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ORIGINAL ARTICLE

Influence of Trap Crop (Marigold) and Cover Crop (Buckwheat) on Population Density of *Helicoverpa armigera* and *Myzus persicae* Pests of Tomato Crop

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ABSTRACT

The experiments were conducted to determine the effect of trap crop (Marigold) and cover crop (Buckwheat) on the populations of *H. armigera* and *M. persicae*, pests of tomato crops. Infestation of the pest population on tomato plant at different distance such as 1 ft., 5 ft., 10 ft. and 20 ft. away from the rows of marigold and buckwheat plantation have been evaluated. The larval population per plant from 1 ft. to 5 ft. and 10 ft. distance in case of marigold row was insignificant, whereas significant increase in larval population of *H. armigera* was recorded when the gap was 10 and 20 ft. In case of tomato cropping done alone larval population per pant was significantly higher as compared to all the treatments. Buckwheat as cover crop, population of *M. persicae* per plant, population increase was insignificant upto 10 ft. gap but population increased significantly when the gap was 20 ft. however the increase was still lower than the control crop when no cover crop was used.

KEY WORDS : Buckwheat,Cover crop, Marigold, *Helicoverpa armigera, Myzus persicae,* Tomato (write scientific name), Trap Crop

INTRODUCTION

Both the pest and its enemies are often highly mobile and regulated at a much larger spatial scale than at the scale of the field, because they often require multiple resources, such as alternate food, hosts, and winter refuges to complete their life cycles (Tscharntke *et al*., 2007). Resources in agricultural landscapes vary strongly over time, as cultivated habitats provide high quality resources for only part of the year (Khan *et al*., 2020a, b). The abrupt decline in habitat quality due to harvesting leads to the active emigration of natural enemies from the cultivated areas toward more stable non-crop habitats (Rusch *et al*., 2010). Understanding determinants of biological control management requires spatial scales exceeding the field scale, namely landscape scale (Bianchi & Wäckers, 2008; Hogg *et al*., 2011). Conservation of biological control of pests in annual cropping systems to be successful, natural enemy response to low pest densities may be important during the initial pest colonization of the crop (Landis & Werf, 1997; Rutledge *et al*., 2004; Brown, 2011; Athey *et al*., 2016; Gomez-Marco *et al*., 2016). However, during this period resources for natural enemies are often low in fields, and supplying necessary resources which are absent from the main crop may increase their abundance (Simpson *et al*., 2011; Salamanca *et al*., 2018; Gurr *et al*., 2017).

Habitats of cover crops and flowering can provide shelter, supply nectar and pollen, house alternative prey (Landis *et al*., 2000; Bone *et al*., 2099) and increase abundance of natural enemies (Blaauw & Isaacs, 2015; Baber & Khan, 2022). Buckwheat (*Fagopyrum esculentum* Moench) is a moisture loving annual flower that can be attractive and beneficial for a wide array of predators and parasitoids (Bickerton & Hamilton, 2012; Parvaiz & Khan, 2022). Several potential flowering plants have been used to preserve and attract natural enemies of aphids to the main crop. These plants are known to produce large quantities of easily accessible food resources. For example, sesame (*Sesamum indicum*) has shown potential in the laboratory as a nectar plant to enhance biological control in Asian rice systems (Zhu *et al*., 2013). Bugg *et al.* (1991) used hairy vetch (*Vicia villosa*) as a cool season cover crop, which has been observed to increase the numbers of predatory lady beetles in pecan orchards. White *et al.* (1995), reported that *Phacelia tanacetifolia* represents

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Table 1: Abundance of *H. armigera* larvae when Marigold row grown as trap crop in tomato field in Kashmir.

Standard Week	Population of *H. armigera* larvae (per plant)*						Weekly mean reduction over control %
	1ft	5ft	10ft	20ft	Mean	Control	
26 (25/06/19)	0.89	1.01	1.23	2.05	1.29	2.09	38.04
27 (02/07/19)	0.90	1.13	1.54	2.41	1.49	3.34	55.24
28 (09/07/19)	1.12	1.25	1.62	1.90	1.47	4.67	68.47
29 (16/07/19)	1.03	1.28	1.46	1.83	1.40	3.91	64.19
30 (23/07/19)	0.78	1.47	1.34	1.61	1.30	3.89	66.58
31 (30/07/19)	0.74	1.16	1.23	1.44	1.14	3.77	69.69
32 (06/08/19)	0.43	0.84	1.21	1.37	0.96	2.63	63.40
33 (13/08/19)	0.41	0.79	1.06	1.16	0.85	3.79	77.44
34 (20/08/19)	0.32	0.74	0.91	1.02	0.75	3.45	78.33
35 (27/08/19)	0.25	0.62	0.86	0.94	0.67	1.78	62.50
36 (03/09/19)	0.31	0.54	0.90	1.10	0.71	2.43	70.68
37 (10/09/19)	0.24	0.51	0.87	0.98	0.60	1.87	63.90
Mean	0.53	0.81	1.02	1.27	0.91	2.78	67.33
SEM±	0.62	0.95	1.18	1.48	1.05	3.14	64.87
SD±	0.32	0.32	0.27	0.48	0.33	0.94	10.59

*Mean of 4 replications

an important pollen resource that attracts hoverflies and consequently reduces infestation by the aphids *Brevicoryne brassicae* and *M. persicae* in cabbage crops. In field experiments, Colley *et al.* (2000) tested 11 flowering plants intercropped with broccoli to enhance the biological control of aphids. Many studies suggested that CP can represent a valued resource of pollen and floral and extra floral nectar, as well as improve the availability of resources necessary for optimal performance of natural enemies, maintaining their survival, fecundity, and longevity (Wackers & VanRijn, 2015). In agricultural systems, the spraying of food as nectar and pollen was used as a food supplement, while the establishment of flowering plants can provide even more stable sources throughout the season (Landis *et al*., 2000).

Trap crops are plants that attract further pests and may keep them away from the main crop. The use of trap plants in association with crops has been known for centuries to protect crops from insect attack, and this method has been exploited in many traditional farming systems (Brooker *et al*., 2015). The use of these plants in cropping systems is based on the fact that insects show a marked preference for certain plant organs, cultivars, species, or phenological stages (Moreno & Racelis, 2015). Hence, trap plants are more attractive to the pest and easier to find than the host plants. In many instances, a trap crop has been used in a push-pull plan (the so-called stimulo deterrent diversionary (SDD)) which requires the involvement of another component such as semio-chemicals (Hare, 2011). Trap cropping is developed for aphids because their host selection is often considered a passive method that mainly depends on wind (Parolin *et al*., 2012). Hurej (2000) determined that small insects such as whiteflies, mites, and aphids have limited ability to detect their hosts. They suggested that trap crops act as a barrier when they are taller than the main crop and planted in the borders. Companion Plants (CP) altering host plant selection such as searching behavior and the selection of dynamic resources for insects such as aphids can be divided into three steps: habitat location, host location, and host acceptance. During these three steps, positive and negative external stimuli interact also with the internal factors of the insect, allowing for the acceptance or rejection of the Host Plant (Dedryver *et al*., 2010).

Results of the present study suggests that, the influence of Marigold as trap crop and Buckwheat as cover crop on the population density management of *H. armigera* and *M. persicae* in tomato ecosystem, and expected that the buckwheat three lines row grown as a cover crop for pollen, nectars and shelter of natural enemies; after that one-line row of marigold grown as a trap crop for tomato fruit borer for avoid egg-laying and damage of main tomato crops.

Table 2: Impact of Marigold as trap crop on the populations of *H. armigera* in tomato plantation in Kashmir

Treatment	Mean larval population (per plant)	Mean reduction over control (%)
1ft	0.53[a]	80.91
5ft	0.81[a]	70.83
10ft	1.02[a]	63.39
20ft	1.27[b]	54.18
Control	2.78[c]	-
CD ($p \leq 0.05$)	0.36	-

MATERIALS AND METHODS

In order to determine the effect of trap crop (Marigold) and cover crop (Buckwheat) on the populations of *H. armigera* and *M. persicae*, field experiments were performed in a Randomized Block Design (RCBD) with five treatments and four replicates each.

Ecological engineered experimental field

Tomato crop was maintained in ecologically engineered field conditions at Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar, Srinagar, Jammu and Kashmir, India, during 2019. In order to estimate the insect pests and natural enemies population, a hybrid tomato variety (Shalimar Hybrid 1) was raised in ecologically engineered field conditions in the plots of size 10 ft. x 11 ft. In order to maintain healthy tomato crop growth, all the recommended agronomic practices were carried out except pesticide application. In Tomato field, buckwheat (*F. esculentum* Moench.) three line row (width of row = one foot) grown as cover crop on boarder for pollen, nectars and shelter of natural enemies; after that one line row of marigold (*Tagetes* spp.) was grown as trap crop (width of row = one foot) for avoiding egg laying of tomato fruit borer damage of main tomato crop, after each plot of tomato crops one row of maize (*Z. mays* L.) crop in between two plots of tomato, grown as barrier crop for aphid and flying insect such as tomato fruit borer for avoiding egg laying on main tomato crop and one row of cowpea (*V. unguiculata* L.) grown as trap crop opposite direction of maize crop for aphid and avoid egg laying of tomato fruit borer damage of tomato crop and results were compared with the control plot their follow the General Management Practices.

Impact of marigold as a trap crop on the population of *H. armigera*

The effect of Marigold on the larvae of *H. armigera* was also evaluated by counting larval population existing at a distance of 1 ft., 5 ft., 10 ft. and 20 ft. away from the rows of marigold. with control. Control plot was 60 meters away from the ecological engineered tomato crops and in control plot the university recommended general package and practices was followed. Observations were taken at weekly intervals.

Impact of buckwheat as cover crop on the populations of *M. persicae*

Similarly, buckwheat a cover crop was grown along the hedges of the tomato plots and the effect of buckwheat on the *M. persicae* population, due to enhancement of their natural enemies population was worked out by counting their population at 1 ft., 5 ft., 10 ft. and 20 ft. away from the rows of buckwheat and results were compared with control.

Statistical analysis

Statistical analysis was done in consultation with the Division of Agri-Statistics, SKUAST-K, Shalimar in OP STAT. Means were separated at p=0.05 and for the comparison of means to assess the significance, and the data collected was subjected to One Way Analysis of Variance (ANOVA) and LSD test. Per cent reduction calculated using formulae described by Handerson and Tiltons (1955).

RESULTS AND DISCUSION

Impact of marigold as a trap crop on the population of *H. armigera*

Population of *H. armigera* larvae at different distances away from the rows of Marigold is presented in Table 1. Observations were the mean of four replications. Weekly mean reduction over control shows that maximum (78.33%) in the third week of August. Observations at different distances showed that mean population during the growing season was lowest at 1 ft. distance and maximum at 20 ft. distance, but it was significantly less than that of control. Impact of Marigold on the population of *H. armigera* is showed in Table 2.

Mean larval population per plant on tomato crop at different distances away from marigold rows revealed that there was marked difference between the sole crop (Control) and ecologically engineered grown tomato crop at p=0.05 significance. However larval population from 1 ft., 5 ft. and 10 ft. increased but was significant between 10 ft. to 20 ft.

Sole tomato crop plantation had significantly higher larval population per pant as compared to the plants of other group. Distance of 1 ft. reduced 80.91% population as against control and 20 ft. distance with lowest reduction over control (54.18%).

Table 3: Abundance of *M. persicae* when buckwheat row grown as trap crop in tomato field of Kashmir.

Standard Week	Population of *Myzus persicae* (per plant)*						Weekly mean reduction over control %
	1ft	5ft	10ft	20ft	Mean	Control	
24 (11/06/19)	2.41	5.41	10.22	17.71	8.94	27.92	67.98
25 (18/06/19)	3.74	6.36	10.84	18.93	9.97	29.76	64.29
26 (25/06/19)	4.65	7.31	11.37	20.25	10.89	31.89	60.97
27 (02/07/19)	4.92	7.82	11.55	20.39	11.17	33.99	59.99
28 (09/07/19)	6.51	9.49	11.71	20.6	12.08	36.65	56.74
29 (16/07/19)	7.28	9.76	12.88	20.92	12.71	36.42	54.47
30 (23/07/19)	6.35	8.93	14.53	20.73	12.64	34.72	54.74
31 (30/07/19)	5.67	8.78	14.71	20.52	12.42	32.92	55.51
32 (06/08/19)	5.49	7.81	11.44	20.35	11.27	31.74	59.62
33 (13/08/19)	5.16	6.92	10.02	20	10.52	29.71	62.30
34 (20/08/19)	4.91	6.54	10	19.91	10.34	30.97	62.96
35 (27/08/19)	4.73	6.7	9.95	19.73	10.28	29.72	63.18
36 (03/09/19)	3.87	6.2	10.21	18.22	9.62	30.87	65.52
37 (10/09/19)	4.6	7.05	10.07	17.89	9.90	31.02	64.53
Mean	5.02	7.51	11.60	19.72	10.96	32.02	60.73

*Mean of 4 replications

Trap crop provides protection by preventing the pest from reaching the main crop and pest are diverted away from the main crop or concentrated in certain products of the field where they are easily arrested or controlled (Khan & Parvaiz, 2024). Therefore the main emphasize of the study is used of marigold as a trap crop against tomato fruit borer on tomato was evaluated impact on a trap crop has been used in a push-pull plan (the so-called stimulo deterrent diversionary (SDD)) which requires the involvement of another component such as semio-chemicals main crop from different distance of marigold. Trap crops have an important attributes that is distinctly more attractive to the pest and have additional function for natural enemies and similar work conducted on marigold as a trap crop for the management of tomato fruit borer, *H. armigera* in *Tarai* region of Uttar Pradesh (Kumar *et al.*, 2012) and also support to the present findings. Moreover, larval population in early crop stages was surely higher on both marigold and tomato plants because had a convenient environment in terms of abundance of flowers, fresh leaves and green fruits which promoted better larval performance (Hussain & Bilal, 2007). The use of these plants in cropping systems is based on the fact that insects show a marked preference for certain plant organs, cultivars, species, or phenological stages and (Moreno & Racelis, 2015). Hence, trap plants are more attractive to the pest and easier to find than the host plants in many instances (Hare, 2011).

Table 4: Abundance of *M. persicae* larvae when buckwheat row grown as cover crop in tomato fields of Kashmir.

Treatment	Mean aphid population (per plant)	Mean reduction over control (%)
1ft	5.02[a]	82.32
5ft	7.51[a]	76.56
10ft	11.60[a]	63.76
20ft	19.72 [b]	38.4
Control	32.02 [c]	-
CD ($p \leq 0.05$)	7.49	-

*Mean aphid population = Mean of the weekly recorded populations of *Myzus persicae* at different distances away from Buckwheat row grown as cover crop.

Impact of buckwheat as cover crop on the populations of *M. persicae*

Population of *Myzus persicae* at different distances away from the rows of Buckwheat is given in Table 3. It is evident that maximum weekly mean reduction over control was 67.98% in second week of June and minimum 54.34% in third week of July. Mean aphid population recorded at different distances showed the lowest population at 1 ft. (5.02 aphids/plant) and maximum at 20 ft. (19.72 aphids/plant). Impact of Buckwheat on the population of *M. persicae* population is given in table 4. Critical Difference (CD) calculated through One Way Analysis of

Variance (ANOVA) and LSD test revealed that population of *M. persicae* showed increasing trend from the gap of 10 ft. towards the distance of 1ft. and population increase was significant at the distance of 20 ft. Even though the population was higher at the distance of 20 ft. but significantly lower than control plantation.

Tendency of higher aphid densities observed at the field level than on the strip and plant level and also depend upon the abundance of natural enemies (Bickerton & Hamilton, 2012; Gurr *et al*., 2017). As to the benefit of, one is that selected flowers can attract more parasitoids in terms of abundance and diversity and also. The distance plays a key role due to presence of volatiles produced by flowering plants (Hare, 2011; Khan & Parvaiz, 2024). Besides, the suitable floral resources including nectar (carbohydrate) and pollen (protein) the flowering plants are of great important as energy and nutrient source for the management of natural enemies (Blanchi & Wackers, 2008. Thus, the attraction of flower and floral resources can result in higher enemy efficacy as biological control agent of pest insects (Simpson *et al*., 2011a). The present study also suggests that cover crops have ability to attract the pests and make a distance from target crops as described earlier (Bone *et al*., 2009; Dedryve *et al*., 2010; Moreno and Racelis, 2015).

CONCLUSION

Thus, from the present study it can be concluded that the planting of a row of marigold and buckwheat at the 20 feet distance would help in management of *H. armigera* and *M. persicae*. Trap crop has been used in a push-pull plan require the involvement of another component such as semio-chemicals and similarly, the cover crops will attract the pests if planted at distance from target crops.

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