest Management science, 59, 1349-1354.