International Journal of Advanced Biochemistry Research

ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2026): 5.29
IJABR 2026; SP-10(1): 959-966
www.biochemjournal.com
Received: 01-11-2025
Accepted: 05-12-2025

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Survey on insect pests of potato (*Solanum tuberosum* L.) and their natural enemies in Hassan district of Karnataka state during *Kharif* and *rabi* season

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DOI: https://www.doi.org/10.33545/26174693.2026.v10.i1Sl.7130

Abstract
A roving survey was undertaken during vegetative, reproductive and harvesting stage of the crop to record the incidence of insect pests and their natural enemies prevailing on potato during both *kharif* and *rabi* seasonof 2015, 2016 and 2017 at Hassan districts of Karnataka. Eleven villages were selected for the study and from each village ten farmer's fields were selected for recording the activity of insect pests and their natural enemies. To record the different insect pests of potato and their damage, fortnightly surveys were conducted in Bhageshapura, Chagachagere, Chikkanahallikoppalu, Dasanahalli, Doddamagge, Gandasi, Habbanaghatta, Malalikere, Mokaligrama, Shankarapura and Dudda villages. In each village, 10 plants were randomly selected. The pooled data of 3 years roving survey revealed that the highest incidence of Aphids/plant, was recorded at Dudda village 33.54 whereas least number of aphids were recorded at Mokaligrama 16.58 aphids/plant during *Kharif*, similarly the highest percent incidence thrips/plant, was recorded at Doddamagge village 20.92 thrips/plant and least incidence of thrips were recorded at Gandasi 14.16. Bhageshapura village recorded 12.29 *Spodopteralitura*/plant and least incidence of *S. litura* were recorded at Habbanaghatta 2.57 *S. litura*/plant. The infestation of Leaf miner was noticed in Habbanaghatta village 32.72 Leaf miner/plant followed by Gandasi 27.74 Leaf miner/plant and least incidence of Leaf miner were recorded at Mokaligrama 13.83 Leaf miner/plant. The infestation of Ash weevil was highest in Doddamagge village 11.20 Ash weevil/plant, mole cricket was maximum in Gandasi village 2.94 Mole cricket/plant, number of mites/plant was recorded at Dasanahalli village 10.84 mites/plant, an incidence of root grub was highest in Mokaligrama village 6.11 Root grub/sq.meter, the highest percent of Potato tuber moth/plant, was recorded at Doddamagge village 4.75% Potato tuber moth/plant and least infestation of Potato tuber moth were documented at Habbanaghatta 2.13% of Potato tuber moth/plant.

Keywords: Insect pests, Karnataka, Hassan, potato and survey

Introduction
Potato (*Solanum tuberosum* L.) is a root vegetable native to America, a starchy tuber of the plant and a perennial in the family of *Solanaceae*. The potato is an essential food fitting to the tuber and root family. It is one of the top four crops in the world after rice, wheat and maize (Ross, 1986; Douches *et al.*, 2004) [18, 8]. Potato is an important food in developing countries claiming fourth place. These countries produce approximately one-third of the worldwide production of potato. It is grown under diverse agro-climatic conditions over an area of 20.85 lakh ha with production of 480.96 lakh metric tonnes and productivity of 23.07 t/ha (Anon., 2016) [2]. In North India, about 85 percent of potatoes are cultivated in Indo-Gangetic plains and 80 percent of the total production is shared by Uttar Pradesh, West Bengal, Punjab, Bihar and Gujarat states. In Karnataka, the potato crop is cultivated over an area of 38,126 hectares with an annual production of 2,25,285 tonnes and a productivity of 6220 kg ha-1 during 2015-16. The major potato growing districts of Karnataka included Hassan (18,671 ha), Belagavi (4802 ha), Kolar (3648 ha), Dharwad (1160 ha) and Bengaluru-Rural (488 ha) (Anon., 2016a) [3]. In Hassan district of Karnataka, about 33 species of insects and a species of mite belonging to 9 orders and 23 families infest potato crop at different stages. Among the insect pests, aphids, thrips, leafhoppers, whiteflies, mites, cutworms, white grubs, epilachna beetles, defoliating caterpillars, tuber moth and stem borers were reported to be economically important causing heavy yield losses (Nandihalli *et al.*, 1996) [13].

Various lepidopterous caterpillars are known to damage potato crop, *viz.*, *Helicoverpa armigera*(Hubner), *Agrotis lpsilon*(Hufnagel), *Spodoptera litura*(F.), whereas the coleopteran pest *Henosepilachna vigintioctopunctata* (F.) also known to cause damage. All these pests are known to occur during monsoon (June-September) on 40 to 59 days old crop. The damage is high, where potato has been grown near irrigated channels and coconut areas (Trivedi and Rajagopal, 1999) [20]. The sucking pest's *viz.*, aphids, thrips and leaf hoppers are considered as a major group of sucking pests because of their role as vectors of viral diseases. The specimens were identified as, aphid, *Myzus persicae* (Sulzer), leaf hopper, *Empoasca* spp., whitefly, *Bemisia tabaci* (Gennadius) and thrips, *Scirtothrips dorsalis* Hood (Natikar *et al.*, 2018) [14, 15].

Roving survey on the numerous insect pests documented on potato during roving survey were mole crickets, gross hoppers, termites, green bugs, psyllids, aphids, whiteflies, leaf hoppers, thrips, root grubs, leaf weevils, blister beetles, flea beetles, cutworms, tobacco cut worms, potato tuber moths and black ants. All most all insect pests were found in all the villages. Among those cut worm *Spodoptera litura*, potato tuber moth *Phthoromea operculella* and greasy cut worm *Agrotis ipsilon* were found as major insect pests. Other insect pests namely aphid *Myzus persicae*, leaf hopper *Empoasca* Spp., whitefy *Bemisia tabaci*, thrips *Scirtothrips dorsalis*, leaf weevil *Myllocerus subfasciatus*, flea beetle *Monolepta signala*, termite *Odontotermis obesus*, green bug *Nezara viridula* and grasshoppers *Chrotogonus* Spp, and *Cyrtocanthacris rancea* were found as moderate insect pests of potato and the remaining were of minor importance in pest status (Bhushan, 2019) [7].

In Karnataka potato is mainly grown in Hassan, Kolar, Dharwad, Bangaluru and Belgaum districts. The farmers of Hassan district grow potato as one of the major vegetable crops especially in Bhageshapura, Chagachagere, Chikkanahallikoppalu, Dasanahalli, Doddamagge, Gandasi, Habbanaghatta, Malalikere, Mokaligrama, Shankarapura and Duddasurrounding villages throughout Hassan district in the transitional zone. The yield of potato is not up to the expected level due to the incidence of different pests and diseases. The major pests of potato are Potato tuber moth, *Phthorimaea operculella* .Zell., potato cutworm, *Agrotis segetum(Hufn)* and *Spodoptera litura* Fab. (Nair, 1970) [12]. Shoot damage due to *Leucinodes orbonalis* Guen. in potato increased as the level of larval density increased from one larva per 2 plants to 6 larvae in Hassan (Murthy and Nandihalli, 2003) [11].

The insect pests of potato has become the most destructive and ubiquitous pest in the recent years causing heavy yield losses in potato crop. The outbreak of these insect pests causes severe losses in potato crop. Therefore, present investigation was undertaken to study the pest complex of potato during *kharif* and *rabi* season in major potato growing villages of Hassan district, Karnataka state.

Material and methods

A roving survey was undertaken during vegetative, reproductive and harvesting stage of the crop to record the incidence of insect pests and their natural enemies prevailing on potato during both *kharif and rabi*of 2015, 2016 and 2017 at Hassan districts of Karnataka. In a district, eleven villages were selected for the study and from each village 10 farmer's fields were selected for recording the activity of insect pests and their natural enemies. To record the different insect pests of potato and their damage, fortnightly surveys were conducted in Bhageshapura, Chagachagere, Chikkanahallikoppalu, Dasanahalli, Doddamagge, Gandasi, Habbanaghatta, Malalikere, Mokaligrama, Shankarapura and Dudda, of Hassan district. Ten fields were selected in in each village. In each field, 10 plants were randomly selected. The survey was conducted at 15 days intervals. The observation was recorded till 65th day old of the crop. The sucking pests were counted in 100 leaves from randomly selected plants, representing top, middle and bottom portions. The defoliators were recorded from 10 randomly sleeted plants in each field for. The percent damage caused by potato tuber moth, *P. operculella* were recorded. Observations were pooled and averaged. The methods of selection of parameters were based on the sampling procedures standardised by CPRI, Shimla and adopted by all potato research centres under the All India Co-ordinated Research Project on potato (AICRP on Potato).

Incidence of aphids was recorded by selecting 34 plants at random and from each plant three compound leaves from top, middle and bottom portions/canopy of the plant was selected and aphids were counted separately with help of 10 x hand lens and expressed in terms of aphid numbers per compound leaf per plant (Anonymous, 1995) [1]. For leafhoppers, thrips and whiteflies, ten plants were selected randomly and from each plant, three leaves representing top, middle and lower portions were selected. The total number of nymphs and adults on each leaf was counted and expressed in terms of number of insects per three leaves per plant (Bhatnagar, 2007) [6]. For samling mites, ten plants were randomly selected and three leaves covering top, middle and bottom canopy were collected in polythene bags. These leaves were brought to the laboratory and observed under stereo binocular microscope for mites. Number of mites per plant was worked out (Patil, 2005) [19].

Observations on larval population of leaf eating caterpillar, *S. litura*was made on ten randomly selected spots of one meter row length. Larval counts were made by shaking the plant gently over a white cloth placed between the rows. Average number of caterpillars found per meter row length was worked out. A total of ten plants were randomly tagged to record the observations on different natural enemies and was expressed in terms of numbers per plant**.** Root grub incidence was recorded by selecting 10 spots of 1 sq.meter radius area.Observations for leaf miner, ash weevil and mole cricket were recorded from 10 randomly sleeted plants in each field and data was averaged and expressed in Mean standard Error.

Results and Discussion

The Roving survey data revealed the presence of insect pests *viz.*, aphids [*Myzus persicae*(Sulzer), leaf hoppers [*Empoasca*spp.,], thrips [*Scirtothrips dorsalis* Hood,], whitefly [*Bemisia tabaci* (Gennadius)], Leafminer (*Liriomyza trifolii*), leaf eating caterpillar (*Spodoptera litura*), mite [*Polyphagotarsone muslatus* (Banks)], Ash weevil, root grub, Potato tuber moth, mole cricket and natural enemies *viz.*, coccinellids [*Cheilomenessex maculate* (Fabricius)], chrysopids [*Chrysoperla* sp.] and spiders in all the villages Bhageshapura, Chagachagere, Chikkanahallikoppalu, Dasanahalli, Doddamagge, Gandasi,

Habbanaghatta, Malalikere, Mokaligrama, Shankarapura and Dudda, surveyed at vegetative, reproductive and harvesting stages of the crop in Hassan district.

Aphid, *Myzus persicae*

The Roving survey was carried out in selected major potato growing villages of Hassan district and the extent of damage in terms of number aphids per plant were recorded during *Kharif* surveys of 2015, 2016 and 2017, The highest incidence of Aphids/plant, was recorded at Dudda village 33.54 Aphids/plant followed by Chikkanahalli 31.42 Aphids/plant, Gandasi 30.68 Aphids/plant, Habbanaghatta 27.78 Aphids/plant and least number of aphids were recorded at Mokaligrama 16.58 Aphids/plant (Table 7) whereas in *Rabi* surveys of 2015, 2016 and 2017 pooled data of 3 yeras indicated that the highest incidence of Aphids/plant, were recorded at Mokaligrama village 43.78Aphids/plant followed by Dudda 41.43 Aphids/plant, Chagachagere 40.40 Aphids/plant, Gandasi 39.34 Aphids/plant and least incidence of aphids were recorded at Shankarapura 32.54 Aphids/plant (Table 8). The present findings are in line with findings of Hegde *et al.* (2008) [9] who opined that the infestation of aphid in potato increased from 25th day onwards ranging from 2.33 to 176 aphids per 50 leaves, Hassan (4.83 and 4.00 aphids/compound leaf, respectively) (Table 1) and continued upto reproductive stage. Similarly Basavaraju *et al.* (2009) [4] conducted study in Hassan and revealed that the aphid, *M. persicae* caused on an average of six percent loss in potato yield.

The present findings are in agreement with Natikar and Balikai, (2018) [14, 15] recorded highest mean incidence of aphid in Hassan district at vegetative stage was 4.83 aphids/compound leaves and it was continued up to reproductive stage. The incidence was low at harvesting stage which might be due to maturity of the crop and reduction in the succulence of crop.

Thrips (*Scirtothrips dorsalis*)

The occurrence of thrips was somewhat high at reproductive stage of the crop than vegetative and harvesting stages in all the surveyed villages of Hassan district during *kharif and rabi* 2015, 2016 and 2017. However during *kharif* 2015, 2016 and 2017, the incidence of thrips was highest in Malalikere village 15.20 Thrips/plant followed by Dasanahalli 15.03 Thrips/plant, Bhageshapura 14.79 Thrips/plant, Mokaligrama 13.61 Thrips/plant and least incidence of thrips were recorded at Dudda 09.20 Thrips/plant (Table 7) whereas in *rabi* surveys of 2015, 2016 and 2017 pooled data of 3 years indicated that the highest percent incidence Thrips/plant, was recorded at Doddamagge village 20.92 Thrips/plant followed by Dudda 20.72 Thrips/plant, Habbanaghatta 20.41Thrips/plant, Chagachagere 20.14 Thrips/plant and least incidence of thrips were recorded at Gandasi 14.16 Thrips/plant (Table 8). The present findings are in line with Natikar and Balikai, (2018) [14, 15] recorded highest mean incidence of thrips in Hassan district at vegetative stage was 2.01 and reproductive stages with 2.90 thrips/3 leaves. The population of thrips was lower at harvesting stage of the crop because of reduced plant sap. However, literature to support this study of Bhatnagar (2005) [6] reported that, early potato crop is affected by stem necrosis diseases, transmitted by thrips, *Thrips palmi* (Karny) in Central India.

Leaf eating caterpillar, *Spodoptera litura*

The incidence of *S. litura*was noticed in all the surveyed villages of Hassan district during *kharif and rabi* 2015, 2016 and 2017. However during *kharif* 2015, 2016 and 2017, the incidence of *S. litura* was highest in Bhageshapura village 12.29 *S. litura*/plant followed by Dudda 11.35 S. litura/plant, Shankarapura 11.18 *S. litura*/plant and least incidence of *S. litura* were recorded at Habbanaghatta 6.90 *S. litura*/plant (Table 7) whereas in *rabi* surveys of 2015, 2016 and 2017 pooled data of 3 years observed that the highest percent incidence *S. litura*/plant, was recorded at Chagachagere village 5.64 *S. litura*/plant followed by Bhageshapura 5.31 S. litura/plant, Mokaligrama 5.18 *S. litura*/plant and least incidence of *S. litura* were recorded at Habbanaghatta 2.57 *S. litura*/plant (Table 8). From the study it is shown that, *S. litura*is emerging as a another leading pest of potato which might be due to availability of alternate host plants in all the three seasons in the surveyed villages. Trivedi and Rajagopal (1999) [20] observed that the occurrence of *S. litura*in potato was more in 40 to 59 days old crop. Hegde *et al.* (2008) [9] witnessed that the foliar damage in potato due to *S. litura ranged* from 0.4 to 13.9 percent during peak vegetative phase. The present findings are in line with Natikar and Balikai, (2018) [14, 15] observed in Hassan, the incidence of *S. litura* during *kharif* 2016 and 2017 was (2.95 and 1.30 larvae/meter row length, 2.42 and 1.00 larvae/meter row length at vegetative and reproductive stages, respectively)

Leafminer, *Liriomyza trifolii*

The infestation of Leafminer was noticed in all the surveyed villages of Hassan district during *kharif* and *rabi* 2015, 2016 and 2017. However throughout *kharif* 2015, 2016 and 2017, the infestation of Leaf miner was highest in Habbanaghatta village 32.72 Leafminer/plant followed by Gandasi 27.74 Leafminer/plant, Chikkanahalli 26.14 Leafminer/plant and least incidence of Leafminer were recorded at Mokaligrama 13.83 Leafminer/plant (Table 7) whereas in *Rabi* surveys of 2015, 2016 and 2017 pooled data of 3 year's observed that the highest infestation of Leafminer/plant, was recorded at Chikkanahalli village 8.81Leaf miner/plant followed by Dasanahalli 6.75 Leafminer/plant, Doddamagge 5.94 Leaf miner/plant and least incidence of Leaf miner were recorded at Dudda 2.67 Leafminer/plant (Table 8).

Ash weevil, *Myllocero spp.*

The infestation of Ash weevil was noticed in all the surveyed villages of Hassan district during *kharif* and *Rabi* 2015, 2016 and 2017. However in *kharif*, the infestation of Ash weevil was highest in Doddamagge village 11.20 Ash weevil/plant followed by Shankarapura 9.57 Ash weevil/plant, Malalikere 9.27 Ash weevil/plant and least incidence of Ash weevil were recorded at Chikkanahalli 5.83 Ash weevil/plant (Table 7) but in *rabi* surveys of 2015, 2016 and 2017 pooled data of 3 years detected that the maximum infestation of Ash weevil/plant, was documented at Habbanaghatta village 6.13Ash weevil/plant followed by Shankarapura 6.03 Ash weevil/plant, Chikkanahalli 5.16 Ash weevil/plant and least incidence of Ash weevil were noted at Dudda 1.86 Ash weevil/plant (Table 8).

Mole cricket,

The infestation of Mole cricket was observed in all the surveyed villages of Hassan district during *kharif* and *rabi*

2015, 2016 and 2017. Though in *kharif*, the infestation of Mole cricket was maximum in Gandasivillage 2.94 Mole cricket/plant trailed by Mokaligrama 2.91 Mole cricket/plant, Dasanahalli 2.23 Mole cricket/plant and minimum incidence of Mole cricket were documented at Dudda 1.18 Mole cricket/plant (Table 7). Whereas in *rabi* surveys of 2015, 2016 and 2017 pooled data of 3 years noted that the maximum infestation of Mole cricket/plant, was recognized at Malalikere village 2.97Mole cricket/plant followed by Dudda 2.18 Mole cricket/plant, Chikkanahalli 2.16 Mole cricket/plant and least occurrence of Mole cricket were recorded at Bhageshapura 0.33 Mole cricket/plant (Table 8).

Mite, *Polyphagotarsonemus latus*

The roving survey was carried out in villages of Hassan and the extent of damage in terms of number mites/plant were recorded during *Kharif* surveys 2015, 2016 and 2017, The highest number of Mites/plant, was recorded at Dasanahalli village 10.84 Mites/plant followed by Gandasi 10.77 Mites/plant, Dudda 10.22 Mites/plant, Bhageshapura 9.56 Mites/plant and minimum incidence of mite were recorded at Habbanaghatta 3.29 Mites/plant (Table 7) whereas in *rabi* surveys of 2015, 2016 and 2017 combined data of three year's showed that the highest percent incidence Mites/plant, were recorded at Bhageshapura village 20.65Mites/plant followed by Doddamagge 20.22 Mites/plant, Gandasi 19.84 Mites/plant, Habbanaghatta 19.65 Mites/plant and least incidence of Mite were recorded at Shankarapura 16.48 Mites/plant (Table 8). The incidence of mite was comparatively more in Hassan district which might be due to intermittent rainfall and increased temperature which play an significant role in development of mites population. These observations are in confirmation with those documented by Raj (1990) [17] who opined that, potato grown in rainy season suffers from heavy damage due to *P. latus* causing upto 60 percent reduction in tuber yield in India. Further, Liu *et al*. (1991) [10] reported 60 percent reduction in tuber yield due to this pest. The present findings are in agreement with Natikar and Balikai, (2018) [14, 15] observed the highest mite incidence during *kharif*2016 and 2017 in Hassan at vegetative (4.67 and 3.78 mites/leaflet, respectively) reproductive (5.10 and 3.70 mites/leaflet, respectively) and harvesting stages (1.09 and 1.17 mites/leaflet, respectively)

Root grub *Holotrichia spp*.

The incidence of Root grub was noticedin all the surveyed villages of Hassan district during *kharif and rabi* 2015, 2016 and 2017. However during *kharif*, the incidence of root grubwas highest in Mokaligramavillage 6.11 Root grub/sq.meter followed by Dasanahalli 5.63 Root grub/sq.meter, Habbanaghatta 5.57 Root grub/sq.meter and least occurrence of Root grub/sq.meter were recorded at Bhageshapura 1.52 Root grub/sq.meter(Table 7) whereas in *rabi* surveys of 2015, 2016 and 2017 collective data of 3 year's witnessed that the maximum percent occurrence of Root grub/sq.meter, was recorded at Mokaligrama village 2.66Root grub/sq.meter followed by Habbanaghatta 2.57 Root grub/sq.meter, Bhageshapura 2.35 Root grub/sq.meter and minimum incidence of Root grub/sq.meter were recorded at Gandasi 2.57 Root grub/sq.meter (Table 8).

Potato tuber moth, *Phthorimaea operculella*

During *rabi* 2015, 2016 and 2017 in Hassan district, the tuber moth population was not observed. However, during *Kharif* surveys 2015, 2016 and 2017,The highest percent of Potato tuber moth/plant, was recorded at Doddamagge village 4.75% Potato tuber moth/plant followed by Chagachagere 4.31% Potato tuber moth/plant, Shankarapura 4.23% Potato tuber moth/plant and least infestation of Potato tuber moth were documented at Habbanaghatta 2.13% of Potato tuber moth/plant (Table 7). Basavaraju *et al.* (2009) [4] reported that, an economic damage by PTM was noticed on the crop of 65 to 70 days old. This report stand as testimony to the present findings. The possible reason for late preference of the crop could be its preference to tuber feeding than the foliage. Natikar and Balikai, (2018) [14, 15] observed that, at reproductive stage, the larval population of potato tuber moth was 0.23 per plant with percent tuber infestation of 3.94 was observed during *kharif* 2016 while in *kharif* 2017, the larval population and percent tuber infestation of 0.23 and 4.33, respectively was recorded. At harvesting stage, the infestation was more prevalent in tubers with 5.28 and 7.08 percent tuber infestation during *kharif* 2016 and 2017, respectively. Similarly, Shahid *et al*.,. 2022**,** studied against PTM in *Kharif* season in 7 taluks of Hassan districts of Karnataka, to understand the extent of foliage damage and leaf mines. Highest mean PTM incidence (6.19%) was witnessed during *Kharif* season. Number of mined leaves per plant and number of mines per plant were detected during *Kharif* season (2.62 and 4.32).

Natural enemies: Coccinellids (*Cheilomenessex maculata*), chrysopids (*Chrysoperla spp*.) and spiders

The occurrence of natural enemies during *kharif 2015*, 2016 and 2017 was in Hassan district with average mean of all the surveyed village includes 2.66 coccinellids/plant, 1.14 chrysopids/plant and 1.32 spiders per plant were observed. However, during *rabi* 2015, 2016 and 2017 in an all the surveyed villages of Hassan district with 1.40 coccinellids/plant, 0.88 chrysopids/plant and 1.81 spiders per plant were observed (Table 9). The present findings are in agreement with Natikar and Balikai, (2018) [14, 15] observed the maximum incidence of natural enemies at vegetative stage during *kharif* 2016 and 2017 was in Hassan district with 0.43 and 0.18 coccinellids, 0.22 and 0.06 chrysopids and 0.24 and 0.34 spiders per plant.

Table 1: Incidence of potato pests during 2015 *Kharif* season

Villages	Aphids/plant	Thrips/plant	Leaf eating caterpillar/Plant	Leaf miner/plant	Ash weevil/plant	Mole cricket/plant	Mites/plant	Root grub/sq. meter	% Potato tuber moth/plant
Bhageshapura	32.14	15.04	8.32	17.62	6.13	2.42	12.33	1.41	4.52
Chagachagere	17.44	12.45	4.65	8.35	4.32	1.14	10.24	2.74	6.21
Chikkanahalli	35.64	11.01	8.44	21.3	1.25	1.26	3.22	3.52	5.41
Dasanahalli	19.33	17.45	9.34	16.35	7.44	4.23	17.44	5.05	3.22
Doddamagge	18.54	12.14	4.35	19.47	9.41	1.22	12.45	1.52	6.47
Gandasi	35.44	13.25	2.35	19.32	2.32	3.12	19.44	4.12	7.21
Habbanaghatta	28.65	17.44	6.94	31.21	1.87	2.32	2.14	5.32	1.24
Malalikere	18.69	22.71	4.69	10.45	7.42	1.24	0.94	5.12	2.54
Mokaligrama	14.33	10.61	10.33	9.12	3.24	6.15	1.45	4.31	3.64
Shankarapura	23.36	7.44	11.34	4.78	5.65	2.31	2.65	5.41	5.12
Dudda	42.34	5.31	5.68	3.65	4.44	0.58	17.67	2.45	3.47
Mean	25.99	13.17	6.95	14.69	4.86	2.36	9.09	3.72	4.46
S. EM (±)	0.84	0.44	0.26	0.75	0.24	0.15	0.66	0.14	0.17

* Values expressed are Mean ± Standard error

Table 2: Incidence of potato pests during 2015 *Rabi* season

Villages	Aphids/plant	Thrips/plant	Leaf eating caterpillar/Plant	Leaf miner/plant	Ash weevil/plant	Mole cricket/plant	Mite/plant	Root grub/sq.meter
Bhageshapura	42.25	18.65	4.56	5.32	1.33	0.19	19.32	1.96
Chagachagere	36.44	19.44	5.21	6.14	2.1	0.13	18.65	0.13
Chikkanahalli	51.21	21.35	3.21	5.05	1.36	2.58	21.34	0.75
Dasanahalli	16.35	23.44	4.1	5.62	0.78	0.60	12.44	0.92
Doddamagge	35.14	28.65	2.1	4.33	0.69	1.15	23.14	2.05
Gandasi	25.89	22.15	3.45	2.32	0.57	0.56	22.05	0.35
Habbanaghatta	44.12	18.44	3.65	3.45	3.2	0.83	19.65	2.34
Malalikere	36.47	17.33	2.1	6.32	1.4	2.92	14.65	0.58
Mokaligrama	39.12	15.24	1.24	1.54	1.65	0.35	13.54	2.53
Shankarapura	19.45	19.64	1.05	1.32	2.01	1.82	16.31	0.58
Dudda	27.44	20.05	2.14	2.66	2.36	1.54	18.78	1.82
Mean	33.99	20.40	2.98	4.01	1.59	1.15	18.17	1.27
S. EM (±)	0.97	0.32	0.12	0.17	0.07	0.09	0.32	0.08

* Values expressed are Mean ± Standard error

Table 3: Incidence of potato pests during 2016 *Kharif* season

Villages	Aphids/plant	Thrips/plant	Leaf eating caterpillar/Plant	Leaf miner/plant	Ash weevil/plant	Mole cricket/plant	Mites/plant	Root grub/sq. meter	% Potato tuber moth/plant
Bhageshapura	17.44	13.66	12.84	21.89	6.72	0.28	8.16	1.69	2..15
Chagachagere	34.91	7.64	6.46	25.11	4.56	3.87	10.82	3.93	3.21
Chikkanahalli	28.26	7.93	7.43	34.82	5.84	0.90	3.93	3.75	4.32
Dasanahalli	23.60	18.79	9.16	15.55	11.50	1.61	4.94	6.26	5.10
Doddamagge	28.50	15.98	11.40	20.90	11.44	0.81	4.73	1.72	2.34
Gandasi	29.20	9.32	5.57	37.17	8.81	2.20	9.89	5.29	1.40
Habbanaghatta	18.78	7.44	5.36	34.80	11.23	1.49	1.16	6.19	2.65
Malalikere	35.51	9.26	11.75	31.76	6.67	1.93	4.95	4.22	3.23
Mokaligrama	17.80	17.10	8.55	13.41	8.71	1.88	2.24	6.85	4.21
Shankarapura	20.49	19.71	11.29	35.29	9.63	1.30	11.36	4.72	4.15
Dudda	31.47	11.35	12.74	19.97	7.73	0.27	7.18	1.60	2.36
Mean	26.00	12.56	9.32	26.42	8.44	1.50	6.31	4.20	3.30
S. EM (±)	0.61	0.42	0.26	0.78	0.22	0.09	0.31	0.17	0.10

* Values expressed are Mean ± Standard error

Table 4: Incidence of potato pests during 2016 *Rabi* season

Villages	Aphids/plant	Thrips/plant	Leaf eating caterpillar/Plant	Leaf miner/plant	Ash weevil/plant	Mole cricket/plant	Mites/plant	Root grub/sq. meter
Bhageshapura	29.39	17.69	4.67	4.14	5.65	0.28	23.36	2.84
Chagachagere	52.55	20.52	8.12	2.41	0.93	0.16	21.38	0.11
Chikkanahalli	30.12	21.51	2.26	10.97	5.39	2.98	16.22	0.88
Dasanahalli	41.26	20.41	1.59	10.95	4.47	0.70	22.66	0.90
Doddamagge	38.59	19.24	8.71	9.12	7.80	1.31	22.38	2.13
Gandasi	46.61	10.17	1.42	5.42	2.32	0.75	19.97	0.23
Habbanaghatta	31.81	21.97	1.78	1.61	7.77	0.76	15.81	2.90
Malalikere	45.89	12.99	3.49	9.28	2.85	3.73	15.40	0.56
Mokaligrama	46.81	8.22	6.82	5.53	4.55	0.65	22.92	2.77
Shankarapura	38.57	9.31	7.63	5.59	8.22	1.73	15.20	0.67
Dudda	49.98	26.61	4.90	1.16	1.35	2.19	14.85	1.94
Mean	41.05	17.15	4.67	6.02	4.66	1.39	19.10	1.45
S. EM (±)	0.73	0.55	0.25	0.33	0.24	0.11	0.33	0.10

* Values expressed are Mean ± Standard error

Table 5: Incidence of potato pests during 2017 *Kharif* season

Villages	Aphids/plant	Thrips/plant	Leaf eating caterpillar/Plant	Leaf miner/plant	Ash weevil/plant	Mole cricket/plant	Mites/plant	Root grub/sq. meter	% Potato tuber moth/plant
Bhageshapura	26.25	15.68	15.70	33.96	12.53	1.21	8.20	1.47	3.12
Chagachagere	16.15	10.56	15.28	22.44	11.68	0.62	6.94	2.81	3.51
Chikkanahalli	30.35	15.88	14.14	22.30	10.39	2.10	11.16	4.26	2.01
Dasanahalli	19.40	8.84	14.67	24.83	8.84	0.85	10.15	5.57	4.31
Doddamagge	24.42	9.81	9.93	18.50	12.74	3.30	1.31	1.54	5.45
Gandasi	27.41	7.94	14.15	26.72	11.59	3.50	2.98	4.20	3.69
Habbanaghatta	35.90	15.90	8.40	32.14	8.49	1.78	6.57	5.19	2.49
Malalikere	20.87	13.64	15.83	23.66	13.71	2.93	13.92	5.20	2.38
Mokaligrama	17.62	13.12	13.40	18.97	8.86	0.71	7.60	7.18	3.16
Shankarapura	33.75	11.80	10.90	19.40	13.42	2.81	11.80	5.71	3.43
Dudda	33.41	10.93	15.63	25.35	9.88	2.69	5.80	2.65	4.23
Mean	25.96	12.19	13.46	24.39	11.10	2.05	7.86	4.16	3.43
S. EM (±)	0.63	0.26	0.23	0.46	0.17	0.10	0.34	0.17	0.09

* Values expressed are Mean ± Standard error

Table 6: Incidence of potato pests during 2017 *Rabi* season

Villages	Aphids/plant	Thrips/plant	Leaf eating caterpillar/Plant	Leaf miner/plant	Ash weevil/plant	Mole cricket/plant	Mites/plant	Root grub/sq. meter
Bhageshapura	44.17	20.12	6.70	6.29	5.39	0.52	19.28	2.24
Chagachagere	32.22	20.46	3.58	6.51	7.96	2.30	18.25	0.32
Chikkanahalli	36.46	10.35	6.58	10.40	8.73	0.91	16.26	0.82
Dasanahalli	47.93	14.26	4.17	3.69	4.13	0.29	21.30	0.65
Doddamagge	39.95	14.87	3.15	4.38	5.51	1.66	15.13	1.85
Gandasi	45.52	10.15	4.97	3.93	6.51	1.56	17.50	0.28
Habbanaghatta	41.29	20.82	2.29	8.37	7.42	2.89	23.48	2.47
Malalikere	38.70	14.71	5.47	1.26	4.21	2.26	24.30	0.59
Mokaligrama	45.42	22.23	7.48	6.94	1.63	2.25	16.38	2.67
Shankarapura	39.60	19.39	3.19	1.88	7.86	0.10	17.93	0.65
Dudda	46.87	15.51	2.73	4.20	1.88	2.82	17.62	1.24
Mean	41.65	16.62	4.57	5.26	5.57	1.60	18.86	1.25
S. EM (±)	0.44	0.38	0.16	0.25	0.22	0.09	0.27	0.08

* Values expressed are Mean ± Standard error

Table 7: Incidence of potato pests of 3 years pooled data (2015, 2016 and 2017) during *Kharif* season

Villages	Aphids/plant	Thrips/plant	Leaf eating caterpillar/Plant	Leaf miner/plant	Ash weevil/plant	Mole cricket/plant	Mites/plant	Root grub/sq. meter	% Potato tuber moth/plant
Bhageshapura	25.28	14.79	12.29	24.49	8.46	1.30	9.56	1.52	3.26
Chagachagere	22.83	10.22	8.80	18.63	6.85	1.88	9.33	3.16	4.31
Chikkanahalli	31.42	11.61	10.00	26.14	5.83	1.42	6.10	3.84	3.91
Dasanahalli	20.78	15.03	11.06	18.91	9.26	2.23	10.84	5.63	4.21
Doddamagge	23.82	12.64	8.56	19.62	11.20	1.78	6.16	1.59	4.75
Gandasi	30.68	10.17	7.36	27.74	7.57	2.94	10.77	4.54	4.10
Habbanaghatta	27.78	13.59	6.90	32.72	7.20	1.86	3.29	5.57	2.13
Malalikere	25.02	15.20	10.76	21.96	9.27	2.03	6.60	4.85	2.72
Mokaligrama	16.58	13.61	10.76	13.83	6.94	2.91	3.76	6.11	3.67
Shankarapura	25.87	12.98	11.18	19.82	9.57	2.14	8.60	5.28	4.23
Dudda	35.74	9.20	11.35	16.32	7.35	1.18	10.22	2.23	3.35
Average	25.98	12.64	9.91	21.84	8.14	1.97	7.75	4.03	3.70
S. EM (±)	0.48	0.19	0.16	0.50	0.14	0.05	0.25	0.15	0.07

* Values expressed are Mean ± Standard error

Table 8: Incidence of potato pests of 3 years pooled data (2015, 2016 and 2017) during *Rabi* season

Villages	Aphids/plant	Thrips/plant	Leaf eating caterpillar/Plant	Leaf miner/plant	Ash weevil/plant	Mole cricket/plant	Mites/plant	Root grub/sq. meter
Bhageshapura	38.60	18.82	5.31	5.25	4.12	0.33	20.65	2.35
Chagachagere	40.40	20.14	5.64	5.02	3.66	0.86	19.43	0.19
Chikkanahalli	39.26	17.74	4.02	8.81	5.16	2.16	17.94	0.82
Dasanahalli	35.18	19.37	3.29	6.75	3.13	0.53	18.80	0.82
Doddamagge	37.89	20.92	4.65	5.94	4.67	1.37	20.22	2.01
Gandasi	39.34	14.16	3.28	3.89	3.13	0.96	19.84	0.29
Habbanaghatta	39.07	20.41	2.57	4.48	6.13	1.49	19.65	2.57
Malalikere	40.35	15.01	3.69	5.62	2.82	2.97	18.12	0.58
Mokaligrama	43.78	15.23	5.18	4.67	2.61	1.08	17.61	2.66
Shankarapura	32.54	16.11	3.96	2.93	6.03	1.22	16.48	0.63
Dudda	41.43	20.72	3.26	2.67	1.86	2.18	17.08	1.67
Mean	38.90	18.06	4.08	5.09	3.94	1.38	18.71	1.32
S. EM (±)	0.27	0.23	0.09	0.16	0.13	0.07	0.12	0.09

* Values expressed are Mean ± Standard error

Table 9: Three years pooled data (2015, 2016 and 2017) during Karif and *Rabi* season, on occurrence of natural enemies in Hassan district

	Pooled data of *kharif* 2015, 2016 and 2017			Pooled data of *rabi* 2015, 2016 and 2017		
Villages	coccinellids	chrysopids	spiders	coccinellids	chrysopids	spiders
Bhageshapura	2.53	1.34	2.54	1.52	0.84	2.05
Chagachagere	1.32	0.84	3.14	2.1	0.63	1.62
Chikkanahalli	3.24	0.67	3.64	1.58	0.94	1.74
Dasanahalli	2.54	0.98	2.47	0.95	1.06	1.61
Doddamagge	4.12	1.54	2.48	0.47	1.48	1.52
Gandasi	3.91	1.28	1.98	0.69	1.04	1.36
Habbanaghatta	2.54	1.64	1.46	0.78	1.31	2.41
Malalikere	3.47	0.84	2.39	1.46	0.85	3.11
Mokaligrama	2.45	0.93	2.81	2.51	0.72	0.98
Shankarapura	1.08	1.04	1.94	1.24	0.61	1.53
Dudda	2.04	1.43	1.32	2.14	0.16	1.94
Mean	2.66	1.14	2.38	1.40	0.88	1.81
S. EM (±)	0.09	0.03	0.06	0.06	0.03	0.05

* Values expressed are Mean ± Standard error

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