Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2018; 6(5): 1141-1145

Received: 11-07-2018
Accepted: 12-08-2018

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Evaluation of different lures (Baits) of pitfall traps on the activity of soil arthropods in *Bt* cotton

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Abstract
An experiment was conducted under field condition at B. A. College of Agriculture, AAU, Anand during 2013-2015 to determine the efficacy of different lures (baits) of pitfall trap against the activity of soil arthropods in *Bt* cotton (RCH- 2 BG-II) by using Complete Randomized Design (CRD) with three repetitions. Bait containing Sugar (50% conc.) + Water in a pitfall trap captured significantly the highest individuals of arthropods/animals (21.97/trap/week) followed by Pitfall trap + Kerosene (17.94). Pitfall traps baited with mixtures of propylene glycol and water (1:3) (13.88) and Pitfall traps baited with Cereals + mixtures of ethylene glycol and water (1:3) (13.88) were equally effective. Pitfall traps baited with water only was found ineffective (9.97). A total 30 species belonging to the ten insect orders *viz.*, Dermaptera (Earwigs), Grylloblattidae (Cricket), Isoptera (Termite), Hemiptera (Red cotton bug, Stink bug), Coleoptera (Ground beetle, Rhinoceros beetle, Dung roller, Myllocerous weevil), Diptera (Technid fly), Lepidoptera (Tobacco leaf eating caterpillar and Hairy caterpillar larva, Sphinx moth, Grapevine moth), Hymenoptera (Red ant, Yellow jacket wasp), Orthoptera (Grass hopper, Mole cricket) and Phasmida (Stick insects); and Araneida (spiders), chilopoda (centipedes), Scorpiones, Anura (frog) and Rodentia (mouse) were recorded in different baits of pitfall trap during two cropping seasons of *Bt* cotton.

Keywords: Cotton, biodiversity, soil arthropods, pitfall trap, lures

Introduction
Physical and mechanical measures are the important components of integrated pest management. Among different trapping method, pitfall trapping is a standard method for sampling of arthropods because of its simplicity, efficiency and low cost [1]. It is an excellent tool for detecting the first activity and monitoring the season-long activity of walking and crawling soil arthropods in row crops, orchards, turf, pastures, woodlands and landscapes especially those active at night [1, 2]. Collections of arthropods from pitfall traps have often been used to assess the effect of insecticides [3]. In some of the cases, pitfall trap is only the device for monitoring especially in the studies of covering the large geographic areas to establish a qualitative inventory or to compare different assemblages [2]. Traps for monitoring and survey of the insect pests population have gained popularity over the past years because of the development of effective food and visual attractants. Besides reducing pest populations, trap catches can provide useful information on the spatial and temporal patterns and also the behaviour of insects critical in making pest management decisions [4]. There may be the also deleterious effect on soil arthropods due to the different baits or lures used in the traps. Pitfall trap with safe baits or lures can improve the better efficiency in catching arthropods. Hence, the present experiment was conducted to evaluate the effectiveness of lures or baits.

Materials and Methods
In order to study the evaluation of different lures (baits) of pitfall traps against the activity of soil arthropods in *Bt* cotton, a field experiment was carried out by using Complete Randomized Design (CRD) with three repetitions during *Kharif*, 2013-14 and 2014-15 at College Agronomy farm, B. A. College of Agriculture, AAU, Anand on variety RCH-2 Bollgard-II (Plate 1). Treatments were used with pitfall traps as: T_1 Simple Pitfall traps + 1:3 mixtures of propylene glycol and water, T_2 Simple Pitfall traps + Cereal + 1:3 mixtures of ethylene glycol and water, T_3 Simple Pitfall traps + Water (2.5 to 5 cm), T_4 Simple Pitfall traps + Sugar (50% conc.) + Water (2.5 to 5 cm), T_5 Simple Pitfall traps + Kerosene (2.5 to 5 cm)

and T_6 Simple Pitfall traps + No lure/bait [Control (Empty)]. The different lures (baits) of pitfall traps were arranged in the *Bt* cotton plot (untreated) randomly in equal distance (4.5 × 3.0 m). The captured individuals were collected at weekly interval from the pitfall traps (12 × 9.5 cm diameter; buried flush with the soil surface within rows and shaded with a white plastic cover). Necessary cares were taken to maintain the bait's level in respective pitfall traps. The collected individuals were identified on the basis of their morphological features and keys by observing with naked eyes or under the stereoscopic binocular microscope. The individual belonging to different taxa were enumerated as well as a number of arthropods per trap was recorded and their mean number per trap was calculated (Plate 2).

Results and discussion

The periodical data on captured arthropods/animals in different lures (baits) of pitfall traps during 2013-14 and 2014-15 are presented in Table 1 and 2, respectively. The efficacy of different lures (baits) of pitfall trap is adjudge based on pooled over periods.

First year (2013-14)

All the different lures (baits) of pitfall traps captured significantly higher arthropods/animals over control except pitfall trap + water (T_3) during the 2013-14 (Table 3). Pitfall traps baited with Sugar (50% conc.) + Water (T_4) captured significantly the highest (23.00/trap) individuals of arthropods/animals over the rest of the treatments. The next best treatment in order of merit was Pitfall trap + Kerosene which captured 18.90 arthropods/animals. Pitfall trap with 1:3 mixtures of propylene glycol and water (T_1); and Pitfall trap with Cereals + 1:3 mixtures of ethylene glycol and water (T_2) were found equally effective as they were at par with each other. Pitfall trap with water (no baits) recorded the lowest (10.62) number of arthropods/animals and found ineffective as it was at par with the Pitfall trap + No lure/bait (T_6) (control-empty trap).

Second Year (2014-15)

More or less same trend was observed as it observed during 2013-14 (Table 3). Pitfall trap + Sugar (50% conc.) + Water (T_4) found significantly superior over the rest of the treatments and recorded the highest number of captured (20.90/trap). The next best treatment in order of merit was Pitfall traps + Kerosene (T_5). There was no significant difference between Pitfall trap + 1:3 mixtures of propylene glycol and water (T_1) and Pitfall trap + Cereals + 1:3 mixtures of ethylene glycol and water (T_2). Treatment T_3 *i.e.* Pitfall trap + Water was not much effective in attracting the individuals as it was at par with the Pitfall trap + No lure/bait (T_6).

Pooled

The data on individual catches of arthropods/animals during 2013-14 and 2014-15 were also pooled and are presented in Table 3. All different lures (baits) of pitfall traps were found significantly superior over control. Pitfall trap + Sugar (50% conc.) + Water (T_4) captured significantly the highest individuals of arthropods/animals (21.97/ trap) over the rest of the treatment. The next best treatment was Pitfall trap + Kerosene with higher captured of individual (17.94). Pitfall trap baited 1:3 mixtures of propylene glycol and water (T_1) was at par with the Pitfall trap + Cereals + 1:3 mixtures of ethylene glycol and water (T_2) and recorded 13.88 and 13.58 arthropods/animals, respectively. Pitfall trap + Water was found ineffective as it caught significantly the lowest (9.97) individuals, although, it was better than Pitfall trap with no lure/bait (T_6).

A total 30 species belonging to the ten insect orders *viz.*, Dermaptera (Earwigs), Grylloblattidae (Cricket), Isoptera (Termite), Hemiptera (Red cotton bug, Stink bug), Coleoptera (Ground beetle, Rhinoceros beetle, Dung roller, Myllocerous weevil), Diptera (Technid fly), Lepidoptera (Armyworm and Hairy caterpillar larva, Sphinx moth, Grapevine moth), Hymenoptera (Red ant, Yellow jacket wasp), Orthoptera (Grass hopper, Mole cricket) and Phasmida (Stick insects); and Araneida (spiders), chilopoda (centipedes), Scorpiones, Anura (frog) and Rodentia (mouse) were recorded in different baits of pitfall trap during two cropping seasons of *Bt* cotton (Table 4).

Overall, it can be concluded that Pitfall trap baited with sugar (50%) + water captured the higher (21.97) number of individuals of arthropods/animals followed by Pitfall trap either baited with kerosene or with propylene glycol. Pitfall trap with water only or without baited was found ineffective. Thus, bait with 50 per cent sugar + water in pitfall trap was the ideal lure or bait for sampling and efficient capturing of soil arthropods/animals in *Bt* cotton. Similar findings were also reported by [5] and stated that trap baited with sugar / vinegar mixture was more effective in the collection of some arthropods (ant's species). Also reported significant differences among the various preservatives/baits *viz.*, water, ethanol-water, brine and ethanol-glycerine in catches of spiders and ground beetles [6]. Pitfall traps with a propylene glycol-water mixture collected higher numbers of ants compared to traps with water only [7].

Studied carried out on the abundance of Carabids, Paederus, Ant (Tapionoma), Black giant ants, Earwig, Ground beetle, Lebidura, Colosoma, Rove beetle, Spider and Mole cricket through pitfall traps in *Bt* cotton grown organically and inorganically and the present findings was also matched more or less with the findings of a similar present investigation [8].

In the absence of additive materials *i.e.* pitfall traps with water recorded the lowest (65 and 77 during 2006-07 and 2007-08, respectively) individual [9]. In the present investigation, the same treatment was also found less effective in capturing the individual of arthropods/animals in *Bt* cotton.

Surveyed the soil arthropods through pitfall traps in *Bt*-cotton in Andhra Pradesh and recorded Araneida (spiders), Acari (mites) and four insect orders. Insects belonging to ten orders were also recorded during the present studies [10]. Captured 46 specimens in non *Bt* cotton and 40 in *Bt*-cotton (Collembola, Ants, Beetles, Crickets, Spiders and Mites) by pitfall traps [11]. Recorded four insect orders *viz.*, Collembola, Hymenoptera, Coleoptera and Orthoptera; and Araneida (spiders) and Acari (mites) in *Bt* and non *Bt* cotton fields by using pitfall traps [12]. Thus, the results obtained in the present investigation are in close agreement with the earlier reports.

Plate 1: Overview of the Experimental Site

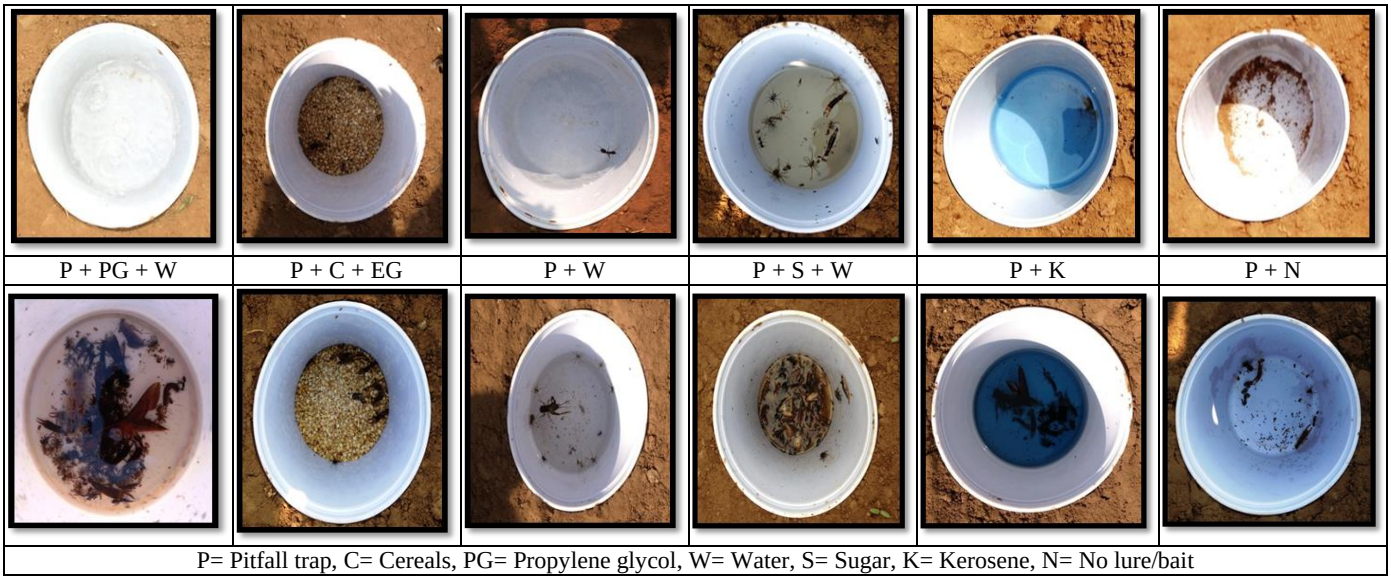

Plate 2: Different lures (baits) with pitfall traps and arthropods /animal caught in *Bt* cotton

Table 1: Evaluation of different lures (baits) of pitfall trap against the activity of soil arthropods/animals in *Bt* cotton during 2013-14

Treatments		No. of individuals/trap/SMW												
		40	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**	**51**	**52**
T_1	Pitfall traps + 1:3 mixtures of propylene glycol and water	7.33	11.33	14.33	16.33	17.00	18.66	20.33	19.33	18.00	20.00	14.00	11.00	7.00
T_2	Pitfall traps + Cereals + 1:3 mixtures of ethylene glycol and water	8.00	12.67	15.67	17.00	17.66	19.00	20.66	19.00	17.66	17.33	12.00	9.00	5.00
T_3	Pitfall traps + Water (2.5 to 5 cm)	5.00	10.33	11.00	11.00	11.66	13.33	15.00	14.00	12.66	14.00	10.00	7.00	3.00
T_4	Pitfall traps + Sugar (50% conc.) + Water (2.5 to 5 cm)	24.00	25.33	23.00	25.00	24.66	26.33	28.00	27.00	24.00	25.33	20.66	15.00	10.66
T_5	Pitfall traps + Kerosene (2.5 to 5 cm)	18.00	22.00	18.00	20.0	20.66	22.33	24.00	23.33	20.33	22.00	15.00	12.00	8.00
T_6	Pitfall traps + No lure/bait [Control (Empty)]	3.66	8.33	9.33	10.00	10.66	12.00	13.66	12.66	12.00	12.67	9.00	6.00	2.00
S. Em. $\pm$		0.56	0.69	0.58	0.64	9.33	0.98	1.20	1.00	0.70	1.00	0.593	0.57	0.59
CD at 5%		1.73	2.14	1.78	1.97	2.88	3.02	3.70	3.08	2.17	3.08	1.82	1.77	1.82
CV (%)		8.83	8.01	6.57	6.67	9.47	9.13	10.26	9.01	7.02	9.33	7.64	10.00	17.28
Note: SMW: Standard Meteorological week														

Table 2: Evaluation of different lures (baits) of pitfall trap against the activity of soil arthropods/animals in *Bt* cotton during 2014-15

Treatments		No. of individuals/trap/SMW												
		40	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**	**51**	**52**
T_1	Pitfall traps + 1:3 mixtures of propylene glycol and water	11.0	7.33	14.0	11.33	16.33	17.00	10.33	11.00	16.00	18.66	15.33	10.00	6.00
T_2	Pitfall traps + Cereals + 1:3 mixtures of ethylene glycol and water	9.00	8.00	12.0	12.66	17.00	17.66	11.66	12.33	17.66	19.00	16.00	8.66	4.00
T_3	Pitfall traps + Water (2.5 to 5 cm)	7.00	5.00	10.0	10.33	11.00	11.66	9.33	10.00	11.66	13.33	10.00	6.33	3.00
T_4	Pitfall traps + Sugar (50% conc.) + Water (2.5 to 5 cm)	15.0	24.00	20.66	25.33	25.00	24.66	23.33	25.00	24.66	26.33	24.00	14.00	6.33
T_5	Pitfall traps + Kerosene (2.5 to 5 cm)	12.0	18.00	15.0	22.00	20.00	20.66	20.00	21.00	20.66	22.33	20.00	12.00	7.00
T_6	Pitfall traps + No lure/bait [Control (Empty)]	6.00	3.66	9.00	8.33	10.00	10.66	7.33	8.33	10.00	12.00	9.00	5.00	2.00
S. Em. ±		0.58	0.56	0.59	0.69	0.64	0.93	0.69	0.69	0.93	0.98	0.64	0.66	0.63
CD at 5%		1.78	1.72	1.82	2.01	1.96	2.87	2.14	2.13	2.87	3.02	1.96	2.05	1.96
CV (%)		10.0	8.83	7.64	8.01	6.67	9.47	8.01	8.01	9.47	9.13	6.67	10.99	9.14
Note: SMW: Standard Meteorological week														

Table 3: Evaluation different lures (baits) of pitfall trap on the activity of soil arthropods/animals in *Bt* cotton

Treatments		No. of individuals/trap/week		
		2013-14	**2014-15**	**Pooled**
T_1	Pitfall trap + 1:3 mixtures of propylene glycol and water	14.97	12.79	13.88
T_2	Pitfall trap + Cereals + 1:3 mixtures of ethylene glycol and water	14.67	12.49	13.58
T_3	Pitfall trap + Water (2.5 to 5 cm)	10.62	8.90	9.76
T_4	Pitfall trap + Sugar (50% conc.) + Water (2.5 to 5 cm)	23.00	20.90	21.97
T_5	Pitfall trap + Kerosene (2.5 to 5 cm)	18.90	16.97	17.94
T_6	Pitfall trap + No lure/bait [Control (Empty)]	9.38	7.95	8.67
S.EM. ±(T)		0.46	0.59	0.12
Year (Y)		-	-	0.08
Period (P)		0.33	0.29	0.17
T X Y		-	-	0.24
T X P		0.80	0.71	0.17
Y X P		-	-	0.42
T X Y X P		-	-	0.60
CD at 5% (T)		1.29	1.66	0.32
Year (Y)		-	-	0.46
Period (P)		0.99	0.87	0.48
T X Y		-	-	NS
T X P		2.22	1.97	0.46
Y X P		-	-	0.17
T X Y X P		-	-	1.65
CV (%)		9.10	9.27	7.22

Table 4: Arthropods/animals recorded in pitfall traps during the study period (2013-14 and 2014-15)

Sr. No.	Order/ Class	Name of arthropods/animals
1	Dermaptera	Earwigs
2	Grylloblattidae	Cricket
3	Isoptera	Termite (worker)
4	Hemiptera	Red cotton bug
		Stink bug
		Brown bug
5	Coleoptera	Rhinoceros beetle
		Ground beetle
		Green beetle
		Dung roller
		Black beetle
		Myllocerous weevil
6	Diptera	Technid fly
		Green fly
7	Lepidoptera	Armyworm
		Hairy caterpillar
		Sphinx moth
		Grapevine moth
8	Hymenoptera	Yellow jacket wasp
		Wasp
		Red ant
9	Orthoptera	Grasshopper
		Mole cricket
10	Phasmida	Stick insects
11	Chilopoda	Centipedes
	Diplopoda	Millipedes
12	Scorpiones	Scorpion
13	Araneae	Spiders
14	Anura	Frog
15	Rodentia	Mouse

Conclusion

It can be concluded that Pitfall trap baited with sugar (50%) + water captured higher (21.97/trap) number of individuals of arthropods/animals followed by Pitfall trap either baited with kerosene or with propylene glycol.

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