Research article

APHID PEST MANAGEMENT IN SWEET PEPPER FIELD WITH RAPESEED AS A COMPANION CROP

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ABSTRACT

Sweet pepper, *Capsicum annum* L. is commercially grown vegetable grown for its nutritional and economical value. Sucking pests like aphids, whiteflies, thrips, mites, etc. are the major insect pest in sweet pepper fields. Farmers deliberately have been using chemical pesticides in their crop to manage various insect pest and such practices of using hazardous chemicals are harmful to human health and the biodiversity. Similarly, farmers don't have an idea of planting trap and/or companion plants and its role in natural control of pest. Hence, a study was conducted to know the population dynamics, especially to assess the aphid (*Myzus persicae,* Sulzer) population and its potential natural enemies by planting rapeseed as companion crop. This field experiment was conducted in six different locations of Bharatpur-23, Chitwan from Nov 2019 to Jan 2020 where three plots of sweet pepper were planted with rapeseed as companion crop and other three plots solely having no floral source around. Aphid population was recorded at weekly interval and its major natural enemies; ladybird beetle and syrphid fly. Abnormal data were squared root transformed and analyzed by using paired sample t-test. The result showed that the aphid population in sweet pepper field with companion crop was significantly lower than in sweet pepper grown without floral source (control). Highly significant number of ladybird beetles and syrphid flies were recorded in sweet pepper with companion crop compared to control. The finding is helpful to develop an integrated management protocol of sweet pepper pests with the practice of following conservation biological control strategy.

Keywords: Aphid, sweet pepper, companion crop, ladybird beetles, syrphid flies

INTRODUCTION

Aphid is a highly polyphagous pest; Approximately 4000 aphid species have been reported, causing damage over 250 agriculturally economic crops all over the world (Blackman & Eastop, 2000). Sweet pepper (*Capsicum annuum* L.), tomato, potato and tobacco are the important vegetable crops belonging to the family Solanaceae (Dias et al., 2013). Numerous insect pests attack sweet pepper plant at various growth stages. During early period of infestation, aphids have no wings are developed, but as they gathered together, wings may appeared in latter generations for moving from one host plant to another. Aphid are actively found on the growing new plant parts, including top underside leaf, flowers and growing pods and occupy the whole host in severe infestation (Nelson & Rosenheim, 2006). Among various production constraints, sucking insects significantly decreases both the production and quality of sweet pepper fruit. Of which, aphids (*Myzus persicae* Sulzer, *Apis gossypi* Glover), are the most dominant sucking pests in sweet pepper fields (Berke & Sheih, 2000).

Biological control of arthropod pests has utilized for quite a while customarily but it ought to be utilized with other compatible IPM techniques (Jonsson et al., 2008). The knowledge of the behavior and biology of the natural enemies (NEs) and the pest should be well known before adding plants or other food sources (Bianchi & Wäckers, 2008). Farmers use synthetic chemical pesticide to keep all pests away from crop field. These pesticides are broad spectrum and have high residual effect. Heavy application of broad spectrum synthetic pesticide brings about the issues like pest resurgence, pesticide resistance and reduction of beneficial natural enemies. There are a number of reasons why pairing companion plants with crops result in less aphid damage and, as a result, a reduction in the need for pesticides. A companion plant may attract and repel pests away from the target crop. These plants, known as trap plants, are more appealing to pests, which may cause them to leave their host plant (Hurej, 2000). Then, by producing volatile organic chemicals, certain companion plants can either act directly on aphids, deterring them from the target plant by repellence or disguising host odors (Bruce et al., 2005), or indirectly, by altering the host plant's characteristics and making it unsuitable for aphids (Baldwin et al., 2002). Others can help natural enemies by providing them with shelter and food (Gurr et al., 2017), increasing their abundance and increasing their predation or parasitism rates. Conservation of NEs like predators and parasitoids are used as an effective IPM strategy for different insect pests in most parts of the world. Having flower habitat provides shelter, nectar, alternative food and pollen to the pest natural enemies and improves conservation biological control (Gonzalez-Chang et al., 2019). Hence, this study was conducted to know the incidence of aphid population and the fitness of biological organisms in sweet pepper field with the integration of rapeseed as a companion crop.

MATERIALS AND METHODS

The study was carried out in three different locations (500 m apart) of Bharatpur-23 (latitude of 27^0 33' North; longitude 84^0 19' East), Chitwan from November 2019 to January 2020. Seedlings were raised in a plastic tray (520×280×45 mm) and ready to transplant forty days after sowing. Twenty healthy seedlings were transplanted maintaining 60 cm row to row and 45 cm plant to plant distance along with rapeseed as a companion crop surrounding the sweet pepper field. Similarly, twenty seedlings were also transplanted with no floral source (check) around the field. Chemical fertilizers viz. Nitrogen, Phosphorus and Potassic fertilizers were applied at the rate of 70:50:40 kg/ha (AITC, 2019). Half dose of nitrogen and a full dose of phosphorus and potassium were applied at basal dose while the remaining half dose of nitrogen was applied in two split doses as a side dressing. Various intercultural operations like earthing up, gap filling, weeding and irrigation were done when necessary. Insecticides were not used throughout the study period.

Data collection and analysis

The aphid population was counted from randomly selected from five sample plants at weekly interval with the help of a hand lens (10×). Similarly, major natural enemies visiting the field; ladybird beetles and syrphid flies were also recorded from those randomly selected sample plants.

The recorded data were entered in MS-Excel and the average population of insect was used for statistical analysis. After testing the population distribution, abnormal data were normalized by square root transformation. A paired-sample t-test was used to compare the two population means.

RESULTS AND DISCUSSION

Table 1. Weather parameters during the research period, Nov 2019 to Jan 2020

Date	Weather parameters			
	Max temp	Min temp	RH	Rainfall
28 Nov 2019 (7 DAT)	26.07 ± 0.93	14.06 ± 0.46	92.9 ± 1.56	0
5 Dec 2019 (14 DAT)	25.16 ± 0.17	10.79 ± 0.40	90.9 ± 0.73	0
12 Dec 2019 (21 DAT)	21.49 ± 1.07	12.27 ± 0.56	93.27 ± 0.45	3.54 ± 3.54
19 Dec 2019 (28 DAT)	19.78 ± 0.56	9.93 ± 0.72	92.46 ± 1.35	0
26 Dec 2019 (35 DAT)	11.77 ± 0.64	10.86 ± 0.57	89.73 ± 1.00	0
2 Jan 2020 (42 DAT)	20.04 ± 0.92	11.16 ± 0.28	91.78 ± 1.85	3.3 ± 2.86

Note: Max temp: Maximum temperature, Min temp: Minimum temperature, RH: Relative Humidity, DAT; Days after transplanting. Average value of seven days weather data was computed.

Incidence of aphid population in sweet pepper field

Aphid populations from randomly selected five sample plants in sweet pepper grown with companion crop and with control (no floral source) were recorded and a paired samples t-test was performed. The result showed that aphids in sweet pepper grown with companion crop ($\mu = 6.17$, $sd = 1.09$) were significantly less compared to control ($\mu = 7.63$, $sd = 0.54$), $t(6) = 2.57$, $p < 0.05$). The AUC mean for treatments rapeseed and control were 4.93 and 6.37 respectively.

Aphid population in sweet pepper field grown with companion crop rapeseed was significantly low than sweet pepper grown soley (no floral source). The interception of the pest can be achieved having trap and/or companion crop around the field. Pests will congregate in the field's boundary sections. A pulling strategy can be employed to guide a certain insect away from a cash crop and towards a more desired target or trap crop (Cook et al., 2007). Key volatiles present in certain or specific ratios can help insects identify the more attractive plant (Bruce et al., 2005). The use of trap crop is to serve as a semio-chemical diversion from the main crop (Hassanali et al., 2008). This method, also known as directed host orientation (Cook et al., 2007), can make use of specific host odors, sex and aggregation pheromones, as well as naturally occurring gustatory and oviposition stimulants and visual stimulants (fruit or flower color). All of these techniques are designed to keep insect pest populations in the trap crop region while preserving natural enemies and lowering insecticide use in the desired crop area.

Table 2. Aphid population in sweet pepper field grown with companion crop (rapeseed) and control (no floral sources).

Date	Mean aphid population (Number)	
	With companion crop	**Control (no floral sources)**
28 Nov 2019 (7 DAT)	7.63 ±1.10	6.84 ± 0.88
5 Dec 2019 (14 DAT)	5.34 ± 0.87	7.28 ± 0.82
12 Dec 2019 (21 DAT)	5.07 ± 0.89	7.45 ± 0.74
19 Dec 2019 (28 DAT)	5.34 ± 0.96	7.83 ± 0.61
26 Dec 2019 (35 DAT)	6.40 ± 0.92	8.07 ± 0.55
2 Jan 2020 (42 DAT)	7.24 ± 0.99	8.31 ± 0.55
AUC Mean	4.93	6.37
Mean (μ)	6.17	7.63
Standard deviation (SD)	1.09	0.54
Significance	*	

Note: Aphid population in five sample plants/plot was square root transformed; (DAT) Days after transplanting; ($\bar{x}$)Sample Mean; (*sd*) Standard Deviation; (AUC) Area under the curve; (*) df (5) & $p < 0.05$, significant. AUC mean was calculated by the area under the curve methods (Hanley and McNeil, 1983).

Incidence of ladybird beetle and syrphid fly in sweet pepper field

Ladybird beetle and syrphid fly were the two main NEs found in sweet pepper field. A paired sample t-test showed that highly significant number of ladybird beetles were found in sweet pepper field grown companion crop (μ= 1.84, *sd*= 0.32) compared with control (μ= 0.99, *sd*= 0.14), $t(6) = 2.57$, $p < 0.05$).The AUC Mean for treatments companion crop and control (no floral sources) were 1.58 and 0.81 respectively.

Likewise, syrphid fly found in sweet pepper field grown with companion crop (μ= 2.62, *sd*= 0.62) were highly significant compared with control (no floral source) (μ= 1.38, *sd*= 0.20), $t(6) = 2.57$, $p < 0.05$). The AUC Mean for treatments rapeseed and control were 2.28 and 1.13 respectively.

Highly significant number of ladybird beetle and syrphid fly were found in sweet pepper field grown with companion rapeseed compared to control. The finding is in conformity with Parajulee & Slosser (1999) who reported that rapeseed (canola) a better trap crop for enhancing the population of predators like lady beetles, big eyed bugs, soft winged flower beetles, lacewings, hover fly, pirate bug, damsel bug, assassin bugs, spiders etc. Aphid population is suppressed in diversified field as compared to the mono cropping (Gurr et al., 2012). Large number of species of organisms prey on aphids, some taxonomic groups that involve predators of aphids are Coleoptera (Coccinellidae, Carabidae, Cantharidae, Staphylinidae) Diptera (Syrphidae, Cecidomyiidae, Chamaemyiidae, Chloropidae), Hymenoptera (Vespidae, Formicidae, Sphecidae), Neuroptera (Chrysopidae, Hemerobiidae, Coniopterygidae), Dermaptera, Heteroptera (Anthocoridae, Nabidae, Reduviidae, Pentatomidae, Capsidae, Miridae, Lygaeidae, Araneae, Acari (Anystidae), Opiliones, Aves etc (Frazer, 1989).Being less mobile aphids are more amenable for biological control. Aphidiidae (Ichneumonoidea) and Aphelinidae (Chalcidoidea) are the two major hymenopteran families that involve the parasitoids of aphids, along with a few species from other hymenopteran families and some species of gall midges (Mackauer & Chow, 1986). NEs also require benefit from pollen, nectar or honeydew (produced by aphids) during non-crop periods. Many crop plants blossom for just brief timeframe, so blooming plants around the field might be required for pollen and nectar (Wackers, van Rijn & Bruin, 2005). Sutrisna et al., (2005) reported 55 percent reduction in aphid population by intercropping. Flowering plants can also provide nectar, alternative food and pollen to the pest natural enemies and promote conservation biological control (Tiwari et al., 2020).

Table 3. Ladybird beetle and syrphid fly in sweet pepper field grown with companion crop (rapeseed) and control (no floral sources).

Date	Ladybird beetle population		Syrphid fly population	
	With companion crop	Control (no floral sources)	With companion crop	Control (no floral sources)
28 Nov 2019 (7 DAT)	1.3 ± 0.14	1.1 ± 0.14	1.5 ± 0.11	1.1 ± 0.14
5 Dec 2019 (14 DAT)	2.0 ± 0.15	1.0 ± 0.42	2.4 ± 0.12	1.3 ± 0.14
12 Dec 2019 (21 DAT)	1.9 ± 0.09	1.1 ± 0.14	2.8 ± 0.06	1.4 ± 0.21
19 Dec 2019 (28 DAT)	2.2 ± 0.13	0.8 ± 0.47	3.2 ± 0.05	1.4 ± 0.21
26 Dec 2019 (35 DAT)	1.9 ± 0.09	1.0 ± 0.42	3.2 ± 0.18	1.3 ± 0.14
2 Jan 2020 (42 DAT)	1.6 ± 0.11	0.8± 0.33	2.6 ± 0.18	1.7 ± 0.21
AUC Mean	1.58	0.81	2.28	1.13
Mean (μ)	1.84	0.99	2.62	1.38
Standard deviation (SD)	0.32	0.14	0.62	0.20
Significance	**		**	

Note: Ladybird beetle and Syrphid fly populations in five sample plants/plot were square root transformed; (DAT) Days after transplanting; ($\bar{x}$) Sample Mean; (*sd*) Standard Deviation; (AUC) Area under the curve; (**) df (5) & $p < 0.05$, highly significant. AUC mean was calculated by the area under the curve methods (Hanley and McNeil, 1983).

CONCLUSION

The present study concluded that ladybird beetles and syrphid flies were the two major natural enemies found in the sweet pepper field grown with rapeseed as a companion crop and aphid population was significantly lower with the presence of those NEs. However, the absence of floral source around the sweet pepper field caused decreased in population of ladybird beetles and syrphid flies resulting significantly increased in aphid population. Having floral source around the field or practice of multiple cropping/trap/companion crops would attract the NEs and help in natural control of harmful pest. Companion crop can be used in association with other integrated pest management strategies (e.g., using resistant host plants, spraying extracts and essential oils, releasing natural enemies etc). Thus, the practice of associating companion crop in an agro-ecosystem pest helps to reduce the use of chemical pesticides and its impacts and maintain the natural control of harmful pests in a eco-friendly and sustainable manner.

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