

Efficacy Of Selected Plant Extracts On The Oviposition Deterrent And Adult Emergence Activity Of *Callosobruchus Maculatus* .F (Bruchidae; Coleoptera)

GJSFR-G (FOR)
Classification: 060799

J.Shifa vanmathi¹, C.Padmala², A.J.A.Ranjit Singh³ and S.Suthakar isaac⁴

Abstract- A study was undertaken to find out the effect of aqueous extracts of *Phyllanthus amarus*, *Ocimum tenuiflorum*, *Cynodon dactylon*, *Catharanthus roseus*, *Azadirachta indica*, *Tephrosia Purpurea*, *Morinda pubescens*, *Calotropis gigantea*, *Vitex negundo* and *Sesbania grandiflora* on oviposition deterrent and F₁ adult emergence were carried out at three different concentrations (1%, 3%, 5%) using black gram *Vigna munga* (L.) against *C. maculatus*. Maximum oviposition deterrent activity was observed in *C. dactylon* treatment (84.32%) which was par with *O. tenuiflorum* followed by *P.amarus* (83.83%) at higher concentration. All these plant extracts showed above 50% oviposition deterrent activity even at lower concentration. Reduction in F₁ adult emergence was also high after using these plant extracts.

Keywords: *Callosobruchus maculatus*, aqueous extracts, oviposition deterrent activity, adult emergence.

I. INTRODUCTION

The cowpea beetle, *Callosobruchus maculatus* is a cosmopolitan insect pest of cowpea. It is a field -to-store pest as its infestation of cowpea often begins in the field as the mature pods dry (Huignard *et al.*, 1985; Sathyaseelan *et al.*, 2008) and when such seeds are harvested and stored, the pest population increases rapidly and results in total destruction within a short duration of 3-4 months (Rahman and Talukder, 2006). It multiplies very rapidly in storage (Ouedraogo *et al.*, 1996) and reported 8.5% loss in pulses during post harvest handling and storage in India. Synthetic chemical insecticides have proved to be effective in the control of the beetle. Earlier, Petroleum ether extract of neem (Ranjana Saxena and Beenam Saxena 2000), dichloromethane and methanol extract of *Acorus calamus* and *Cassia siamiae* (Jayakumar *et al.*, 2005a), *Jatropha curcas* seed oil (Adebawale and Adedire, 2006), powdered leaves and extracts of *Vitex negundo* (Rahman and Talukder, 2006), plant lectins derived from *Cicer arietinum* (Sadeghi *et al.*, 2006) and powder of *Terminalia chebula* and *Cassia*

auriculata (Govindan and Jeyarajan Nelson, 2008) were reported to have significant oviposition deterrent and other biological activity against *C. maculatus*. In this context, based on the earlier literatures and easy availability of the plants, ten plants were screened viz *Phyllanthus amarus*, *Ocimum tenuiflorum*, *Cynodon dactylon*, *Catharanthus roseus*, *Azadirachta indica*, *Tephrosia purpurea*, *Morinda pubescens*, *Calotropis gigantea*, *Vitex negundo* and *Sesbania grandiflora* for their oviposition deterrent and adult emergence activity against *C. maculatus*

II. MATERIALS AND METHODS

1. Insect culture

Black gram seeds infested by the *C. maculatus* were collected from the grocery shop and brought to the laboratory. The infested seeds were set aside in a plastic container and covered with muslin cloth till the emergence of adult. Healthy adults emerged from the container were shifted to another plastic container and provided cleaned blackgram seed for oviposition and maintained at 28 ± 2°C and 70 ± 5% R.H. The container was undisturbed until the emergence of adults. Freshly emerged subsequent generations were used for further experiments.

2. Preparation of plant extracts

Fresh leaves of selected plants *Phyllanthus amarus*, *Ocimum tenuiflorum*, *Cynodon dactylon*, *Catharanthus roseus*, *Azadirachta indica*, *Tephrosia Purpurea*, *Morinda pubescens*, *Calotropis gigantea*, *Vitex negundo* and *Sesbania grandiflora* were collected at their respective places and brought to the laboratory. Each plant material was dried under shade and powdered by using electric grinder and pass through a 20 mesh sieve and kept in a 1 kg capacity polypropylene bag. 300 g of each powdered plant material were taken into 1 litre capacity conical flask and 1000 ml of distilled water was added to it and shaken for 8 h in a mechanical shaker and then kept it for 24 h. The extract was separated using fine muslin cloth and then filtered. The filtrate was collected in a 2 litre capacity conical flask and volume was made up to 1000.ml. This was considered as stock solution. Required concentrations (1%, 3%, 5%) were prepared from the stock solution.

About¹-PG Department of Zoology, Sarah Tucker College (Autonomous), Perumalpuram, Tirunelveli – 627 007.

About²-Dept of Advanced Zoology and Biotechnology, Rani Anna Govt. College for Women Gandhi Nagar, Tirunelveli – 627 008.

About³-Dept of Advanced Zoology and Biotechnology, Sri Paramakalyani College, Alwarkurichi, Tirunelveli – 627 412.

About⁴-PG & Research Department of Zoology, St.John's College, Palayamkottai.

Corresponding author: latharac@gmail.com

3. Oviposition deterrent activity

Black gram seeds were cleaned and sterilized at 45° C for 6 h in order to kill the eggs and developing larvae. For each concentration, 25g blackgram seeds were taken in a conical flask and mixed with each concentration of aqueous extracts and seeds treated with water alone used as control. After thorough mixing the seeds were air dried and they were stored in plastic containers and 5 pairs of newly emerged adult *C. maculatus* were introduced in each container. Three replicates were maintained for each concentration and control. After 15 days, number of eggs laid on treated seeds (Ts) and control seeds (Cs) were recorded and the percentage of oviposition deterrence (POD) was calculated as $POD [(Ts-Cs)/Cs] \times 100$.

4. Adult Emergence activity

After the eggs were counted the experimental set up was kept undisturbed till the emergence of F_1 adults from the treated and untreated seeds. The number of F_1 adults emerged from the control seeds (Ac) and treated seeds (At) were recorded. The percentage reduction in F_1 adult (PRA) emergence (FI) was calculated as $PRA [(Ac-At)/Ac] \times 100$.

5. Data analysis

Mean number of eggs laid on treated and control seeds and F_1 adult emergence were calculated using the above said formula. The data obtained from the experiments were subjected to two-way analysis of variance (ANOVA).

III. RESULT AND DISCUSSION

Earlier literature indicate the importance of plant extract in protecting seeds by way of direct mixing of the dried leaves, plant powders, solvent extracts, vegetable/ essential oils on seeds during post harvest storage (Rajapakse, 1996; Ngamo *et al.*, 2007; Meera Srivastava and Lalitha Gupta, 2007; Zahra Sahaf and Moharramipour, 2008; Othira *et al.*, 2009). The reduction in oviposition was increased with the increase in dosage of each treatment. Earlier, Olaifa and Erhun (1998) found that higher concentration of the powder of *Piper guineense* significantly reduced the oviposition. These earlier findings are in conformation with the present study. Higher concentrations of plant extracts (5%) were found to be effective as compound to lower ones (1% and 3%) in bringing down the egg laying by the pest insect. Present study revealed that, maximum oviposition deterrent activity was observed in *O. tenuiflorum* and *C. dactylon* followed by *P. amarus* (Table 1). It is noteworthy that all these plant extracts showed more than 50% of deterrent activity even at lower concentration. It appears that these plant extracts might possess repellent and/or oviposition deterrent principles. Oviposition detergency may be due to the changes induced in physiology and behaviour in the adult of *C. maculatus* as reflected by their egg laying capacity. The data shown in Table 2 revealed the effect of leaf extracts on adult emergence of pulse beetle. A significant reduction in adult emergence was among the treatments. It is added that efficacy of these selected plant extracts was much stronger against F_1 than egg laying.

Jayakumar *et al.* (2003) reported that plant extracts have obvious effects on postembryonic survival of the insect and resulting reduction in adult emergence in all the concentrations of different plants. In the present study, maximum reduction in the adult emergence was observed in the seeds treated with *Azadirachta indica*. Adult emergence was reduced to 5.66 ± 0.66 at 1% 2.66 ± 0.33 at 3% and 1.66 ± 0.33 at 5% concentration of *Azadirachta indica*. It was followed by *T. purpurae* (82.11%) at 1% (88.62%) at 3% and (94.31%) at 5% concentrations. However *O. tenuiflorum* was found to be effective in reducing the adult emergence at a higher concentration. Annie Bright (2001) and Raja *et al.* (2001) reported that botanicals inhibited adult emergence in *C. maculatus* in cowpea. They further stated that, when the eggs were laid on treated seeds, the toxic substance present in the extract may enter in to the egg through chorion and suppressed their embryonic development. It is in agreement with the present study that adult emergence was greatly reduced in treated seeds than control seeds. Raja *et al.* (2001), Keita *et al.* (2001) and Sathyaseelan *et al.* (2008) reported that various plant products were effective in reducing oviposition and adult emergence of *C. maculatus* only, but the seed quality and germination were not affected. These results are in accordance with our findings. The present investigation has brought out the efficacy of *Phyllanthus amarus*, *Ocimum tenuiflorum*, *Cynodon dactylon*, *Catharanthus roseus*, *Azadirachta indica*, *Tephrosia purpurae*, *Morinda pubescens*, *Calotropis gigantea*, *Vitex negundo* and *Sesbania grandiflora*. Preparation of these aqueous extracts and application on the seeds are so easy and cheaper. Hence, effectual plant extract can be used as one of the component in Integrated Pest Management especially small godowns or shop retailer for short term storage.

Heading 1 Table: 1 Effect of plant extracts on Oviposition of pulse beetle, *C. maculatus*

Treatment	Total no. of Eggs laid		
	Conc % v/w		
	1%	3%	5%
Control	134.00±2.88		
<i>Phyllanthus amarus</i>	39.66±0.66 (70.4)	31.66±1.45 (76.37)	21.66±0.33 (83.83)
<i>Ocimum tenuiflorum</i>	38.66±5.23 (71.14)	27.33±3.38 (79.6)	21.00±0.00 (84.32)
<i>Cynodon dactylon</i>	41.33±3.28 (69.15)	28.33±2.33 (78.85)	21.00±1.15 (84.32)
<i>Catharanthus roseus</i>	49.66±1.85 (62.94)	39.66±4.25 (70.4)	30.33±1.76 (77.36)
<i>Azadirachta indica</i>	55.33±4.33 (58.7)	43.66±5.45 (67.41)	26.00±0.57 (80.59)
<i>Tephrosia Purpurea</i>	69.00±2.30 (48.5)	55.00±2.00 (58.95)	40.66±1.20 (69.65)
<i>Morinda pubescens</i>	65.33±2.33 (51.24)	49.66±1.66 (62.94)	44.00±1.00 (67.16)
<i>Calotropis gigantea</i>	63.33±1.20 (52.73)	52.33±0.88 (60.94)	41.66±1.45 (68.91)
<i>Vitex negundo</i>	70.33±5.60 (51)	53.33±1.76. (60.2)	44.00±2.51 (67.16)
<i>Sesbania grandiflora</i>	73.66±3.52 (45.02)	52.00±4.50 (61.19)	35.00±0.57 (73.88)

Within the column values was statistically significant ($P < 0.05$)

Heading 2 Table: 2 Effect of plant extracts on adult emergence of pulse beetle, *C. maculatus*

Treatment	Total no. of Eggs laid		
	Conc % v/w		
	1%	3%	5%
Control	41.00±0.57		
<i>Phyllanthus amarus</i>	27.00±3.00 (34.15)	15.66±0.33 (34.15)	14.33±0.33 (65.04)
<i>Ocimum tenuiflourum</i>	20.33±0.33 (50.41)	20.33±0.33 (50.41)	4.00±0.57 (90.24)
<i>Cynodon dactylon</i>	27.66±2.66 (32.52)	19.00±4.93 (53.66)	10.00±0.00 (75.61)
<i>Catharanthus roseus</i>	36.33±0.33 (11.38)	26.00±0.00 (36.59)	16.33±0.33 (60.16)
<i>Azadirachta indica</i>	5.66±0.66 (86.18)	2.66±0.33 (93.50)	1.66±0.33 (95.93)
<i>Tephrosia Purpureae</i>	7.33±0.33 (82.11)	4.66±0.33 (88.62)	2.33±0.33 (94.31)
<i>Morinda pubescens</i>	26.33±0.33 (35.77)	21.66±0.33 (47.15)	19.00±0.57 (53.66)
<i>Calotropis gigantea</i>	24.66±0.33 (39.84)	21.33±0.33 (47.97)	18.00±0.57 (56.10)
<i>Vitex negundo</i>	27.33±0.66 (33.33)	23.00±0.57 (43.90)	19.00±0.57 (53.66)
<i>Sesbania grandiflora</i>	27.33±0.66 (33.33)	23.00±0.57 (43.90)	19.00±0.57 (53.66)

Within the column values was statistically significant ($P < 0.05$)

IV. REFERENCES

- 1) Adebawale, K. O. and Adedire, F. O. 2006. Chemical composition and insecticidal properties of the underutilized *Jatropha curcas* seed oil. *African Journal of Agricultural Research*, 5(10): 901-906.
- 2) Ajayi, F. A. and Wintola, H. U. 2006. Suppression of the cowpea bruchid (*Callosobruchus maculatus* (F.)) infesting stored cowpea (*Vigna unguiculata* (L.)) seeds with some edible plant product powders. *Pakistan Journal of Biological Sciences*, 9(8): 1454-1459.
- 3) Annie Bright, A. B. abu, A., Ignacimuthu, S. and Dorn, S. / 2001. Efficacy of *Andrographis peniculata* N. On *Callosobruchus chinensis* L. during post harvest storage of cowpea. *Indian Journal of Experimental Biology*, 39: 715-718.
- 4) Govindan, K. and Jeyaraj, N. 2008. Effect of ten plant powders on mortality, oviposition, adult emergence and seed weight loss on pulse beetle, *Callosobruchus maculatus* (F.) (Coleoptera: Bruchidae). *Hexapoda*, 15(1): 64-66.
- 5) Ouedraogo, A. P., Sou, S., Sanon, A., Monge, J. P., Huignard, J. (2006). Influence of the parasitoid *Dinarmus basalis* (Pteromalidae) in two climatic zones of Burkina Faso. *Bulletin Entomological Research*, 86: 695-702.
- 6) Rahman, A. and Talukder, F. A. 2006. Bio efficacy of some plant derivatives that protect grain against the pulse beetle, *Callosobruchus maculatus*. *Journal of Insect Science*, 6(3): 19-25.
- 7) Jayakumar, M., Raja, N. and Ignacimuthu, S. 2003. Efficacy of crude extracts of *Hyptis suaveolens* and *Melochia corchorifolia* on pulse beetle *Callosobruchus maculatus*. In: *Biological control of Insect Pests*. (Ignacimuthu, S. and Jeyaraj, S. eds.). Phoenix Publishing House, New Delhi, 218-221 PP.
- 8) Jayakumar, M., John William, S. and Ignacimuthu, S. 2005a. Evaluation of some plant extracts on the oviposition deterrent and adult emergence activity of *Callosobruchus maculatus* F. (Bruchidae: Coleoptera). *Pestology*, 29(1): 37-41.
- 9) Keita, S. ML, Vincent, C., Schmit, J. P., Arnason, J. T., Belanger, A. 2001. Efficacy of essential oil of *Ocimum basilicum* L. and *O. gratissimum* L. applied as an insecticidal fumigant and powder to control *Callosobruchus maculatus* (Fab.) (Coleoptera: Bruchidae). *Journal of Stored Products Research*, 37(4): 339-349.
- 10) Meera Srivastava and Lalita Gupta, 2007. Effect of formulations of *Solanum surratense* (Family: Solnaceae) an Indian desert plant on oviposition by the pulse beetle *Callosobruchus chinensis* Linn. *African Journal of Agricultural Research*, 2(10): 552-554.
- 11) Ngamo, T. S. L., Ngatanko, I., Ngassoum, M. B., Mapongmestsem, P. M. and Hance, T. 2007. Persistence of insecticidal activities of crude essential oils of three aromatic plants towards four major stored product insect pests. *African Journal of Agricultural Research*, 2(4): 173-177.
- 12) Olaifa, J. I. and Erhun, W. 1998. Laboratory evaluation of *Piper guineense* for the protection of cowpea against *Callosobruchus maculatus*. *Insect Science and Its Application*, 9: 55-59.
- 13) Othira, J. O., Onok, L. A., Deng, L. A. and Omolo, E. O. 2009. Insecticidal potency of *Hyptis spicigera* preparation against *Sitophilus zeamais* (L.) and *Tribolium castaneum* (Herbst) on stored maize grains. *African Journal of Agricultural Research*, 4(3): 187-192.
- 14) Ouedraogo, A. P., Sou, S., Sanon, A., Monge, J. P., Huignard, J. (2006). Influence of the parasitoid *Dinarmus basalis* (Pteromalidae) in two climatic zones of Burkina Faso. *Bulletin Entomological Research*, 86: 695-702.
- 15) Rahman, A. and Talukder, F. A. 2006. Bio efficacy of some plant derivatives that protect grain against the pulse beetle, *Callosobruchus maculatus*. *Journal of Insect Science*, 6(3): 19-25.
- 16) Raja, N., B. abu, A., Dorn, S. and Ignacimuthu, S. 2001. Potential of plants for protecting stored pulses from *Callosobruchus maculatus* (Coleoptera: Bruchidae) infestation. *Biological Agriculture and Horticulture*, 19:19-27.
- 17) Rajapakse, R. H. S. 1996. The effect of four botanicals on the oviposition and adult emergence of *Callosobruchus maculatus* (F.). (Coleoptera: Bruchidae). *Entomon*, 21: 211
- 18) Ranjana Saxena and Beenam Saxena, 2000. Bioactivity of certain plant extracts against *Callosobruchus maculatus* (Fab.). *Journal of Applied Zoological Research*, 11(1): 29-32.
- 19) Sadeghi, A., Van Damme, E. J. M., Peumans, W. J., Smagghe, G. 2006. Deterrent activity of plant lectins on cowpea weevil *Callosobruchus maculatus* (F.) oviposition. *Phytochemistry*, 67: 2078-2084.
- 20) Sathyaseelan, V., Baskaran, V. and Mohan, S. 2008. Efficacy of some indigenous pesticidal plants against pulse beetle, *Callosobruchus chinensis* (L.) on green gram. *Journal of Entomology*, 5(2): 128-132.

- 21) Talukder, F. A. and Howse, P. E. 2000. Isolation of secondary plant compounds from *Aphanamixis polystachya* as feeding deterrents against adults *Tribolium castaneum* (Coleoptera: Tenebrionidae). *Journal of Stored Product Research*, 107(5): 395-402.
- 22) Zahra Shahaf, B. and Moharramipour, S. 2008. Fumigant toxicity of *Carum copticum* and *Vitex pseudo-negundo* essential oils against eggs, larvae and adults of *Callosobruchus maculatus*. *Journal Pest Science*, 81(4): 213-220.

Problems And Constraints of Rabbitry In India: A Study of Himachal Pradesh

Ashok Kumar¹, Atul Dogra², J.S. Guleria³

*GJSFR-G FOR
Classification: 830307*

I. INTRODUCTION

The state of Himachal Pradesh has achieved the distinction of being regarded as model of hill development. Agriculture and allied activities continues to be the mainstay of majority of the population as they provide livelihood to about 71 per cent of the working population. Only about 17.2 per cent of net sown area is irrigated and the rest is all rainfed. In the state, agriculture exhibits the blend of both progressive and the traditional nature. The objectives of the government policy to meet immediate challenges of poverty, unemployment and malnutrition include full employment, economic growth, price stability, wage maintenance, reduced inequality in income distribution, regional balance, protection of the national environment, greater opportunities for women and minorities. The effective route to development is to raise productivity of agricultural sector, which will then act as a stimulus to other areas of the economy. To boost the meager income of small holdings there is a need for incorporation of the supplementary enterprises which not only increase productivity and income but also induces stability in the farm income. Rabbitry is one such micro-enterprise which is economical because of their early maturity, prolificacy (7-8 young ones) and short gestation period (31 days). The credit of introducing and popularizing Angora rabbits in India goes to ICAR through its North Temperate Regional Station of Central Sheep and Wool Research Institute (CSWRI), Garsa, Kullu in Himachal Pradesh. The rabbits require a few inputs

and can be reared by workers lacking in great physical strength. Rabbitry gives an opportunity to develop 20 subsidiary industries including nursery raising wool farming, cage fabrication; feed formulation, shearing, wool collection and grading etc. The meat obtained from rabbitry is low in fat and cholesterol level. It can close protein gap and raise income of rural and sub-urban people. The present study is an attempt to study the problems and constraints of rabbitry in Himachal Pradesh and suggest suitable policy measures.

II.METHODOLOGY

Complete enumeration of the rabbit farms in the state was done. The list of rabbit entrepreneurs in each district was obtained with the help of officials of the Development Blocks, progressive rabbit entrepreneurs, traders, concerned officials of government etc. Though rabbitry for wool is taken-up in all districts except Una, Bilaspur and Lahaul and Spiti, where the climatic conditions are not congenial, Chamba, Hamirpur, Kangra, Kinnaur, Kullu, Mandi, Shimla, and Solan districts were chosen for the study. In each district a list of rabbit entrepreneurs was prepared alongwith their flock size. The rabbit farms were categorised into small, medium and large classes with the help of cumulative cube root frequency method according to distribution of the flock size. For each category the size and number of rabbit farms have been given in Table 1

TABLE -1 CLASSIFICATION OF THE RABBIT FARMS

Sr. No.	Category	Number of Rabbits	Number of Rabbit Farms	Percentage of Rabbit Farm
1.	Small	Less than 25	93	54.70
2.	Medium	25-150	45	26.47
3.	Large	≥150	32	18.83
	Total		170	100.00

About-Department of Agricultural Economics
CSK HPKV Palampur (H.P.) 176 062 INDIA

The problems and constraints confronted by rabbit entrepreneurs have been categorised into different sub-heads viz; production, financial, marketing and institutional problems. The per cent response was recorded on different size of rabbit farms. To test the difference in the extent of problems confronted on different size of farms, chi-square test was employed to test the rejection or acceptance of the following null hypothesis.

$$H_0 : \pi_1 = \pi_2 = \pi_3 = \pi_4$$

π_{ij} = Problems on different categories of farms.

The value of chi square was compute as follow:

$$n \left[\sum_{I=1}^k \sum_{j=1}^k \frac{f_{ij}^2}{f_{i0j}} - 1 \right] \sim \chi^2_{(k-1)(l-1)} \text{ df.}$$

Where

$$F_{i0} = \sum_{J=i} f_{ij}$$

$$n = \sum_{i=1}^k f_{ij}$$

If calculated value is greater than table value. Ho (null hypothesis) is rejected

III. RESULTS AND DISCUSSION

The problems and constraints faced by rabbit entrepreneurs have been categorised into four subheads viz; production, financial, marketing and institutional problems. The rabbit entrepreneurs were interviewed in respect of various problems and their response has been given in various sub-heads. The null-hypothesis ($H_0: \pi_1 = \pi_2 = \pi_3 = \pi_4$) i.e. the extent of problems is same in all the categories of rabbit entrepreneurs was tested. The calculated value ($\chi^2 = 411.65$) of Chi-square was greater than the table value ($\chi^2 = 112.33$). Therefore, it led to the rejection of null-hypothesis i.e. hypothesis of no difference and revealed that the problems differ significantly in different categories of entrepreneurs and they can be reduced if proper management practices are adopted by rabbit entrepreneurs and requires different way of tackling for each category.

A) Production Problems of Rabbit Entrepreneurs

The production problems of rabbit entrepreneurs have been further sub-categorised into twelve types viz; availability of feed, price of feed, shortage of fodder, availability of cages,

feeders, waterers, process of equipments, problem of pests and diseases, availability of veterinary aid, availability of medicine, availability of labour, high labour wages, availability of fresh blood (breeding animals to avoid inbreeding), maintenance of financial and pedigree records. The different problems confronted by wool rabbitry entrepreneurs are given in Table 2 and are as under. The availability of quality feed is an important component in rabbit production. About 52 per cent of rabbit entrepreneurs reported that the feed was not available at right time. The rabbit entrepreneurs reported that the sub-standard feed led to deaths *en-masse* and heavy losses to them. The perusal of the table reveals that the gravity of the problem and farm size has an inverse relationship. The feed prices when compared to output prices are quite high. About 72 per cent of the rabbit entrepreneurs on overall farms reported this problem and the gravity of the problem and farm size shows inverse relationship. The per cent response decreased with increase in farm size. The commonly fed fodder in the study area are common grasses, bamboo leaves, barseem, *biul* leaves and kitchen waste. About 12 per cent of the rabbit entrepreneurs reported acute shortage of fodder in the study area especially during winter. The maximum shortage of fodder was experienced on medium farms (15.56 per cent) followed by small and large farms. About 18 per cent of the entrepreneurs reported that the inputs like cages, feeders and waterers are not available. The extent of problem increased with the increase in farm size hence showed positive correlation between gravity of problem and farm size. The problem of high prices of cages, feeders and waterers showed a positive correlation with the size of the farm. About 24 per cent of rabbit entrepreneurs on all farms reported the problems of high prices of these equipments.

TABLE 2. PRODUCTION PROBLEMS OF THE RABBIT ENTREPRENEURS

		(Per cent)			
		Farm Size			
No.	Particulars	Small	Medium	Large	All farms
	<u>Production Problems:</u>				
1.	Quality feed not available at appropriate	72.04	35.56	16.13	52.07
2.	Feed prices not reasonable	94.62	51.11	35.48	71.9
3.	Shortage of fodder	11.83	15.56	9.68	12.43
4.	Cages, feeders and waterers not available at right time	6.45	28.89	35.48	7.75
5.	Price of cages, feeders and waterers are high.	7.53	37.78	54.84	24.26
6.	Problem of pest and diseases	1.08	11.11	29.03	8.88
7.	Veterinary aid not available when required	7.53	35.56	45.16	21.89
8.	Medicines not available at right time	6.45	24.44	6.45	11.24
9.	Labour not available when required	58.06	22.22	16.13	40.83
10.	Labour charges not reasonable	37.63	26.66	25.81	31.95
11.	Non-availability of fresh blood.	8.71	31.11	9.68	36
12.	Maintenance of financial and pedigree records	97.85	7	74.19	86.9
	Total number of farms	93	45	31	169

Note: Figures have been rounded off to their nearest digit.

The problem of pest and diseases was depicted by about 9 per cent of entrepreneurs on all farms and the per cent response increased with the increase in farm size. About 22 per cent of rabbit entrepreneurs confronted this problem on all farms category of rabbit entrepreneurs. The gravity of non-availability of veterinary aid and farm size showed positive correlation. The maximum response of 45.16 per cent was reported on large farms followed by 35.56 per cent on medium farms and 7.53 per cent on small farms. The non-availability of medicines was reported to the extent of about 11 per cent on all farms. The maximum per cent response was recorded on medium farms 24.44 per cent. However, it was a tie (6.45 per cent) on small and large farms. The non-availability of labour was experienced by about 41 per cent on all farms category. The gravity of the problem of non-availability of labour and farm size showed an inverse relationship. The response was maximum on small farms (58.06 per cent) followed by medium farms 22.22 per cent on medium farms and 16.13 per cent on large farms. The high wages of labour for attending rabbits was experienced by about 32 per cent of entrepreneurs on all farms category. The extent of the problem decreased with increase in size and thereby showing an inverse relationship between extent of problem and farm size. The response recorded was as high as 37.63 per cent on small farms followed by 26.66 per cent on medium farms and 25.81

per cent on large farms. The inbreeding in rabbits leads to decreased output, high incidence of diseases and mortality among the flock. Therefore, introduction of fresh blood of pure strain at frequent intervals is very important to eliminate the adverse consequences of inbreeding in a rabbitry. About 31 per cent of rabbit entrepreneurs on all farms reported the problem of non-availability of fresh blood. The gravity of the problem was maximum on small farms (38.71 per cent) followed by medium farms 31.11 per cent and 9.68 per cent on large farms thereby depicting inverse relationship between extent of problem and farm size.

The problem of maintaining financial and pedigree records was as high as about 86 per cent on all farms.

B) Financial Problems of Rabbit Entrepreneurs

The establishment of rabbitry units requires some capital investment in the beginning. The finance is needed to construct shed, purchase cages, waterers, feeders and purchase of the breeding stock. The banks have a scheme to finance small and marginal farmers or agricultural labourers for small units size of 10 female+2 male. However, if large farmers entrepreneurs are interested to take up the scheme they could be financed more than one unit depending upon individual needs and merits of each case. The banks also make provision for providing veterinary aid, fodder and

concentrated feed and training of beneficiaries. The loan limit is Rs. 2430.00 for a unit of 10 females+2 males for fur/ meat and Rs 8850.00 for a unit of wool type breeding rabbits. Considering larger loan required for the latter unit, it is necessary that beneficiaries with adequate resources and experience be selected. The disbursement of loan is against purchase of equipments and breeding animals on the supply of bills of such items. The initial recurring expenses for first 6 months for pelleted feed have been capitalized term loan. The disbursement against supply of feed is also done against bills of supply. The loan against breeding animals is disbursed only when equipment and initial stock of one month feed is purchased and inexperienced farmer receives adequate training. Margin money by beneficiaries at the rate of 15 to 25 per cent for wool unit as per ARDC norms is envisaged. The rate of interest to ultimate borrowers will depend upon the amount of loan raised. However, the rate of interest varies from 12 per cent to 23.75 per cent with quarterly or half yearly interests. The security against the loan

is hypothecation of rabbits, feed, fodder, equipment fixtures and other movable created out of the bank loan. Secondly, creation of equitable mortgage/ charge over applicants land where sheds are constructed and thirdly, third party guarantee of sufficient worth good for loan amount. The supervision of the credit is through regular visits to the unit in order to ensure proper utilization of loan amount disbursed for construction of sheds, purchase of equipments and rabbit stock. Thereafter, monthly inspections will be carried out regularly when the project commences. The bank also makes a provision for adequate and comprehensive insurance cover in respect of shed equipment against fire, theft, earthquake, riots and rabbit mortality during the period of loan and relevant policies are also arranged in favour of bank. Banks assume that daily requirements of about two hours per unit for adult rabbits and the progeny, scheme would provide additional employment of 90 days per year per unit. The contact with the farmers through survey revealed that majority of the farmers are not aware of the loan facility.

TABLE 3. FINANCIAL PROBLEMS OF THE RABBIT ENTREPRENEURS

(Per cent)

Sr. No.	Particulars	Farm Size			
		Small	Medium	Large	All farms
1.	Credit not available at appropriate time	93.55	86.67	96.77	92.31
2.	Credit given not supervised	95.70	93.33	96.77	95.27
3.	Available credit is inadequate	93.55	86.67	96.77	92.31
	Total number of farms	93	45	31	169

Note: Figures have been sounded off to their nearest digit.

The non-availability of credit at appropriate time was reported by 92.31 per cent of rabbit entrepreneurs on all farms situation. The maximum response to this problem was recorded on large farms 96.77 per cent followed by small farms 93.55 per cent and medium farms 86.67 per cent. Since the rabbit industry in Himachal Pradesh is in recession and banks advance loans only to those entrepreneurs whose risk bearing ability and repayment capacity is high. Small rabbit entrepreneurs do not gather courage to have loan under present circumstances when rabbit industry is passing through a slump. About 95 per cent of rabbit entrepreneurs on all farms situations reported that credit once given is not properly supervised. The response recorded was maximum on large farms (96.77 per cent) followed by small and medium rabbit entrepreneurs respectively. The rabbit entrepreneurs reported that credit given is not adequate 92.31 per cent of rabbit entrepreneurs on all farms reported that available credit was inadequate. Among different size of rabbit entrepreneurs, the maximum response was recorded on large farms and it was to

the tune of 96.77 per cent followed by small farms 93.55 per cent and 86.67 per cent on medium farms.

C) Marketing problems

The availability of proper marketing facilities is a pre-requisite for the development of any enterprise. An efficient marketing system for the disposal of farm produce leads to faster growth and development. The profitability also depends on the factors like location of market, storage, transportation facilities and grading of farm products. So far there is no stable and organized market for Angora rabbit farming on large scale. There is a demand for better breeds of Angoras but the sale/ disposal of ordinary surplus animals is not organized and ensured. The various marketing problems noticed on farms are as under:

TABLE 4: MARKETING PROBLEMS OF THE RABBIT ENTREPRENEURS

Sr. No.	Particulars	(Per cent)			
		Farm Size			
		Small	Medium	Large	All farms
1.	Inadequate Transportation Facilities	0	11.11	45.16	11.24
2.	Regular markets for farm product	37.63	37.78	51.61	40.24
3.	Unremunerative price of meat	100.00	100.00	100.00	100.00
4.	Unremunerative price of wool	100.00	100.00	100.00	100.00
5.	Problem of grading of wool	29.03	2.22	9.68	18.34
6.	High marketing costs	10.75	31.11	61.29	24.26
7.	Support price by Govt.	43.01	62.22	77.42	54.44
8.	Price of rabbits for remunerative	98.92	73.33	77.42	88.17
9.	Demand of wool products seasonal	100.00	95.56	100.00	98.82
	Total number of farms	93	45	31	169

Note: Figures have been sounded off to their nearest digit.

Transportation plays an important role in the marketing of produce which has to be shifted from the point of production to the point of final consumption. Comparatively the problem of transportation of the inputs and produce was revealed by a less number of rabbit entrepreneurs. On all farms situation only 11.24 per cent of entrepreneurs reported this problem. Maximum response in favour of inadequate transportation was recorded on large farms (45.16 per cent) followed by large farms (11.11 per cent). However, the problem of transportation was not confronted on small farms. Rabbitry entrepreneurs in the study area reported to have insufficient market system. There were no ready buyers of rabbit products, especially wool, locally, so the farmers had either to transport it to distant towns or sell in the local market at low premium. About 40 per cent of the farmers on all farms situation responded to this problem. The problem of unremunerative prices of meat was responded positively by each and every entrepreneur on all categories of farms. Rabbit meat could not be popularized among meat eaters in Himachal Pradesh. However, rabbit meat has many desirable traits like low fat and cholesterol, high proteins and minerals. The wool rabbits when become uneconomical with the passage of age are sold at throw away prices. Therefore, 100 per cent of rabbit entrepreneurs in all the categories confronted this problem. The problem of unremunerative prices of wool has been responded positively by each and every rabbit entrepreneur on all the categories of farms. With the liberalisation the access to market by developed nations has increased. The Government of India has reduced tariff on import of wool to a greater extent and as a result the rabbit

wool was available at a cheaper rate than home produced. Therefore, in the recent past year the prices of wool have slashed and farmers are not getting remunerative prices for their produce. The different grades of rabbit wool have different prices and traders cheat rabbit entrepreneurs by designating their produce as "B" grade wool. The problem of grading of wool before selling was revealed by 18.34 per cent of rabbit entrepreneurs on all farms situation. The maximum response was recorded on small farms which was to the extent of 29.03 per cent followed by large farms (9.68 per cent) and medium farm 2.22 per cent. The marketing costs in rabbitry includes the cost of transportation, storage and other fees if any. High marketing costs were reported by 24.26 per cent of rabbit entrepreneurs on all farms situations. The problem of high marketing cost and size of the farm showed a positive correlation. The gravity of the problem of high marketing costs increased with the increase in farm size. On small farms 10.75 per cent of rabbit entrepreneurs responded to this problem. On medium farms (31.11 per cent) and on large farms 61.29 per cent reported this problem. About 54 per cent of rabbit entrepreneurs on all farms situation revealed that the government should fix support price for rabbit wool. The per cent response of the rabbit entrepreneur increased with the increase in size of a farm. 43.01 per cent of small farms, 62.22 per cent of medium farms and 77.42 per cent of large rabbit entrepreneurs revealed that government should fix the support price for rabbit wool. The rabbits are purchased for establishing new rabbit units and also for cross-breeding purpose. About 88 per cent of rabbit entrepreneur on all farms situation revealed that the existing price of the animals is not

remunerative. The problem of unremunerative prices was reported by 98.92 per cent entrepreneurs on small farms followed by large farms (77.42 per cent) and medium farms (73.33 per cent). The demand for rabbit wool and other products is seasonal. During winter the demand for wool products rises, whereas, it decreases in other months of the year. The seasonal demand for wool products was reported by 98.82 per cent on all farms.

D) Institutional Problems

The institutional problems faced by rabbit entrepreneurs have been studied under subheads like lack of training and extension facilities and availability of package of practices and presented in Table 5. The knowledge acquired through training is of great relevance. The different institutions organize training programmes for rabbit entrepreneurs. About 27 per cent of rabbit entrepreneurs on all farms situation reported that existing training facilities are not adequate. The

TABLE-5: INSTITUTIONAL PROBLEMS OF THE RABBIT ENTREPRENEURS

Sr.No.	Particulars	(Per cent)			
		Farm Size			
		Small	Medium	Large	All farms
1.	Training Facilities not adequate	12.90	51.11	32.26	26.63
2.	Lack of Extension Facilities	93.55	66.67	83.87	84.62
3.	Package of Practices available	100.00	53.33	74.19	82.84
	Total number of farms	93	45	31	169

Note: Figures have been rounded off to their nearest digit.

maximum response in favour of this problem was found on medium farms (51.11 per cent) followed by large farms (32.26 per cent) and small farms (12.90 per cent). The rabbit entrepreneurs expect time to time help and guidance from different agencies of government. 84.62 per cent of rabbit entrepreneurs on all farms reported the lack of extension facilities. The improved technology developed by research institutes is disseminated through package of practices. The 82.84 per cent of rabbit entrepreneurs reported the non-availability of package of practices. Cent per cent response with regard to this problem was recorded on small farms. However, 53.33 per cent of medium farms and 74.19 per cent of large farms reported this problem, respectively.

IV. FUTURE STRATEGY AND POLICY IMPLICATION

The rabbit wool industry in Himachal Pradesh is in recession. In order to revive the industry the following policy points may be taken into consideration by the planners and policy makers:

i) For making rabbit as a viable livestock species it has to be introduced on scientific lines. The Government of India and Indian Council of Agricultural Research may open a National Rabbit Research Centre as has been done in case of sheep, goat, horses, camels, buffaloes and poultry thereby accepting rabbit as also one of the important livestock species having overall multifaceted utility to the country. Training of scientists, technicians and farmers should also be a component objective of such a National Rabbit Research Centre

ii) Case of slashing down of the import duty abruptly should be taken-up with the Ministry of Commerce, Government of India, so that the prices of the

imported wool are at par with the domestic produce and domestic production is encouraged

iii) Good Angora rabbits are always in demand by the government agencies in other states which are keen to introduce rabbitry as supplementary enterprises. The rabbits are also required by private entrepreneurs within the state as well as in other states. The sale and disposal of surplus animals if organized through some state/ private marketing agencies/ farmers' cooperatives will bring economic gains to Angora farmers.

iv) The provision of training to rabbit entrepreneurs should be strengthened and package of practices should be readily available. Involvement and training of farm women has to be further encouraged. The farmers should make a co-operative and should shear the rabbit wool at one time for the uniform length and quality. Awareness among the entrepreneurs will abridge the gap between existing and recommended levels of inputs.

V. REFERENCE

- 1) A.K. Sharma, Prakash Mehta and S.K. Sharma (1998). "Economic viability, Technological Gap Problems and Future Strategy to Enhance Export of Rabbit Wool in Himachal Pradesh". *Seminar*
- 2) *on Management of Export Marketing of High Value Farm Strategies*, Hissar (p152-p160)
- 3) Bhat, T.K. (1999). "Angora Rabbit Farming in the Hilly Regions of India". *Himachal Veterinary Journal*. 3:61-63.

- 4) Cheeke, P.R., Patton, N.M., and Templeton – G.S., Rabbit Production, (5th edition), Published by the Interstate Printers and Publishers, INC, USA, 1982.
- 5) James, I. and M.C. Nitt, “Waste Water in Rabbitries”, *The Journal of Applied rabbit Research*, Vol. 9, No. 2, (1986).
- 6) Jithendran, K.P. (1998). “Rabbit Production in Sub-Himalayan Region”. *Indian Farming*. May 1998: 15-19.
- 7) Kumar, Ashok (2004), “Rabbit Wool Industry” Daya Publishing House.
- 8) Phull, Archana, “Economic Analysis of Rabbit Farming in Kangra District of Himachal Pradesh”. *M.Sc. Thesis* (Unpublished), Himachal Pradesh Krishi Vishvavidyalaya, Palampur 1991.
- 9) Sharma, A.K. and S.K. Sharma (2001). Economic Analysis of Rabbit Farming Alongwith Technological Gap, Problems and Future Strategy. (Technical Lecture Copy): 135- 141.
- 10) Sharma, A.K. (1998) “Untapped Potential of Rabbitry”. *The Tribune* December 5, 1998.
- 11) Sharma, A.K. (2000). “Rabbitry – A Hidden Treasure – Needs Attention”. *The Himachal Reporter*, July 31, 2000.