



POPULATION DYNAMICS AND DAMAGE POTENTIAL OF WHITE GRUB (COLEOPTERA: SCARABAEIDAE) COMPLEX IN POTATO CROP OF NORTH WESTERN INDIAN HILLS

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ABSTRACT

Faunal composition of scarabaeids associated with potato crop in Shimla and Sirmour districts of Himachal Pradesh (India) was investigated and a survey on grub population and tuber damage was carried out at five locations including Shimla, Fagu, Shillaroo, Kharapathar and Kheradhar during 2007–08. Weekly catches of adult beetles from light traps were also recorded from all locations except Shillaroo. During the survey in three consecutive years (April 2007 to August 2009) seven species of scarabaeid beetles belonging to four genera representing two sub families Melolonthinae and Rutelinae were recorded. Among the identified species, *Brahmina coriacea* (71.39%) was predominant followed by *Holotrichia longipennis* (12.33%) and *B. flavoserica* (8.24%) at all the surveyed locations, during study period. Other species encountered were *Anomala dimidiata* (2.82%), *B. cirincolis* (2.38%), *A. lineatopennis* (1.82%) and *Lepidiota stigma* (1.49%). The scarabaeid adult emergence began soon after the first rain either during last week of May or early June and continued up to the end of July or beginning of August in North Western Indian hills. Mean number of grubs per plant and percent tuber damage was found maximum at Kharapathar (15.5 and 44) and minimum at Shimla (4.45 and 8.1). A positive correlation between beetle population and rainfall during three years was also observed.

Key words: White grubs, Population dynamics, Potato crop, and Tuber damage

INTRODUCTION

Shimla (31°N–77° E, 2,202m amsl), Fagu (32°N–77° E, 2,502m amsl), Shillaroo (31°N–77° E, 1,820m amsl) Kharapathar (31°N–77° E, 2,727m amsl) of Shimla district and Kheradhar (30°N–77° E, 1,048 m amsl) of Sirmour district are the important potato seed growing areas of Himachal Pradesh, India. The successful production of potato crop is hindered by damage caused by several insect pests belonging to different orders like Coleoptera (white grubs and beetles) and Lepidoptera (tuberworms and cutworms). The other insect pests include aphids, white flies, leaf hoppers, and defoliating caterpillars (Rajenderan and Chandla, 1986). White grubs are reported as major pests of potato crop in Northern Himalayas and are categorized among the five national pests of India. White grub activity above the ground is of short period only for the purpose of mating and feeding, while the rest of its life is spent inside the soil. Adult beetles generally start emerging from the soil after the pre-monsoon showers in May– June and continue emerging up-to September. The beetles feed on the foliage of many host plants viz., apricot, apple, pear, plum, robinia, kaithi and forest trees in order to gain the energy needed for reproductive development. Eggs are laid into soil and young grubs feed

initially on the mother tuber roots of developing potato plants. After tuber formation, second and third instar grubs feed on the underground tubers by making large circular holes into them and hence deteriorate their marketing quality. These grubs damage the tubers without any symptoms on the foliage. Thus, the farmer remains unaware of the damage to tubers until harvest. The damage is more severe in the years following high adult activity (Mishra, 1995; Mishra and Chandel, 2003). White grubs are responsible for causing 10.5 to 90.0 % losses in potato yield in endemic areas of higher hills of Uttar Pradesh, Himachal Pradesh, Jammu & Kashmir and North Eastern hills of India (Mishra, 2000; Mishra and Chandla, 1989). *Brahmina coriacea* has been reported predominant species on different fruit trees in mid and higher hills of Himachal Pradesh (Anon, 1977; Chandel *et al.*, 1997). White grub species infesting potato crop at Fagu was investigated by soil sampling and *B. coriacea* was observed as predominating species (Chandel *et al.*, 2003). In spite of varying degree of damage caused by white grubs, published information on their population dynamics, species diversity and damage to potato crop is scanty from the areas under study. Therefore, a detailed study on the distribution pattern, population dynamics and damage of white grub species infesting potato crop in North Western

Indian hills with an altitude varying from 1,048 m to 2,727 m amsl during 2007–09 was carried out. Survey on number of grubs per plant and percent tuber damage was carried out at five locations during 2007–08 and correlation coefficient between beetle population and the ecological factors (temperature, relative humidity and rainfall) was determined.

MATERIALS AND METHODS

Mass trapping: To collect adults (beetles) of white grubs, two light traps at each potato farm were installed at different positions during April to August, 2007–09. Light traps (Fig. 1) made of galvanized iron steel having a funnel



Figure 1. Light trap for mass trapping of beetles

shaped trapping subunit and a collecting drum fitted with a 100–Watt milky compact fluorescent lamp were used for the collection of beetles. The traps were installed two meter above the ground level so as to avoid any sort of obstacle in beetle's vision and to attract beetles from a longer

distance. The units were operated every night from dusk to dawn and collections of trapped beetles were done weekly. Beetles were brought to laboratory with the help of potable insect cages and were sorted and identified to compile an inventory of beetles. Data on population density of scarabaeids in potato fields was compiled based from the collected mass of beetles. The metrological data viz., temperature, relative humidity and rainfall were taken from meteorological department, CPRI, Shimla during the course of study.

Soil Sampling: Soil sampling for white grub's incidence infesting potato crop was carried out in potato farms at five different locations viz., Shimla, Fagu, Shillaroo, Kharapathar of Shimla districts and Kheradhar of Sirmour districts of Himachal Pradesh, India during April 2007 to August 2008. Sampling was carried out from root zone of randomly selected potato plants in 30 cm² area and minimum of 10 samples from each quadrat of selected location were taken. The number of damaged, healthy and total tubers was also recorded to determine the percent tuber damage by white grubs.

Data Analysis: The data on number of grubs and tuber damage were subjected to analysis of variance (ANOVA) after approximate transformation by using MSTAT–C software. Correlation coefficients (r) between beetle population and ecological factors (temperature, relative humidity and rainfall) were determined by using SPSS–10 software.

RESULTS AND DISSCUSION

Faunal composition of scarabaeids in potato fields: A systematic survey of faunal composition of scarabaeids (Fig. 2) in potato fields at four different locations belonging

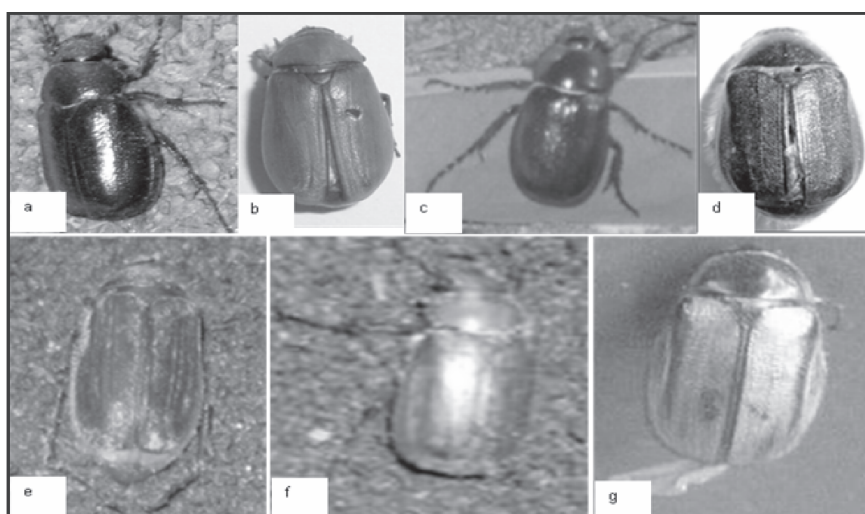


Figure 2. White grub species infesting potato in Shimla and Sirmour (HP), *Brahmina coriacea* (a) *B. flavoserica* (b) *B. crinicollis* (c) *Anomala dimidiata* (d) *Lepidiota stigma* (e) *Holotrichia longipennis* (f) *A. lineatopennis* (g)

to Shimla and Sirmour hills of Himachal Pradesh was carried out and a total of seven species belonging to two subfamilies *Melolonthinae* (3, genera) and *Rutelinae* (1, genus) were recorded (Table 1).

Subfamily: *Melolonthinae*: Population densities of scarabaeid beetles belonging to subfamily, *Melolonthinae* in potato fields were high with a total number of five species. Genus *Brahmina* was most abundant followed

Table 1. Mean population density of different species of scarabaeid beetles in potato fields at various locations during 2007–09

Year	Location	Melolonthinae					Rutelinae	
		<i>Brahmina coriacea</i>	<i>Brahmina flavoserica</i>	<i>Brahmina cirinicollis</i>	<i>Holotrichia longipennis</i>	<i>Lepidiota stigma</i>	<i>Anomala dimidiata</i>	<i>Anomala lineatopennis</i>
2007	Shimla	66.36	18.44	4.52	3.46	2.66	2.39	2.13
	Fagu	72.08	19.86	2.64	2.02	1.21	1.10	1.07
	Kharapathar	69.55	–	–	28.20	–	2.61	–
	Kheradhar	79.32	–	–	13.83	–	3.97	2.87
Mean of all locations		71.83	9.58	1.79	11.88	0.97	2.52	1.52
2008	Shimla	61.09	10.23	7.29	9.15	5.58	3.41	3.26
	Fagu	67.15	26.36	4.70	2.69	1.33	1.03	0.79
	Kharapathar	67.73	–	–	29.50	–	2.78	–
	Kheradhar	86.21	–	–	6.48	–	3.74	3.56
Mean of all locations		70.55	9.15	2.30	11.95	1.73	2.89	1.90
2009	Shimla	63.88	9.87	6.35	6.02	5.35	4.52	4.01
	Fagu	77.07	11.90	3.06	2.71	2.09	1.85	1.32
	Kharapathar	65.96	–	–	32.89	–	1.14	–
	Kheradhar	80.63	–	–	11.89	–	4.32	3.16
Mean of all locations		71.89	5.44	2.35	13.38	1.86	3.04	2.12
Mean (2007–09)	Shimla	63.78	12.85	6.05	6.21	4.53	3.44	3.13
	Fagu	72.1	19.37	3.47	2.47	1.54	1.33	1.06
	Kharapathar	67.75	0	0	30.20	0	2.49	0
	Kheradhar	82.05	0	0	10.73	0	4.01	3.2
Mean of all locations (2007–09)		71.39	8.24	2.38	12.33	1.49	2.82	1.82

by *Holotrichia* in all the places. Scarabaeid beetles have been found more diverse at Shimla and Fagu with seven species as compared to Kharapathar and Kheradhar with three and four species, respectively. In Shimla, *Brahmina coriacea* was 66.36% of total scarab beetles, followed by *B. flavoserica* (18.44%) during 2007. Other species found were *B. cirinicollis* (4.52%), *Holotrichia longipennis* (3.46%) and *Lepidiota stigma* (2.66%). At Fagu, again *B. coriacea* (72.08%) was found to be dominating followed by *B. flavoserica* (19.86%) and other species were *B. cirinicollis* (2.64%), *H. longipennis* (2.02%) and *L. stigma* (1.21%). Out of these five species, only two species, *B. coriacea* (69.55% and 79.32%) and *H. longipennis* (28.20% and 13.83%) were present at Kharapathar and Kheradhar, respectively. Mean population densities of *B. coriacea* were found 71.83% followed by *H. longipennis* (11.88%),

B. flavoserica (9.58%), *B. cirinicollis* (1.79%) and *L. stigma* (0.97%), at all the locations surveyed during 2007. Population densities of beetles were found almost similar during the year 2008. Highest population density of *B. coriacea* was also observed at all places during 2008–09. Mean population density of *B. coriacea* was found to be 70.55% followed by *H. longipennis* (11.95%), *B. flavoserica* (9.15%), *B. cirinicollis* (2.30%) and *L. stigma* (1.73%) in all the locations surveyed during 2008. During 2009, mean population density of *B. coriacea* was found to be 71.89% followed by *H. longipennis* (13.38%), *B. flavoserica* (5.44%), *B. cirinicollis* (2.35%) and *L. stigma* (1.86%) in all the locations surveyed. Mean population density during three consecutive years in all the locations were found to be 71.39 % of *B. coriacea* followed by *H. longipennis* (12.33%), *B. flavoserica* (8.24%), *B. cirinicollis* (2.38%)

and *L. stigma* (1.49%). In Shimla mean population density of three years, revealed *B. coriacea* (63.78%) as dominating species followed by *B. flavoserica* (12.85%), *H. longipennis* (6.21%), *B. cirinicornis* (2.35%) and *L. stigma* (1.86%). Whereas in Fagu, mean population density of three years indicated 72.1% of *B. coriacea* followed by *B. flavoserica* (19.37%), *B. cirinicornis* (3.47%), *H. longipennis* (2.47%) and *L. stigma* (1.54%). In Kharapathar mean population density for three successive years was 67.75 and 30.20 % of *B. coriacea* and *H. longipennis*, respectively, whereas mean population density of both the species in Kheradhar for three consecutive years was 82.05 and 10.73 per cent, respectively.

Subfamily: Rutelinae: Population density of beetles belonging to Rutelinae was found less as compared to Melolonthinae. Out of two species, *Anomala dimidiata* was found in all locations whereas *A. lineatopenis* at three locations except Kharapathar. Higher population densities of *Anomala dimidiata* (4.01%) was found at Kheradhar followed by Shimla (3.44%) and Kharapathar (2.49%) and least at Fagu (1.33%) during three consecutive years. Population density of *A. lineatopenis* was found highest at Kheradhar (3.2%) followed by Shimla (3.13%) and least at Fagu (1.06%).

Correlation coefficient (r) between beetle population and some ecological factors: Significant positive correlation coefficient between beetle population and rainfall during 2007 and 2009 and highly significant correlation coefficient during 2008 was observed (Table 2). A negative correlation between beetle population and temperature was observed during 2007–08 and a positive correlation between beetle

population and temperature was obtained during 2009. A low positive correlation was found between beetle population and relative humidity during 2007 and 2009, whereas significantly negative correlation was observed during 2008.

Grub population and tuber damage: Survey conducted on grub population and percent tuber damage in potato fields at five different locations showed highest grub population and tuber damage was recorded at Kharapathar (Table 3). Mean number of grubs per plant during 2007 were 16.90 per cent with highest tuber damage (49.90%) at Kharapathar followed by Kheradhar (14.00 and 38.60), Shillaroo (9.80 and 40.50) and Fagu (6.30 and 13.60), respectively. Least number of grubs and percent tuber damage was observed at Shimla (4.80 and 9.20%). During the year 2008, mean number of grubs per plant and percent tuber damage observed at Karapathar was 14.10 with 38.10, respectively followed by Kheradhar (12.50 and 33.40), Shillaroo (7.40 and 26.70) and Fagu (5.60 and 10.90) respectively. Similarly, least number of grubs and percent tuber damage was observed at Shimla (4.10 and 7.00%). In the present survey *B. coriacea* has been found as predominating species at all the locations surveyed during three consecutive years (2007–09). *B. coriacea* has already been reported to be predominant species in high hills of Shimla district and 25.87% of total catches from mid hills of Himachal Pradesh has been recorded earlier (Annual Report, 1977). In a later study, *B. coriacea* was recorded to constitute 45.5 – 51.7 in mid hills of Himachal Pradesh (Chandel *et al.*, 1997) but in present study, *B. coriacea* was recorded 82.05% of total catches from at Kheradhar

Table 2. Correlation coefficient (r) between beetles population and some ecological factors

Year	Rain	Temperature °C		RH (%)	
		Minimum	Maximum	Minimum	Maximum
2007	0.46	-0.30	-0.20	0.14	0.11
2008	0.84	0.21	-0.55	-0.69	-0.68
2009	0.43	0.61	0.31	0.27	0.34

Table 3. Number of grubs and tuber damage caused at various locations during 2007–08.

Location	Number of grubs/plant			Tuber damage (%)		
	2007	2008	Mean	2007	2008	Mean
Shimla	4.80 (2.28)*	4.10 (2.10)	4.45	9.20 (17.65)**	7.00 (15.30)	8.1
Fagu	6.30 (2.59)	5.60 (2.46)	5.95	13.60 (21.61)	10.90 (19.26)	12.25
Shillaroo	9.80 (3.19)	7.40 (2.80)	8.6	40.50 (39.51)	26.70 (31.03)	33.6
Kharapathar	16.90 (4.17)	(3.80)	15.5	49.90 (44.96)	38.10 (38.12)	44
Kheradhar	14.00 (3.78)	12.50 (3.59)	13.25	38.60 (38.38)	33.40 (35.30)	36

Each value is mean of ten observations; * $\sqrt{x + 0.5}$ transformed values; ** Arc sine transformed value

(mid hills) and also highest among all locations. Second highest species has been found to be *B. flavoserica* at Shimla and Fagu and *H. longipennis* in Kharapathar and Kheradhar. According to Annual Report (1977) the mid and higher hills of Himachal Pradesh, *H. longipennis* constitute 24.01–44.96% of total scarabaeid fauna. But in present survey, *H. longipennis* were 10.73–30.20% of total catches at Kheradhar (mid hills) and Kharapathar (Higher hills) respectively. However, at Shimla and Fagu, *B. flavoserica* forming 12.85–19.37% of total catches was dominant over *H. longipennis*. Chandel *et al.* (1997) have reported *H. longipennis* (8.2–19.8% of total catches) from different fruit trees while other species were found in less abundance. Only three species have been observed from Kaharpathar and four from Kheradhar whereas seven species from Shimla and Fagu.

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