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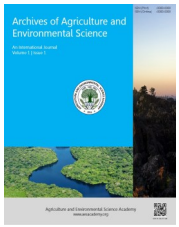

ORIGINAL RESEARCH ARTICLE

Study of snail and slug population dynamics in relation to edaphic factors in plant nurseries near Buddha Nullah, Ludhiana (Punjab), India

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ABSTRACT

The present study was conducted to study of snail and slug population dynamics in relation to edaphic factors in plant nurseries near Buddha Nullah, Ludhiana (Punjab), India., In the survey of four ornamental plant nurseries *viz.,* Prabhakar, Tulsigaurd, Laxmi plant nurseries near Buddha nullah, Ludhiana and one reference site Punjab Agricultural University nursery, Ludhiana revealed the presence of only one species of both snails and slugs viz., *Macrochlamys indica* and *Filicaulis alteviz.* brown slug with black spots respectively in the four plant nurseries. Population density of slugs and snails was maximum in the month of August in all the plant nurseries indicating moisture ranging from 32.36 to 33.5 and temperature ranging from 21.5 to 23.25°C favours the population growth of both slugs and snails. Snail, *M. indica* and slug, *F. alte* preferred sandy loamy alkaline soil with high moisture, nitrogen, particle density, high organic matter content, high potassium and phosphorous concentrations, porosity and low bulk density.

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INTRODUCTION

Snails and slugs belong to the phylum Molluscs and class Gastropoda. These are regarded as invertebrates with soft unsegmented bodies. Slugs are also described as snails that are without a shell, while snail bodies are enclosed in hard calcareous shells (Barker, 2002; Ramzy, 2009). Soil invertebrates are regarded as effective bio monitors of heavy metal pollution in land or terrestrial ecosystem (Berger *et al.,* 1993). These are important pollution indicators as their faecal pellets contain high concentration of heavy metals that is helpful in determining the degree of pollution in rivers, lakes and other land areas. They are also biological indicators of radioactive pollution (Godan, 1983).

Both snails and slugs are commonly known as agricultural pests. These are also used in scientific research processes especially in relation to immunological haematology studies, while their shells are used as a model for the study of process of bones calcification (Godan, 1983).

Buddha Nullah is a seasonal water stream thatruns all the way through the Malwa region of Punjab. After passing through this highly populated city of Ludhiana, it drains into Sutlej River, a tributary of the Indus River. It has now become a main source of pollution in the region as well as in the main Sutlej River as it gets polluted after entering the highly populated and industrialized Ludhiana city. Chemicals, various types of dyes, cyanide, chrome, nickel traces of heavy metals that end up in Buddha Nullah. There are certain evidences of presence of heavy metals and toxins in the food chain, as vegetables and crops cultivated along the water course are irrigated by this water (Singh, 2008). Keeping in view, the present investigation was carried out to study of snail and slug population dynamics in relation to edaphic factors in plant nurseries near Buddha Nullah, Ludhiana (Punjab), India.

MATERIALS AND METHODS

The present studies were conducted at four commercial ornamental plant nurseries *viz.,* Tulsigaurd nursery, Prabhakar nursery, Laxmi nursery, PAU Campus nursery at Ludhiana and the laboratories of Department of Zoology and Soil Science at PAU, Ludhiana.

Surveillance: Plant nurseries at Ludhiana were surveyed and the population density of slugs and snails was studied throughout the year at fortnightly intervals by placing damp sacks at 10 spots per nursery during the evening hours (1800-1900 hours). Gastropods under these bricks

were collected in the morning (0600-0700 hours) of the third day. The length and breadth of the collected specimens were measured along with their weight in the laboratory. The soil moisture and temperature were also recorded to find the relationship of these edaphic factors with population density of slugs and snails.

Soil moisture: Soil sample was taken in pre-weighed moisture boxes and weighed them along with soil. The soil in moisture boxes was dried in oven at 105 ° C for 24 hrs and weight of dry soil recorded.

Moisture (%) =

$$\frac{\text{Weight of wet soil - Weight of dry soil}}{\text{Weight of wet soil}} \times 100$$

RESULTS AND DISCUSSION

Surveillance: Slug and snail population structure, density and fluctuation was studied throughout the year by counting the number of slugs and snails active at soil surface (collected under the damp sacks) at randomly selected 10 spots in each plant nursery. In all the four plant nurseries *viz*., PAU plant nursery, Prabhakar plant nursery, Laxmi plant nursery and Tulsigaurd plant nursery, single snail species i.e. *Macrochalmys indica* and single slug species i.e. *Filicaulis alte viz.,* brown slug with black spots were found. Sixty four specimens i.e. 5 slugs and 59 snails were found in PAU plant nursery, one hundred specimens i.e. 10 slugs and 90 snails were found in Prabhakar plant nursery, ninety six specimens i.e. 20 slugs and 76 snails were found in Laxmi plant nursery and eighty five specimens i.e. 16 slugs and 69 snails were found in Tulsigaurd plant nursery. So highest number of gastropods was found at Prabhakar plant nursery located near Buddha nullah, and lowest number of gastropods was recorded at PAU plant nursery. Study on the population density of slug, *F. alte* and snail, *M. indica* in relation to soil temperature and moisture in all the selected nurseries revealed that their population density was highest in the month of August at soil temperature ranging from 21.5% to 23.5°C and soil moisture ranging from 32.36% to 33.5%. However, population density of slugs reduced to nil from October to April and that of snails reduced to nil from November to February (Tables 1 -4). Correlation analysis of seasonal factors and slug and snail population density revealed that there was significant positive correlation between slug and snail population with soil moisture at 1% C.V. Sebay *et al.* (2009) reported maximum population density of glassy clover snail, *Moncha cartusiana* during spring months (March, April and May) as compared with winter or autumn months in Sharkia Governorate. Slugs remained active on soil surface in the months of May and August while snails were active on soil surface from May to October. Both snails and slugs were in hibernation from November to February. Klimas *et al.* (2002) reported that activity of snails mainly depends

Table1. Variation in size and number of slug, *Filicaulis alte* and snail, *Macrochalmys indica* in relation to soil temperature and moisture in PAU nursery, Ludhiana.

Month-Year	Number and size of slugs and snails/m^2 (n=20)					Soil temperature (ºC) at different depths		Percent soil moisture
	Slugs	Snails	Slug length (cm)	Snail length (cm)	Snail shell diameter (cm)	5cm	10cm	
May/2013	0.05±0.04 (0-1)	0.2±0.13 (1-2)	3.0	3.52±0.17 (3.0-4.0)	1.2±0.03 (1.0-1.4)	23.37±1.57	22.37±1.45	21.2±0.35
Jun/2013	-	0.45±0.24 (2-3)	-	3.55±0.08 (3.6-4.0)	2.3±1.03 (1.1-1.6)	25.5±1.99	24.75±1.98	26.33±0.61
Jul/2013	-	0.2±0.12 (1-2)	-	2.8±0.12 (3.2-3.8)	1.32±0.07 (1.4-1.6)	24.75±1.39	23.75±1.43	25.61±1.56
Aug/2013	0.15±0.07 (0-3)	1.3±0.25 (2-4)	4.9±0.12 (5.0-5.2)	4.04±0.14 (4.1-4.6)	1.45±0.05 (1.2-1.8)	22.5±1.84	21.5±1.60	33±0.47
Sept/2013	0.05±0.04 (0-1)	0.5±0.19 (1-2)	5.4	2.8±0.26 (4.0-4.2)	1.33±0.09 (1.1-1.4)	22.37±0.48	19.12±1.48	24.55±0.27
Oct/2013	-	0.3±0.14 (1-3)	-	3.8±0.09 (3.5-4.0)	1.56±0.07 (1.4-1.6)	18.75±0.91	17.5±1.03	23.56±0.27
Nov/2013	-	-	-	-	-	15.37±0.99	14.37±0.92	22.15±0.39
Dec/2013	-	-	-	-	-	12.87±0.71	12.12±0.77	19.9±0.27
Jan/2014	-	-	-	-	-	12.25±0.73	11.25±0.80	18.83±0.35
Feb/2014	-	-	-	-	-	12.62±0.62	12.12±0.48	16.86±0.81
Mar/2014	-	0.1±0.048 (0-1)	-	3.3±0.07 (3.2-3.4)	0.12±0.07 (0.3-0.7)	13.12±0.54	11.87±0.56	19.4±1.64
Apr/2014	-	0.05±0.04 (0-1)	-	3.5	1.4	19.75±0.45	19.25±0.45	20.93±0.143

Values are Mean±SE (range).

Table 2. Variation in size and number of slug, *Filicaulis alte* and snail, *Macrochlamys indica* in relation to soil temperature and moisture in Prabhakar plant nursery, Ludhiana.

Month-Year	Number and size of slugs and snails per m^2 (n=20 spots)					Soil temperature (°C) at different depths		Percent soil Moisture
	Slugs	Snails	Slug length (cm)	Snail length (cm)	Snail shell diameter	5cm	10cm	
May/2013	0.1±0.06 (0-1)	0.65±0.28 (1-4)	3.6±0.04 (3.5-3.8)	3.53±0.14 (3.1-4.0)	1.35±0.06 (1.1-1.6)	22.25±1.43	21.37±1.51	21.41±0.45
Jun/2013	0.15±0.14 (0-1)	0.7±0.20 (1-3)	4.6±0.23 4.7-5.60	4.43±0.23 (4.1-4.7)	1.38±0.05 (1.3-1.6)	26±2.26	25.12±2.19	27.01±0.32
Jul/2013	0.05±0.04 (0-1)	0.6±0.20 (2-4)	5.7	3.52±0.17 (3.8-4.5)	1.55±0.05 (1.4-1.7)	24.5±1.62	23.75±1.75	30.56±0.41
Aug/2013	0.25±0.11 (1-2)	1.1±0.21 (1-4)	5.3±0.14 (5.1-6.0)	5.06±0.22 (4.1-5.6)	1.56±0.06 (1.6-2.2)	22.87±1.82	22±1.89	33.5±0.69
Sept/2013	0.05±0.04 (0-1)	0.5±0.33 (1-3)	4.0	4.93±0.20 (4.1-5.2)	1.52±0.04 (1.4-1.8)	20.75±1.50	20.25±1.50	23.45±0.55
Oct/2013	-	0.45±0.17 (1-4)	-	3.52±0.18 (3.2-4.5)	1.53±0.03 (1.2-1.7)	19.37±1.45	18.75±1.39	22.93±0. 23
Nov/2013	-	-	-	-	-	16.12±1.20	14.62±0.95	21.75±0.35
Dec/2013	-	-	-	-	-	13.5±0.53	12±0.35	20±0.22
Jan/2014	-	-	-	-	-	12.13±0.20	10.37±0.20	21.23±0.38
Feb/2014	-	-	-	-	-	14.37±1.57	13.37±1.74	17.15±0.53
Mar/2014	-	0.3±0.10 (1-2)	-	2.73±0.21 (2.3-3.4)	1.46±0.09 (1.3-1.7)	19.75±0.87	18.5±0.63	20.25±0.60
Apr/2014	-	0.2±0.13 (0-2)	-	3.55±0.10 (3.4-4.3)	0.85±0.11 (0.7-1.0)	18.75±0.27	17.5±0.72	22.58±0.62

Values are Mean±SE (range).

Table 3. Variation in size and number of slug, *Filicaulis alte* and snail, *Macrochlamys indica* in relation to soil temperature and moisture in Laxmi plant Nursery, Ludhiana.

Month-Year	Number and size of slugs and snails/m^2 (n=20)					Soil temperature (°C) at different depths		Percent soil Moisture
	Slugs	Snails	Slug length (cm)	Snail length (cm)	Snail shell diameter	5cm	10cm	
May/2013	0.35±0.10 (1-2)	0.7±0.46 (1-4)	3.75±0.22 (3.1-4.5)	3.52±0.21 (3.1-3.5)	1.35±0.05 (1.2-1.5)	23±1.62	21.87±1.69	21.66±0.69
Jun/2013	0.2 ± 0.19 (1-2)	0.45±0.20 (3-4)	4.37±0.09 (4.1-4.6)	3.35±0.07 (3.2-3.8)	1.4±0.03 (1.2-1.6)	25.37±2.04	24.87±1.89	27.25±0.54
Jul/2013	0.1±0.06 (0-2)	0.55±0.19 (1-3)	4.5±0.21 (4.2-4.8)	4.32±0.19 (4.0-5.0)	1.52±0.11 (1.3-2.0)	24±1.27	23.12±1.32	30.83±1.76
Aug/2013	0.3±0.16 (1-2)	1±0.21 (2-4)	4.64±0.20 (5.1-5.2)	4.36±0.13 (4.1-5.5)	1.43±0.05 (2.8-2.4)	22.12±1.69	21.5±1.63	33.33±0.56
Sept/2013	0.05±0.04 (0-1)	0.45±0.17 (1-3)	4.6	-	1.3±0.04 (1.5-1.8)	23.37±0.36	19.75±1.64	23.83±0.34
Oct/2013	-	0.35±0.14 (1-2)	-	3.7±0.18 (2.5-3.7)	1.4±0.05 (1.3-1.6)	17.75±1.95	17.25±1.95	21.83±0.27
Nov/2013	-	-	-	-	-	14.37±1.36	13.5±1.55	20.26±0.43
Dec/2013	-	-	-	-	-	13.37±0.67	12.37±0.77	18.1±0.47
Jan/2014	-	-	-	-	-	12±0.17	11.37±0.20	16.46±0.45
Feb/2014	-	-	-	-	-	13.12±0.20	12.25±0.27	15.28±0.20
Mar/2014	-	0.2±0.13 (1-2)	-	3.1±0.07 (2.5-3.7)	1.45±0.10 (1.1-1.4)	17±1.89	16±1.76	20.41±0.47
Apr/2014	-	0.1±0.06 (0-2)	-	2.7±0.07 (2.6-2.8)	1.65±0.01 (1.3-1.8)	21.75±0.83	21.12±0.77	21.98±0.52

Values are Mean±SE(range)

Table 4. Variation in size and number of slug, *Filicaulis alte* and snail, *Macrochlamys indica* in relation to soil temperature and moisture in Tulsigaurd plant nursery, Ludhiana.

Month-Year	Number and size of slugs and snails/m^2 (n=20)					Soil temperature (ºC) at different depths		Percent soil Moisture
	Slugs	Snails	Slug length (cm)	Snail length (cm)	Snail shell diameter	5cm	10cm	
May/2013	0.25±0.24 (1-2)	0.35±0.29 (1-3)	3.6±0.07 (3.4-3.7)	4.05±0.13 (3.5-4.0)	1.36±0.03 (1.3-1.5)	21.87±1.12	21.12±1.15	21.3±0.45
Jun/2013	0.05±0.04 (0-1)	0.4±0.38 (1-2)	4.0	4.17±0.35 (3.1-3.8)	1.5±0.063 (1.3-1.7)	26±2.28	25.25±2.16	27.05±0.52
Jul/2013	0.15±0.10 (1-2)	0.7±0.47 (1-4)	4.2±0.12 (4.6-4.8)	3.97±0.21 (3.2-3.8)	1.47±0.07 1.4-1.7)	25.87±1.82	24.87±2.09	30.6±0.56
Aug/2013	0.3±0.20 (1-4)	1.25±0.48 (4-5)	4.95±0.15 (5.6-5.4)	3.57±0.21 (4.0-4.3)	1.50±0.04 1.6-2.3)	23.25±2.00	22.5±2.01	32.36±0.59
Sept/2013	-	0.5±0.11 (2-4)	-	3.56±0.46 (3.6-4.0)	1.06±0.20 (1.3-1.8)	20.75±1.50	20±1.76	23.53±0.58
Oct/2013	0.05±0.04 (0-1)	0.15±0.07 (1-2)	5.5	3.8±0.14 (3.6-4.0)	0.9±0.49 (1.2-1.6)	18.75±1.43	18±1.31	22.38±0.71
Nov/2013	-	-	-	-	-	15.87±1.32	14.62±1.47	21.96±0.46
Dec/2013	-	-	-	-	-	12.87±1.06	12±1.10	20.15±0.22
Jan/2014	-	-	-	-	-	12.75±1.24	11.87±1.20	19.86±0.62
Feb/2014		-	-	-	-	13.12±0.44	12.12±0.64	17.26±0.53
Mar/2014	0.05±0.04 (0-1)	0.1±0.09 (0-2)	3.6	3.15±0.10 (3.0-3.3)	1.15±0.24 (0.8-1.3)	14.25±0.73	13.12±0.79	20.33±0.56
Apr/2014	-	-	-	-	-	19.37±0.59	18.5±0.68	23.65±0.32

Values are Mean±SE (range).

on the meteorological condition with maximum activity in humid weather. Thakur and Kumari (1998) reported that maximum population of snails prevailed during August and September and minimum during February and practically nil in January in Bihar. Thakur (2003) from Bihar reported that infestation of *Achatina fulica*commenced with monsoon season and declined from middle of November. Ravikumara (2007) reported maximum population density of Giant African Snail, *A. Fulica* at the average temperature of 25.93°C.

Conclusions

Therefore, annual slug and snail population was more in Prabhakar plant nursery (100) followed by Laxmi plant nursery (96) and Tulsigaurd Plant nursery (85) and least in PAU plant nursery (64). It was observed that the soil characteristics of Prabhakar plant nursery were more favourable for both slugs and snails. High density of slug and snail population in Prabhakar plant nursery might be due to sandy loam texture of the soil, high organic matter content, phosphorous, nitrogen, porosity and less bulk density of soil. The number of both slugs and snail was least in PAU plant nursery. It might be due to poor soil conditions like pH, EC, organic matter, soil texture, nitrogen, phosphorous etc in PAU plant nursery. In case of Tulsigaurd plant nursery, density of both slugs and snails was low as compared to other two plant nurseries near Buddha Nullah.

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