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**Pallavi HS**
Department of Agricultural
Entomology, College of
Agriculture, V. C. Farm,
Mandya, Karnataka, India

**Basavaraju BS**
Department of Agricultural
Entomology, College of
Agriculture, Karekere, Hassan,
Karnataka, India

**Umashankar N**
Department of Agricultural
Molecular Biology, College of
Agriculture, Karekere, Hassan,
Karnataka, India

**Shivashankar T**
Department of Agricultural
Entomology, College of
Agriculture, V. C. Farm,
Mandya, Karnataka, India

**Rajegowda**
Programme Co-ordinator, Krishi
Vigyan Kendra, Kandli, Hassan,
Karnataka, India

# Seasonal incidence and population dynamics of giant African snail, *Achatina fulica* bowdich on mulberry

## Pallavi HS, Basavaraju BS, Umashankar N, Shivashankar T and Rajegowda

**Abstract**
A study on seasonal incidence of giant African snail (*Achatina fulica* Bowdich) on mulberry and the influence of weather parameters on it was carried out at H. Kodihalli village of Mandya district and Hoovinahallikavalu village of Hassan district of Karnataka from September, 2016 to February, 2017 during which the pest incidence usually occurs. The study revealed a gradual increase of snail population from September, 2016 to November, 2016, thereafter a gradual decrease was observed in both the locations. At H. Kodihalli village maximum snail population was recorded during fourth week of November, 2017 (103.22 snails/10 m$^2$) and minimum during fourth week of February, 2017 (2.25 snails/10m$^2$) which showed significant positive correlation with minimum temperature (r=0.46) and rainfall (r=0.54). At Hoovinahallikavalu village maximum snail population was recorded during second week of October 2016 (115.67 snails/10 m$^2$) and minimum during second week of February, 2017 (2.37 snails/10m$^2$) and it showed significant positive correlation with minimum temperature (r=0.52) and rainfall (r=0.56).

**Keywords:** *Achatina fulica*, seasonal incidence, weather parameters, correlation

## Introduction

The giant African snail, *Achatina fulica* Bowdich is one of the world's largest and most damaging land snail pests. It belongs to the Phylum: Mollusca, Class: Gastropoda, Sub-class: Pulmonata, Order: Stylommatophora and Family: Achatinidae. *A. fulica* is generally nocturnal pest but has been seen actively moving during cloudy and rainy days though the pest always avoid direct sunlight. The conspicuous occurrence of *A. fulica* is generally noticed during rainy season and the climatic conditions like high humidity (> 80%,) and moderate temperature (9 °C to 29 °C) are more congenial for the population build-up of the pest (Thakur, 1998 and 2003) [8, 9]. The snails appear in mid-June with the onset of monsoon and continue their activity till November. Being a prolific breeder, each individual is capable of laying eggs, and soon rehabilitates itself by rebuilding its population, spreads over all around and becomes a menace of vegetation (Gupta and Doharey, 1985) [3]. The information regarding seasonal incidence of *A. fulica* in Mandya and Hassan districts is scanty hence, the study was undertaken in mulberry gardens selected at H. Kodihalli village of Mandya taluk, Mandya district and Hoovinahallikavalu village of Hassan taluk, Hassan district of Karnataka from September, 2016 to February, 2017 during which the pest incidence usually occurs.

## Material and Methods

The study was carried out to record the seasonal incidence of *A. fulica* on mulberry at H. Kodihalli village of Mandya taluk, Mandya district and Hoovinahallikavalu village of Hassan taluk, Hassan district of Karnataka from September 2016 to February 2017.

Fixed plot survey was carried out in two mulberry gardens selected at each village at weekly interval from September 2016 to February 2017. Observations on number of snails per 25 m$^2$ area inside the plot and near the bund, and 10 m$^2$ area all along the bund were recorded during evening hours from five randomly selected spots and average number of snails per 10 m$^2$ area was computed (Chandaragi, 2014) [1].

To study the influence of abiotic factors on population fluctuation of *A. fulica* on mulberry, the data on meteorological variables prevailed during the study period *viz.*, maximum and minimum temperature, morning and afternoon relative humidity, sunshine hours and rainfall were collected from Agro-meteorological observatory unit, College of Agriculture, V. C. Farm, Mandya and Krishi Vigyan Kendra, Kandli, Hassan, and weekly means were worked out. The weekly mean observation recorded on population of *A. fulica* on mulberry and weather parameters were subjected to Pearson's rank correlation.

**Correspondence**
**Pallavi HS**
Department of Agricultural
Entomology, College of
Agriculture, V. C. Farm,
Mandya, Karnataka, India

Further, the data were subjected to "Multiple Linear Regression Analysis Techniques" (Pans and Sukhatme, 1967) [6] by fitting different functions by using software "SAS Syntax Reference Guide 2016, version 16.0 (SPSS 16), South Wacker Drive, Chicago, IL.

## Results and Discussion

The results of the seasonal incidence of *A. fulica* on mulberry at H. Kodihalli village of Mandya taluk, Mandya district and Hoovinahallikavalu village of Hassan taluk, Hassan district of Karnataka from September 2016 to February 2017, and its relationship with meteorological variables are presented in Table 1, 2, 3 and 4.

The present investigation on seasonal incidence of *A. fulica* on mulberry conducted at H. Kodihalli village of Mandya taluk, Mandya district of Karnataka at weekly interval from September 2016 to February 2017 revealed a gradual increase of snail population from first week of September, 2016 to fourth week of November, 2016 thereafter, a gradual decrease was observed. The snail activity was maximum during second week of September (86.96 snails/10 m² area), second week of October (85.60 snails/10 m² area) and fourth week of November (103.22 snails/10 m² area), and minimum during fourth week of February, 2017 (2.25 snails/10 m² area). Whereas at Hoovinahallikavalu village of Hassan taluk, Hassan district of Karnataka the snail population gradually increased and reached its peak of 115.67 snails/10 m² during second week of October, 2016, 112.04 snails/10 m² during fourth week of September, 2016 and 97.11 snails/10 m² during first week of November, 2016 thereafter, the population gradually decreased and reached its minimum of 2.37 snails/10 m² during second week of February, 2017.

**Table 1:** Seasonal incidence of giant African snail on mulberry at H. Kodihalli village of Mandya taluk, Mandya district from September 2016 to February 2017

| Month | MSW | Inside field (25 m²) | Near bund (25 m²) | Bund (10 m²) | Snail population/10 m² area | Maximum temp. (⁰C) | Minimum Temp. (⁰C) | RH (%) 7.30 AM | RH (%) 2.30 PM | Sunshine hours day⁻¹ | Rainfall (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| September | 36 | 51.40 | 61.00 | 87.40 | 44.12 | 33.26 | 19.29 | 91.57 | 59.00 | 3.43 | 0.00 |
| | 37 | 71.60 | 125.60 | 182.00 | 86.96 | 33.33 | 17.90 | 89.57 | 60.00 | 2.29 | 62.2 |
| | 38 | 17.40 | 26.40 | 52.90 | 23.47 | 33.19 | 20.09 | 93.14 | 62.71 | 0.86 | 0.00 |
| | 39 | 59.20 | 88.20 | 105.80 | 54.92 | 33.24 | 18.79 | 92.43 | 60.71 | 2.57 | 6.00 |
| October | 40 | 40.20 | 45.40 | 78.70 | 37.65 | 33.57 | 18.50 | 92.29 | 53.29 | 7.43 | 0.00 |
| | 41 | 61.40 | 125.60 | 182.00 | 85.60 | 33.24 | 18.57 | 87.71 | 59.71 | 5.14 | 65.00 |
| | 42 | 37.80 | 44.60 | 78.10 | 37.02 | 36.54 | 17.44 | 82.57 | 53.29 | 5.29 | 0.00 |
| | 43 | 15.00 | 20.40 | 30.40 | 14.85 | 34.50 | 15.24 | 89.00 | 51.00 | 7.71 | 0.00 |
| November | 44 | 27.40 | 33.60 | 56.60 | 27.00 | 34.11 | 18.21 | 78.57 | 54.00 | 8.00 | 4.40 |
| | 45 | 17.40 | 24.20 | 37.70 | 18.11 | 32.77 | 16.53 | 88.14 | 41.71 | 8.86 | 0.00 |
| | 46 | 45.20 | 49.80 | 76.40 | 38.13 | 31.44 | 17.91 | 87.14 | 49.43 | 9.00 | 0.00 |
| | 47 | 98.00 | 173.00 | 201.26 | 103.22 | 31.97 | 15.14 | 91.43 | 38.71 | 9.14 | 0.00 |
| | 48 | 71.40 | 87.60 | 129.80 | 64.47 | 30.83 | 11.21 | 92.86 | 38.43 | 7.29 | 3.10 |
| December | 49 | 21.40 | 25.60 | 38.80 | 19.20 | 30.71 | 12.53 | 95.29 | 52.57 | 7.00 | 0.00 |
| | 50 | 21.20 | 26.20 | 44.70 | 21.22 | 29.93 | 14.36 | 93.00 | 39.29 | 5.14 | 38.8 |
| | 51 | 15.60 | 21.00 | 34.30 | 16.31 | 30.57 | 13.29 | 93.57 | 39.14 | 8.71 | 0.00 |
| | 52 | 14.00 | 19.20 | 31.20 | 14.83 | 30.50 | 9.54 | 92.50 | 24.75 | 9.75 | 0.00 |
| January | 1 | 7.60 | 14.80 | 25.13 | 11.36 | 31.30 | 11.50 | 92.00 | 42.00 | 9.60 | 0.00 |
| | 2 | 6.40 | 14.40 | 23.62 | 10.65 | 31.30 | 13.90 | 91.00 | 39.00 | 8.90 | 0.00 |
| | 3 | 4.40 | 8.20 | 16.40 | 7.15 | 32.30 | 12.80 | 86.00 | 49.00 | 8.60 | 0.10 |
| | 4 | 4.40 | 7.20 | 12.53 | 5.72 | 31.00 | 16.30 | 91.00 | 47.00 | 6.40 | 6.40 |
| February | 5 | 3.20 | 7.60 | 13.93 | 6.08 | 31.40 | 13.40 | 91.00 | 50.00 | 9.15 | 0.00 |
| | 6 | 1.80 | 4.00 | 8.66 | 3.66 | 32.90 | 11.00 | 77.00 | 61.00 | 8.64 | 0.00 |
| | 7 | 1.60 | 4.00 | 7.42 | 3.22 | 32.90 | 10.60 | 78.00 | 66.00 | 7.90 | 0.00 |
| | 8 | 1.20 | 2.20 | 5.40 | 2.25 | 34.60 | 11.10 | 49.00 | 63.00 | 5.96 | 0.00 |
| | Mean | 28.65 | 42.39 | 62.45 | 30.29 | 32.46 | 15.01 | 87.43 | 50.19 | 6.91 | 7.44 |
| | Max | 98.00 | 173.00 | 201.26 | 103.22 | 36.54 | 20.09 | 93.57 | 66.00 | 9.75 | 65.00 |
| | Min | 1.20 | 2.20 | 5.40 | 2.25 | 29.93 | 9.54 | 49.00 | 24.75 | 0.86 | 0.00 |
| | SD± | - | - | - | 28.50 | 1.58 | 3.20 | 9.46 | 10.28 | 2.49 | 18.62 |

N=25; MSW- Meteorological Standard Week

**Table 2:** Seasonal incidence of giant African snail on mulberry at HoovinahalliKavalu village of Hassan taluk, Hassan district from September 2016 to February 2017

| Month | MSW | Inside field (25 m²) | Near bund (25 m²) | Bund (10m²) | Snail population/ 10 m² area | Maximum Temp. (⁰C) | Minimum temp. (⁰C) | Morning R.H (%) | Rainfall (mm) |
|---|---|---|---|---|---|---|---|---|---|
| September | 36 | 38.40 | 100.00 | 137.00 | 64.12 | 29.29 | 16.94 | 83.29 | 0.00 |
| | 37 | 12.20 | 26.40 | 54.20 | 23.21 | 29.49 | 17.26 | 84.58 | 0.00 |
| | 38 | 14.20 | 29.00 | 52.60 | 23.29 | 29.55 | 16.26 | 82.72 | 0.00 |
| | 39 | 36.20 | 214.60 | 235.80 | 112.04 | 28.66 | 15.11 | 83.00 | 6.80 |
| October | 40 | 17.80 | 42.80 | 69.00 | 31.08 | 32.51 | 18.29 | 82.86 | 0.00 |
| | 41 | 39.40 | 215.60 | 245.00 | 115.67 | 30.43 | 18.11 | 82.57 | 8.20 |
| | 42 | 22.20 | 128.80 | 154.00 | 71.47 | 32.91 | 18.43 | 81.14 | 0.00 |
| | 43 | 19.60 | 41.00 | 63.60 | 29.28 | 31.00 | 14.63 | 82.29 | 0.00 |
| November | 44 | 35.80 | 179.00 | 205.40 | 97.11 | 29.69 | 15.54 | 83.15 | 14.4 |
| | 45 | 13.40 | 41.20 | 65.80 | 29.21 | 30.89 | 15.20 | 84.00 | 0.00 |
| | 46 | 7.80 | 22.00 | 42.40 | 18.11 | 31.09 | 13.97 | 83.29 | 0.00 |
| | 47 | 9.00 | 26.20 | 49.20 | 21.09 | 30.94 | 13.89 | 74.72 | 0.00 |
| | 48 | 7.20 | 19.40 | 43.20 | 17.95 | 31.51 | 11.60 | 77.86 | 0.00 |
| December | 49 | 6.80 | 20.20 | 42.40 | 17.73 | 30.03 | 13.77 | 75.14 | 0.00 |
| | 50 | 11.40 | 26.00 | 50.60 | 21.85 | 28.34 | 13.97 | 77.00 | 16.00 |
| | 51 | 7.60 | 20.00 | 31.80 | 14.28 | 30.71 | 14.11 | 79.29 | 0.00 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 52 | 7.60 | 16.40 | 31.20 | 13.60 | 30.53 | 12.90 | 81.25 | 0.00 |
| January | 1 | 3.60 | 9.20 | 23.20 | 9.44 | 29.43 | 10.89 | 79.57 | 0.00 |
| | 2 | 3.00 | 7.20 | 17.00 | 7.03 | 29.80 | 11.17 | 79.71 | 0.00 |
| | 3 | 2.20 | 4.80 | 12.60 | 5.13 | 30.06 | 10.91 | 83.29 | 0.00 |
| | 4 | 3.40 | 6.40 | 12.20 | 5.37 | 29.91 | 13.11 | 83.00 | 0.00 |
| February | 5 | 2.40 | 4.80 | 8.80 | 3.89 | 31.51 | 15.60 | 83.71 | 0.00 |
| | 6 | 0.60 | 3.20 | 5.60 | 2.37 | 32.14 | 15.94 | 84.00 | 0.00 |
| | 7 | 1.20 | 3.20 | 6.00 | 2.59 | 32.86 | 14.71 | 76.71 | 0.00 |
| | 8 | 0.40 | 2.00 | 6.20 | 2.39 | 33.89 | 14.57 | 49.86 | 0.00 |
| | Mean | 12.94 | 48.38 | 66.59 | 30.37 | 30.69 | 14.68 | 79.92 | 1.82 |
| | Max | 39.40 | 215.60 | 245.00 | 115.67 | 33.89 | 18.43 | 84.58 | 16.00 |
| | Min | 0.40 | 2.00 | 5.60 | 2.37 | 28.34 | 10.89 | 49.86 | 0.00 |
| | SD± | - | - | - | 34.02 | 1.39 | 2.19 | 6.90 | 4.54 |

N=25; MSW- Meteorological Standard Week

**Table 3:** Correlation coefficient and regression equation for *A. fulica* at H. Kodihalli village of Mandya taluk, Mandya district from September 2016 to February 2017

| Location | Correlation coeffecient | | | | | | $R^2$ | Regression equation |
|---|---|---|---|---|---|---|---|---|
| | Maximum temp. ($^0$C) ($X_1$) | Minimum temp. ($^0$C) ($X_2$) | Morning R.H (%) ($X_3$) | Afternoon R.H (%) ($X_4$) | Sunshine hours day$^{-1}$ ($X_5$) | Rainfall (mm) ($X_6$) | | |
| Mandya | 0.13 | 0.46* | 0.27 | 0.04 | -0.35 | 0.54** | 0.29 | $Y=24.16+0.12X_1+0.33X_2+0.22X_3-0.06X_4-0.14X_5+0.82X_6$ |

**Table 4:** Correlation coefficient and regression equation for *A. fulica* at HoovinahalliKavalu village of Hassan taluk, Hassan district from September 2016 to February 2017

| Location | Correlation coeffecient | | | | $R^2$ | Regression equation |
|---|---|---|---|---|---|---|
| | Maximum temp. ($^0$C) ($X_1$) | Minimum temp. ($^0$C) ($X_2$) | Morning R.H (%) ($X_3$) | Rainfall (mm) ($X_4$) | | |
| Hassan | -0.27 | 0.52** | 0.26 | 0.56** | 0.52 | $Y=-80.05-0.23X_1+7.06X_2+0.16X_3+3.75X_4$ |

* Significant at $P \leq 0.05$; ** Significant at $P \leq 0.01$

This finding is in agreement with Javaregowda (2006) [4] who reported peak activity of the snail from October to November during 2001-02 and 2002-03, Ravikumara *et al.* (2007) [7] and Kumari *et al.* (2015) [5] reported maximum snail activity during second fortnight of September and minimum activity during first fortnight of February, 2005, Thakur (2003) [9] recorded minimum activity of snail during third week of December, 1998, and Justin *et al*. (2008) reported minimum snail activity between January and March.

The results of correlation and regression studies on relationship between snail incidence and meteorological variables at H. Kodihalli village of Mandya taluk, Mandya district of Karnataka revealed that the snail population exerted a positive association with maximum temperature (r= 0.13), minimum temperature (r= 0.46), morning RH (r= 0.27), afternoon RH (r= 0.04) and rainfall (r= 0.54), and negative association with sunshine hours (r=-0.35). However, the influence of minimum temperature and rainfall on snail population was found to be significant (Table 3). The results of multi linear regression analysis (MLR) revealed that 29 per cent of snail population ($R^2$= 0.29) was influenced by rainfall positively (Table 3).

At Hoovinahallikavalu village of Hassan taluk, Hassan district of Karnataka the snail population exerted a negative association with maximum temperature (r= -0.27) and positive association with minimum temperature (r= 0.52), morning relative humidity (r= 0.26) and rainfall (r= 0.56). However, the influence of minimum temperature and rainfall on snail population was found to be significant the results of multi linear regression analysis (MLR) revealed that 52 per cent of snail population ($R^2$= 0.52) was influenced by minimum temperature and rainfall positively (Table 4).

The present findings are in line with Thakur (2003) [9], and Chandaragi and Patil (2014) [2] who reported significant positive relationship of snail population with relative humidity and rainfall. The negative association of snail population with maximum temperature is in agreement with Chandaragi (2014) [1].

**Summary**
The study on seasonal incidence of *A. fulica* on mulberry from September 2016 to February 2017 at weekly interval revealed that at both H. Kodihalli village of Mandya taluk, Mandya district and Hoovinahallikavalu village of Hassan taluk, Hassan district of Karnataka the snail population gradually increased from September, 2016 to November, 2016 thereafter, the population gradually decreased. At H. Kodihalli village the snail population exerted a positive association with maximum temperature, minimum temperature, morning RH, afternoon RH and rainfall, and negative association with sunshine hours. Whereas at Hoovinahallikavalu village the snail population exerted a negative association with maximum temperature and positive association with minimum temperature, morning relative humidity and rainfall. However, the influence of minimum temperature and rainfall was found to be significant at both the locations.

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