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ASSESSMENT OF PEAS AS A TRAP CROP IN WHEAT ECOSYSTEM

Faryal Kanwal Chaudary[1ǂ], Bazmir Khan[2ǂ], Paio Khan[3ǂ], Asma Hafeez[4], Farah Liaqat[4], Shamsullah Shams[5], Aiman Salah Ud Din[6*]

[1]**Department of Zoology,** Wildlife and Fisheries, University of Agriculture, Faisalabad, Pakistan
[2]**Directorate of Agriculture Research,** Government of Balochistan, District Zhob, Pakistan
[3]**Department of Epidemiology and Public Health,** University of Veterinary and Animal Sciences, Lahore, Pakistan
[4]**Department of Zoology,** University of Sialkot, Pakistan
[5]**Faculty of Agriculture**, Urozgan Higher Education Institute, Urozgan, Afghanistan
[6]**Department of Food Science and Technology,** Muhammad Nawaz Sharif University of Agriculture, Multan, Pakistan

ǂContributed equally.
***Corresponding Author:** Aiman Salah Ud Din. E. mail: aimansala99@gmail.com

Abstract
Push-pull strategy in integrated pest management (IPM) is employed for controlling aphid population as the aphid produces deleterious damage to crops. For wheat aphid management, wheat (Triticum aestivum) and peas (Pisum sativum) were scrutinized to observe pest and predator population and peas act as the stimuli that allure the aphids (pull). In this study the pea-wheat trap crop area was divided into control (pea and wheat) and experimental (wheat sandwiched between peas) zones with an area of 0.13 acres (0.0526 hectare). The purpose was to determine natural abundance of Aphids in peas and wheat, Population abundance of natural enemies attacking aphids in peas and wheat and comparison of abundance of natural enemies and aphids in peas and wheat. Pea-wheat trials were surveyed on a weekly basis by visual observation utilizing five fixed sampling methods. Results indicated the mean number of aphid population was 54.77 in wheat control zone while in experimental zone 63.79 per 100 tillers while predators in experimental zone were 767.72 and control had 82.99 per 100 tillers. Moreover, peas considered as pull had an aphid population in control zone was 937.83 and experimental had 1147.56 per 100 plants whereas, predator in control was 33.50 and in experimental 8.66 per 100 plants. The research findings statistically showed that the population abundance of predators was 8.66 in the experimental zone for peas and 82.99 in wheat, attacking aphids in the peas and wheat ecosystem. The population abundance of predators was determined in peas and wheat, with the higher population observed in wheat compared to the peas. Thus, it can be concluded peas proved beneficial in reducing aphid population from main crop without aid of pesticides, on the basis of present research underpin the existing knowledge on Trap crop in IPM.

Key words: *Aphids, Peas, Predator, Pesticides, Pisum sativum, Triticum aestivum*

INTRODUCTION

Over the course of years, increasing number of the population without any check and balance resulted in the various issues related to the health and food. Major issues are food security and the edibles for human nourishment, which has consistently caused hindrance in human developments (1). As the growing community around the world also acquire the greater amount of the food yield to maintain their life balances in the case of nourishment including meat, milk and other agriculture products. These products are more potentially affected from different pathogens in an open environment such as *Escherichia coli* and so many others in milk and meat (2). Therefore, greater demand of food utilizes definitely demands for the greater amount of the water and farming area for the cultivation. Not only is the area, but the safety of the food resources also major concern (3). Growing population is exposed to various provocations in regard to enormous production rate, adjustment of editing frameworks to environmental change, hereditary improvement of plant assortments, bother the board and new homestead rehearses. These provocations also impact on biodiversity in the number of ways, food squander and landscape management (4). Food security is the evident issue in the developing countries such as varying mode of living in striving countries has entirely altered the requirement for meat and milk products (5). Hence, it is evident that requirement of greater amount of food for feeding the number of peoples all around the world require more and more land

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for cultivation and securing food from the attack of pests either small or large, while these are the two main objectives for saving the food resources. Cultivation and the attack of the pests are the two issues that go hand in hand. There is no doubt, where there is the cultivation of the crop there will be the pests. Therefore, pests have the most deleterious effects in the number of ways. As the pests are considered as the important fragment of crop insurance for enhancing production and standard. Marketing of the crops requires standard quality as well as quantity; pests are affecting all three objectives of the products. Pests can be characterized as deleterious creatures, for instance, pests can exist in the variety of forms such as weeds, bugs, microorganisms and parasites are affecting the lives of the humans (6). As the pests induce the lower production of crop yield and quality on harvest (7) the most important pests are the insects. These insects are of various forms, they crawl, jump or fly. They depend on the leaves, flowers and strike roots for their nourishment. In order to explain the types of the pest let's consider an example of cabbage root maggot and many more species of caterpillars and beetles. Insects usually have piercing mouth parts for feeding on the vascular fluids by insertion such as aphids, thrips and spider mites. Pest could be animals either large or small which produce devastating damage like rodents, mouse, rabbits etc. Weeds are also considered as the pests as they are unwanted. Weeds are responsible for attracting the pest population that compete for food, space, light, water and nutrients. Diseases spread due to pathogens, bacteria, viruses and the major cause of their spread are insects and animals and producing devastating damage to plants.

Integrated Pest Management (IPM) suggests a methodology which is a blend of techniques which employs the variety of procedures and techniques either chemical or nonchemical in order to eradicate the pest population and enhancing the yield in befitting manner also aids in economy. Moreover, the biotechnology improvements resulted in the development of semi chemicals, predators for pests and pest resistant varieties. For pest control selective pesticides are produced to target the non-targeted pest species. Moreover, a trap crop system has also been introduced, which is the major concern in this article. In short, the purpose of the IPM is the eradication of the excessive usage of pesticides that add contamination to the food and environment and tries to add more quality to the products at the marketing level. Pesticide is an injurious synthetic substance or a blend of number of substances or natural operators that are deliberately discharged in ground so as to deflect, discourage, control or potentially slaughter and annihilate populaces of various insects and pests or larger pest animals. The mode of action of pesticides is by pulling in, enticing or afterward crushing or alleviating the nuisances. Over the previous years the utilization of pesticides has been increased to the greater extent. 5.2 billion pounds of pesticides have been employed all over the world without acknowledging the harmful impacts all over the world annually. Excessive use of pest forced the pests to migrate all over the world. The employment of the pesticides is not only confined to the farming fields, moreover they are excessively utilized without knowing the required amount of the pesticides in homes, toxic substances and grinded material for controlling cockroaches, mosquitoes, rodents, insects, ticks and other harmful bugs. All this discussion over the excessive use of pesticides resulted in the indication of these chemicals are consistently found in food products not withstanding their essence noticeable all around. Pesticides are usually synthetic such as organochlorines, carbamates, organophosphates, pyrethroids and neonicotinoids (8,9,10).

Excessive use of the chemicals in the form of pesticides masked away the advantageous consequences. Pesticides mostly produce deleterious impacts on the non-targeted population of the insects and in return effecting the biodiversity of land and aquatic. Pesticides are also responsible for effecting the food web. This happens mostly due to sprayers and these volatile compounds vaporize and affect the non-targeted species. For an instance the herbicide, which evaporates from sprayed plants, these vapors have potential to cause damage to the other plants. Insect pests are the major cause for the transfer of pathogens. One of the most important insect pests among the insects is aphids that are also considered as plant lice. Aphids are highly hazardous in spite of their smaller insect group round about 4000 species globally. While in comparison of aphids, 12,000 species of lepidopterans, 60,000 species of weevils and 10,000 species of grasshoppers. Aphids are the habitants of the temperate areas where they populate 25% of the standing crops. Not with standing, just around 100 species have effectively abused the agrarian condition to the

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degree that they are of huge financial significance (11,12). By looking at their morphology, aphids are generally soft-bodied bearing a pair of elongated antennae that are extend much of the length of their body and a pair of cornicles on the abaxial fifth abdominal segment that release alarm pheromones in reciprocation to natural enemies. They utilize a prickling stylet to suck phloem and actively ingest sap by poking the crop superficially with their proboscis and mature aphids are of 4.5mm in length, perhaps pink or green and can be winged or unwaged (13, 14, 15). The mode of action of the aphids are quite diverse and they usually diminish the plant. Foremost, they are phloem feeders and benefit themselves by providing nutrients which are essential for the development of the plant and reproduction. Furthermore, in the course of nourishing they insert their saliva that might be phytotoxic. As aphid infestation in the major risk to wheat production for this purpose the forecasting is the excellent technique to lower the devastating effects on wheat. An exemption remembers 1986 in USA Russian wheat aphid, *Diuraphis noxia*, was reported that is native from the steppe regions of the southern CEI (former USSR). In these manner aphids quickly spread all through wheat-creating districts such as western US where it caused damages of several million dollars misfortunes in wheat and barley production thus by diminished production and pesticide induction prices (16). Intense proliferation and minimal spawning time resulting in devastating damage to crops eventually cause death of plant and cause the food security problems. One of the most important damages caused by the aphids is their tendency to vector catastrophic plant virus. Pests are gainful disease vectors because some of the degree in light of the way that winged changes dissipates extensively. Aphids are, accordingly, fit for going starting with one farming field then into the next, spreading the viral outbreaks as they scatter (17). Having an outline around the world, Aphid are widely allocated, while most abundant and consequential in temperate region. By the way of illustration, a little aphid aggregation has observed in Australia and Sub-Saharan Africa with just 219 and 180 species. As compared to North America has 1416 species, Europe has rounded about 1,500 species and China has above 1,000 species (18). Most deleterious aphid species in China is grain aphid (*Sitobion aveae*) influencing wheat sectors in Yellow Huai and the Northern China Plain, the Southwest, Northwest and the Middle Yangtze Rivers zones (19). According to another investigation *Metopolophium dirhodum* also produces huge damage to the crops resulting in yield reduction (20). Trap crop acknowledged as crops are developed to draw in insects or other living beings like nematodes to shield the main plant stand from bug assault, counteracting bothers from achieving the yield or amassing them in a specific piece of the zone where they can be financially pulverized. Nowadays, attentiveness has diverted towards the trap crop as IPM due to enhanced damage caused due to insecticides and pesticides.

As the enormous damage caused by pea aphids which are roughly 4,400 species of aphids belonging to order Hemiptera and related to family *Aphididae,* subfamily *Aphidinae* and are frequently acknowledge according to their main crop stand and linked to the Peas family *Fabaceae Leguminosae* (21) . The most important pea aphid (*A. pisum*) brings about devastating damage to crop, checking around the entire globe after China, India is recognized as the biggest manufacturer of vegetables with the mass production of 4 million hectares of land region (22). The provinces of Pakistan produce peas in various amounts such as in Punjab 71.2, Sindh 4.7, Khyber Pakhtunkhwa 12.8 and Baluchistan 11.3 percent respectively (23). During the varied periods of growth frequent number of insects are ruining peas as many as 24 such as insect pests implicate pea stem fly (*Melanagromyza phaseoli*), pea leaf miner (*Chromatomyia horticola*), pea aphid (*Acyrthosiphon pisum*) and pod borer complex (*Helicoverpa armigera*) and thrips (*Caliothrips indicus*) causing devastating reduction to the production. Most devastating pest is pea leaf miner (*Phytomyza horticola*) which is keeping down pea's production rate to 90%.

In order to monitor the populations of pests and predators, wheat (*Triticum aestivum*) and peas (*Pisum sativum*) were closely examined in this study on wheat aphid management. Peas serve as the stimulant that attracts aphids (pull). The 0.13-acre (0.0526-hectare) pea-wheat trap crop area was split into experimental (wheat between peas) and control (pea and wheat) zones. The major goals of the study were to compare the abundance of aphids and natural enemies in peas and wheat, as well as the natural abundance

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of aphids in peas and wheat as well as the population abundance of natural enemies that attack aphids in peas and wheat.

MATERIALS AND METHODS

STUDY DESIGN

This study was conducted in 2019 to assess the population abundance of natural enemies attacking aphids in pea-wheat trap crop at the Entomological Research area in University of Agriculture, Faisalabad, Pakistan exists in rolling flat plains of northeast of Punjab, at the height of approximately 186 meters above sea level. The climatic condition of Faisalabad indicates a semi-arid climate according to Koppen-Geiger classification with very hot and humid summers and dry cool winters. The average maximum and minimum temperatures in June are 40.5°C (104.9°F) and 26.9°C (80.4°F). The average annual rainfall is only about 375 millimeters (14.8 in), which is highly seasonal since approximately half of the yearly rainfall takes place in July and August during the monsoon season, total area was 0.13 acres (0.0526 hectare). The seed rate was 25 kg/hectare. Wheat variety 'Ujala' and pea variety 'peas-2009' planted on 24 October 2018 and 2019. Seed was purchased from Ayub Agriculture Research Institute (AARI), Faisalabad. Weeds are eliminated by hands despite of using weedicides. No pesticides applied to the research field. The field irrigated according to respective periods of time.

The research field was designed according to split plot design and divided into 3 blocks which continued as replications in 2019. The field was directed in an east-west direction, the cultivation of the crops was in the progression of block 1 as Pea 1, block 2 as Wheat 1 and trap crop zone involved Wheat 2 interjected among block Pea 2 and Pea 3. The selected experimental area was 0.0526 hectares. According to Figure 1, area of 1st block as pea with width 388cm × length 1910cm with 5 rows. 2nd block as Wheat W1 had width 510cm × length 1910cm with 9 numbers of rows. From P1 and W1 block to block distance was 146cm. Distance from W 1 to trap crop zone was 80cm in length. Trap crop Area based on 3 smaller blocks. In trap crop zone 1st pea block was in width 300cm × length 1910cm with 5 rows. Wheat block of trap crop had width 400cm × length 1910 cm with 5 rows. 2nd block of pea in trap crop zone had width 200cm× length 1910 cm with 3 rows. The distance among each block of trap crop zone was of 80 cm. Edge effect in North measured as 190 cm in length, in east 260 cm, in west 480 cm and in south there was no edge effect as shown in Fig. 1.

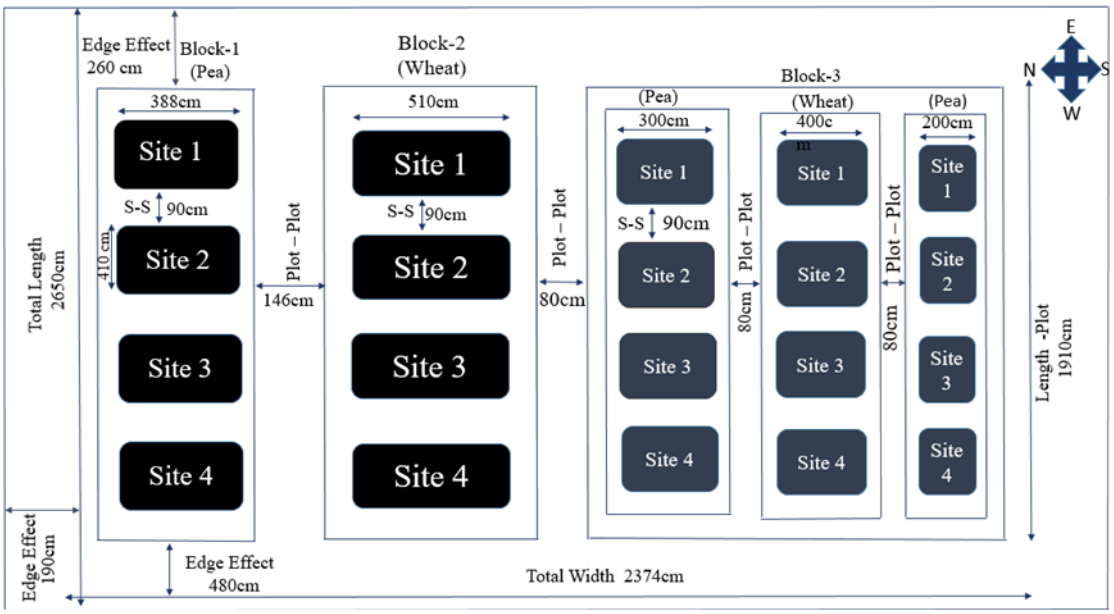

Fig. 1. Layout of Peas-wheat trap crop 2019 at University of Agriculture Faisalabad

SAMPLE COLLECTION

Four plants were selected in each corner and fifth selected in the middle of each site for tagging. In each site of pea-wheat trap crop, 5 plants of peas and 5 tillers of wheat were chosen, out of which was

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infested by aphids. Sampling was carried out according to five fixed plant sampling methods. Each tagged plant of pea and tillers of wheat was observed visually from top to bottom involving stem, leaves and flowers if any with the high degree of precision and neglecting human error. The observation was carried out during three different stages of the development of the plant including early stage, middle development, final maturation stage and fully developed stage. All the pest and predator populations on peas and wheat examined every week in morning including aphids, syrphid fly, lady bird beetle, leaf miners and parasitoid mummies (black and white).

STATISTICAL DATA

Data recorded on data sheets and shifted to Microsoft Excel sheets. Average number, sum and standard error of insects/100 tillers and plants were calculated. Data sheets submitted in IPM laboratory (Integrated Pest Management Laboratory). Graph pad prism® 5.01 utilized for plotting graphs.

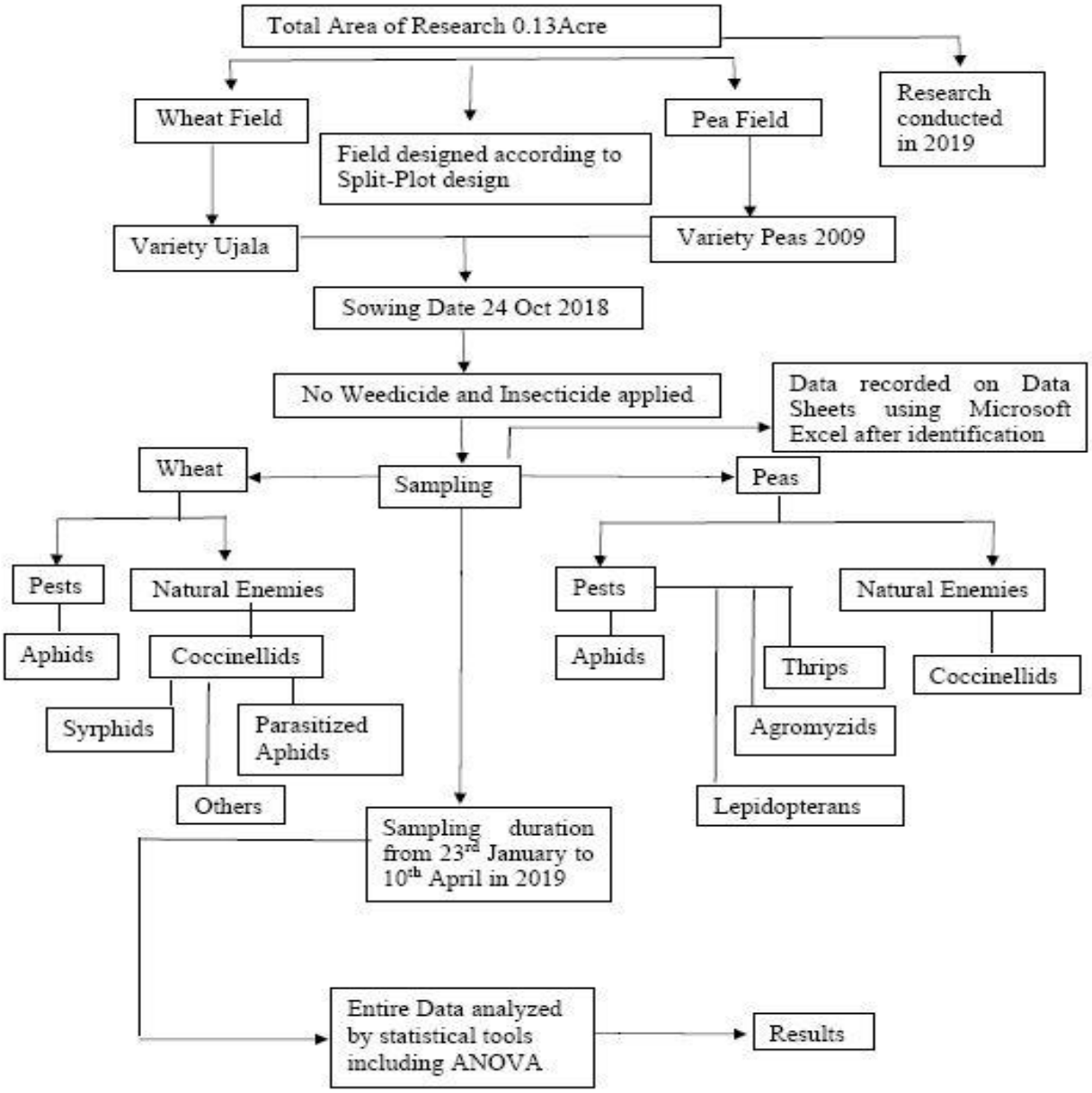

Fig. 2. Technical flow of the study

RESULTS

POPULATION DYNAMICS OF INSECTS PESTS IN PEA AND WHEAT FIELD (CONTROL ZONE)

Pea aphids deliberated on pea (*Pisum sativum*) in an open field survey under natural environmental conditions considering different time interim in 2019. Aphids' population dynamics studied per 100 plants

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during 9 weeks from 28th January to 2nd April. According to Fig. 3a, the population of aphids was zero from January 28th to February 5th. Trend of aphids' population enhanced from February 5th to February 23rd in spring as the mean number of aphids was 100±26.81 to 800±21.21 per 100 plants respectively. All of sudden, population of aphids further increased from February 23rd to March 12th in early summer, mean number of aphids population was 800±21.21 to 3800±596.34 per 100 plants. Highest aphids' population was recorded on March 26th indicating the highest peak and mean number of aphids 8000±937.83 per 100 plants. Population declined to 3800±1449.95 aphids per 100 plants on 2nd April.

POPULATION DYNAMICS OF AGROMYZIDS (LEAF MINER) ON PEA

The agromyzids examined on pea in an open field survey under natural environmental conditions while different time interim in 2019. Agromyzids population dynamics studied per 100 plants during 9 weeks January 28th to April 2nd. According to Fig. 3b, agromyzids population during the early and middle stages of development was zero starting from 28th January in spring to February 23rd ending of spring season. Sudden increase in population occurred from 23rd February ending of spring to starting of summer 12th March representing the mean number of agromyzids population 0 to 230±25.50 per 100 plants. Agromyzids population reached to the higher point indicating the 1st peak having the mean number of agromyzids 500±45 per 100 plants on 12th March in summer. Agromyzids population further enhanced from March 12th to 26th March indicating highest peak 500±45 to 600±80.12 per 100 plants. Population of agromyzids dropped all of sudden from peak point during the last observation of 2nd April in summer indicating the maturation stage to near about while the mean number of agromyzids population was 150±108.25 per 100 plants.

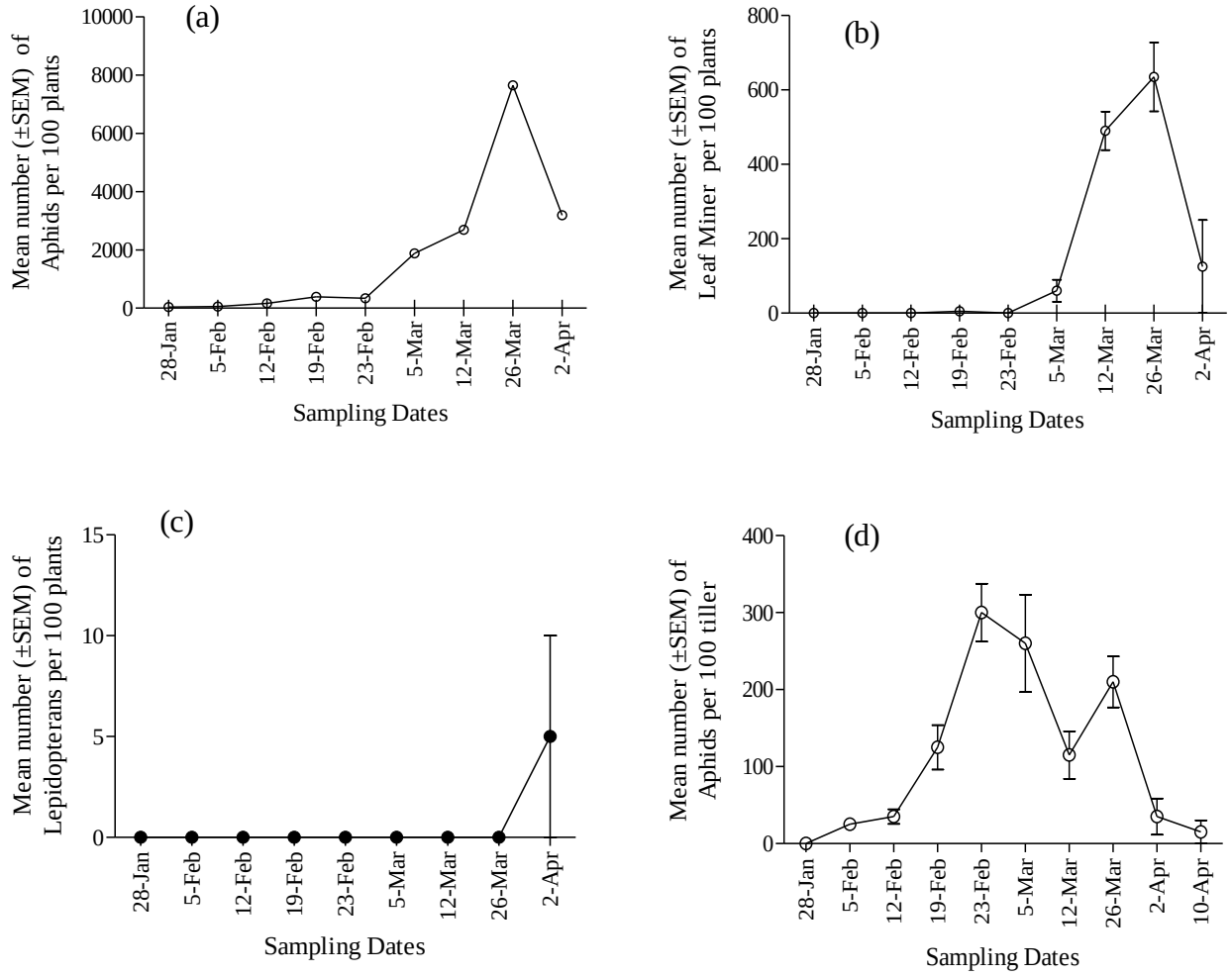

Fig. 3a. Mean number (± SEM) of population dynamics of insect pest pea aphids surveyed in end of January 28th to early April 2nd, 2019, in pea field per 100 plants. **Fig. 3b.** Mean number (± SEM) of population dynamics of insect pest agromyzids surveyed in end of 28th January to early 2nd April 2019 in pea field per 100 plants. **Fig. 3c.** Mean number (±

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SEM) of population dynamics of pest lepidopterans surveyed in end of 28th January to early 2nd April 2019 in pea field per 100 plants . **Fig. 3d.** Mean number (± SEM) of population dynamics of insect pest aphids surveyed in end of 28th January to early 10th April 2019 in wheat field per 100 tillers

POPULATION DYNAMICS OF LEPIDOPTERANS ON PEA

Lepidopterans studied on pea in an open field survey under natural environmental conditions during different time interim in 2019. Lepidopterans population dynamics studied per 100 plants during 9 weeks from 28th January to 2nd April. Population of lepidopterans was observed only on in summer 26 March and reached to highest point on 2nd April with mean number of lepidopterans 5±4.33 per 100 plants Fig. 3c.

POPULATION DYMNAMICS OF WHEAT APHIDS ON WHEAT

Wheat aphids studied on wheat (*Triticum aestivum*) in an open field survey under natural environmental conditions during different time interim in 2019. Aphids' population dynamics studied per 100 tillers during 10 weeks from January 28th to April 10th. According to Fig. 3d, lower population of aphids infested wheat from 28 January to 5 February mean number of aphids ranging 0 to 30±4.33 per 100 tiller in spring season. Population was continuously enhanced from February 5th to February 23rd reaching highest population in late spring indicating the 1st peak point; here the mean number of aphids was 300±32.40 per 100 tillers. Population slightly declined in summer on 5 March and mean number of aphids was 250±54.77 per 100 tillers representing 2nd peak point, which continue to decline till March 12th while the mean number of aphids was 120±26.80 per 100 tillers. Slight increase in population occurred on 26th March representing the mean number of aphids 210±28.72 per 100 tillers. All of sudden mean number of aphids declined to 30±20.46 on April 2nd which continued to reduce 10±12.99 per 100 tillers on April 10th.

POPULATION DYNAMICS OF INSECTS PESTS OF PEA-WHEAT TRAP CROP (EXPERIMENTAL ZONE)

Pea aphids studied on Pea (a) in an open field survey under natural environmental conditions during different time interim in 2019. Aphids population dynamics studied per 100 plants during 9 weeks from 28th January to 2nd April. Fig. 4a illustrated, trend aphids population was tend to increase continuously in same pattern from spring 5 February to 19 February indicating the mean number of aphids 15±4.33 to 370±66.52 per 100 plants. Population of aphids slightly declined and indicating the mean number of aphids 290±38.41 per 100 plants. Immediate population rise occurred from 5th March to 26th March in summer representing the highest peak of population with mean number of aphids 675±174.55 to 7980±758.78 per 100 plants. Whole population declined all of sudden in last observation to 1185±481.11 per 100 plants on 2nd April.

POPULATION DYNAMICS OF INSECTS PEST AGROMYZIDS (LEAF MINER) ON PEA (a)

Population dynamics of agromyzids studied on Pea (a) in an open field survey under natural environmental conditions during different time interim in 2019. Agromyzids population dynamics studied per 100 plants during 9 weeks from 28th January to 2nd April. According to Fig. 4b, population of agromyzids tend to increase from 5th March to 12th March in summer with mean number of agromyzids 10±8.66 to 375±88.71 per 100 plants. From here population of agromyzids continued to increase till 26 March where the highest population occurred with mean number of aphids population 1855±692.04 per 100 plants. Population of agromyzids dropped to 170±147.22 per 100 plants on 10th April.

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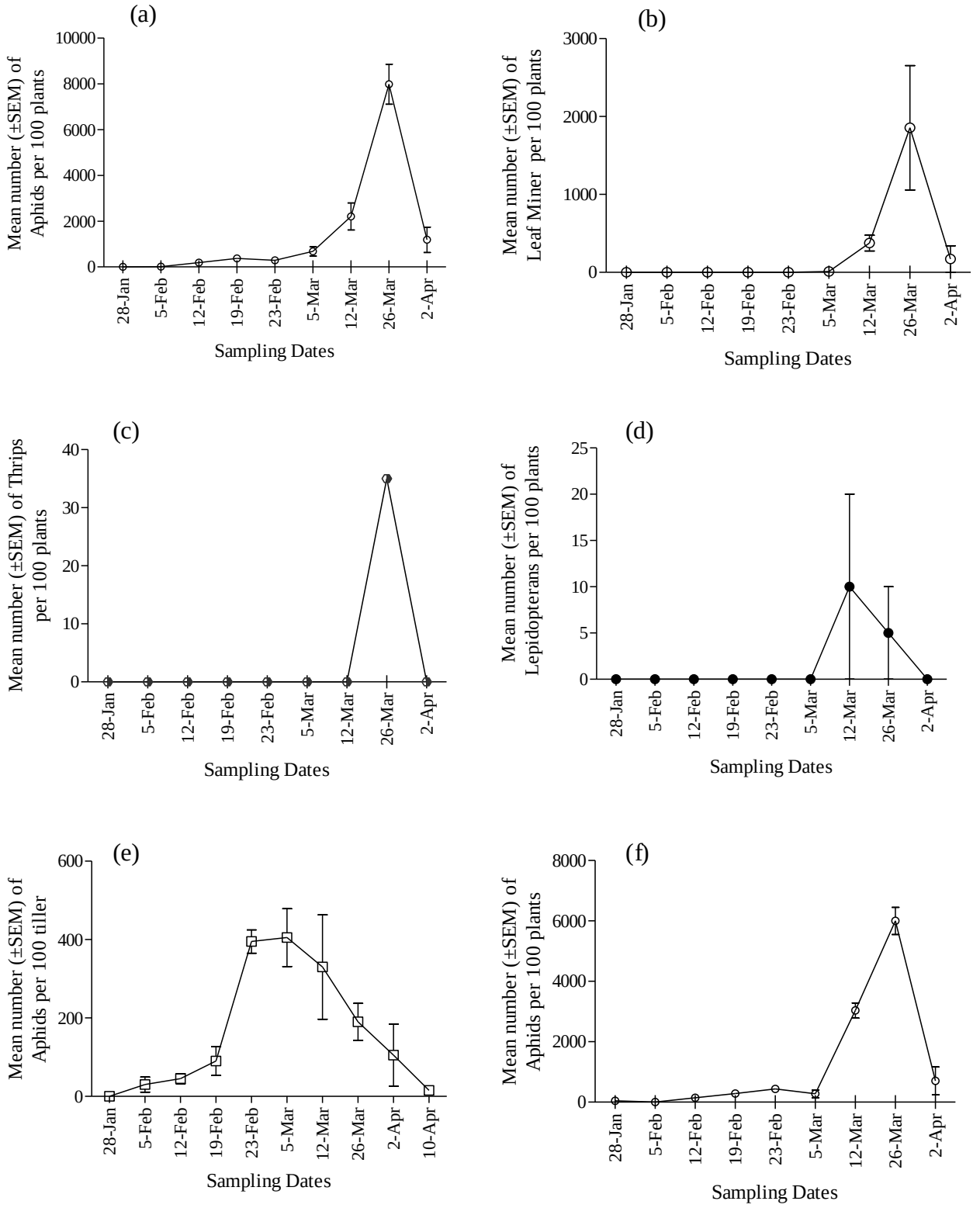

Fig. 4a. Mean number (± SEM) of population dynamics of insect pest aphids surveyed in end of 28th January to early 2nd April 2019 in pea (a) field per 100 plants. **Fig. 4b.** Mean number (± SEM) of population dynamics of insect pest agromyzids surveyed in end of 28th January to early 2nd April 2019 in pea (a) field per 100 plants. **Fig. 4c.** Mean number (± SEM) of population dynamics of predator thrips surveyed in end of 28th January to early 2nd April 2019 in pea (a) field per 100 plants. **Fig. 4d.** Mean number (± SEM) of population dynamics of lepidopterans surveyed in end of 28th January to early 2nd April 2019 in pea (a) field per 100 plants . **Fig. 4e.** Mean number (± SEM) of population dynamics of insect pest wheat aphids surveyed in end of 28th January to early 10th April 2019 in wheat (b) field per 100 tillers. **Fig. 4f.** Mean number (± SEM) of population dynamics of insect pest aphids surveyed in end of 28th January to early 2nd April 2019 in pea (c) field per 100 plants.

POPULATION DYNAMICS OF PEST THRIPS ON PEA (a)

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Pest thrips studied on Pea (a) in an open field survey under natural environmental conditions during different time interim in 2019. Thrips population dynamics studied per 100 plants during 9 weeks from 28th January to 2nd April. According to Fig. 4c, thrips population trend enhanced from 12 March to 26 March where population touched the peak point with mean number of thrips 35±30.31 per 100 plants. Population declined to zero on in last observation on 2nd April.

POPULATION DYNAMICS OF LEPIDOPTERANS ON PEA (a)

Lepidopterans studied on pea (a) in an open field survey under natural environmental conditions during different time interim in 2019. Lepidopterans population dynamics studied per 100 plants during 9 weeks from 28th January to 2nd April. According to Fig. 4d, population of lepidopterans was 1st observed in pea (a) field on 5th March in summer where the population of lepidopterans was near about zero and suddenly raised to peak point where the mean number of moth was 10±8.66 per 100 plants on 12th March. Mean number of lepidopterans declined to 5±4.33 on 26th March and immediately dropped to zero in last observation on 2nd April.

POPULATION DYNAMICS OF WHEAT APHIDS ON WHEAT (b)

Wheat aphids studied on wheat (b) in an open field survey under natural environmental conditions during different time interim in 2019. Wheat aphids population dynamics studied per 100 tillers during 10 weeks from 28th January to 10th April. According to Fig. 4e, wheat aphids population tend to increase continuously in spring from 28 January to 19 February with mean number of wheat aphids from 0 to 90±32.02 per 100 tillers. Wheat aphids population was observed at higher level as 2nd peak on 23 February with mean number of aphids population 395±25.86 per 100 tillers on the other hand 1st highest peak was noticed on 5 March with 405±63.79 per 100 tillers. Population continued to decline from 1st highest peak till 10 April in the same pattern with mean number of aphids population 15±4.33 per 100 tillers.

POPULATION DYNAMICS OF PEA APHIDS ON PEA (C)

Pea aphids studied on Pea (c) in an open field survey under natural environmental conditions during different time interim in 2019. Pea aphids population dynamics studied per 100 plants during 9 weeks from 28th January to 2nd April. In Fig. 4f, lower pea aphids' population was observed in spring to summer from 28th January to 5 March with continuous increase with mean number of pea aphids 40±14.14 to 275±111.66 per 100 plants. 1st highest peak of pea aphids population was observed on 26th March which tend to increase from 5th March with mean number of pea aphids 6000±388.780 per 100 plants. Population of pea aphids fell down from peak point all of sudden on 2nd April with mean number of pea aphids 705±399.02 per 100 plants. All in all, population dynamics of pea aphids varied due to sampling dates.

POPULATION DYNAMICS OF AGROMYZIDS (LEAF MINER) ON PEA (C)

Agromyzids studied on Pea (c) in an open field survey under natural environmental conditions during different time interim in 2019. Agromyzids population dynamics studied per 100 plants during 9 weeks from 28th January to 2nd April. According to Fig. 5a, agromyzids population was observed lowest from 19th February to 5th March with mean number of agromyzids 5±4.33 to 5±4.33 per 100 plants. Population continues to increase till 26 March representing the highest peak with mean number of agromyzids 1410±76.32 per 100 plants. Population of agromyzids dropped to 865±362.72 per 100 plants on 2nd April in summer.

POPULATION DYNAMICS OF PREDATORS ON PEA AND WHEAT (CONTROL ZONE)

Coccinellids studied on pea in an open field survey under natural environmental conditions during different time interim in 2019. Coccinellids population dynamics studied per 100 plants during 9 weeks from 28th January to 2nd April. According to Fig. 5b, coccinellids population was 1st observed in end of spring 23 February and reached to higher point indicating 1st peak in summer on 5 March with mean number of

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coccinellids was 0±0 to 20±17.32 per 100 plants. All of sudden population dropped to 5±4.33 per 100 plants on 12 March. Population again increased to highest point indicating 2nd peak on 26 March with mean number of coccinellids was 50±28.78 per 100 plants and from here population dropped to zero on 2nd April.

POPULATION DYNAMICS OF COCCINELLIDS ON WHEAT

Coccinellids studied on pea in an open field survey under natural environmental conditions during different time interim in 2019. Coccinellids population dynamics studied per 100 tillers during 10 weeks from 28th January to 10th April. According to Fig. 5c, population of lady beetles was observed in summer on 12 March and reached at its peak point on 26 March having the mean number of coccinellids 45±28.61 per 100 tillers and dropped to zero on 2nd April. All in all, population dynamics of coccinellids varied due to sampling dates.

POPULATION DYNAMICS OF SYRPHIDS ON WHEAT

Wheat syrphids studied on wheat in an open field survey under natural environmental conditions during different time interim in 2019. Syrphids population dynamics studied per 100 tillers during 10 weeks from 28th January to 10th April. According to Fig. 15d, population of syrphids was nil from 28 January spring to 12 March. All of sudden population was enhanced and reached to the peak point on 26 March indicating the highest population of syrphids, here the mean number of syrphids was15±8.92 per 100 tiller. The population of syrphids declined to entirely zero on 2nd April of summer.

POPULATION DYNAMICS OF PARASITIZED APHIDS ON WHEAT

Population dynamics of parasitized aphids was studied on Pea (*Pisum sativum*) in an open field survey under natural environmental conditions during different time interim in 2019. Parasitized aphid population dynamics studied per 100 tillers during 9 weeks from 28th January to 10th April. According to Fig. 5e, parasitized aphid was 1st observed in summer on 26th March and reached to the highest point on 2nd April with the mean number of parasitized aphids 60±30.82 per 100 tillers. Population of parasitized aphids was dropped to lower number on 10 April from peak point with mean number of parasitized aphids 10±8.66 per 100 tillers.

COMPARISON OF POPULATION DYNAMICS OF INSECT PEST ON PEA-WHEAT TRAP CROP

According to Fig. 5f, population dynamics of pea and wheat aphids were compared in trap crop (Pea (a), Wheat (b) and Pea (c), during late spring from 28th January to summer 10th April in 2019. From the graph, it could be concluded that aphid's population was lower in initial dates of observation, then sudden rise in population occurred in summer season in both pea (a) and (b). While the population of aphids was lower in wheat as compared to pea blocks during the entire sampling dates.

Population dynamics of aphids in Pea (a) and (c) and Wheat (b) were nil from 28th January in spring till 5th February. Immediately population enhanced from middle of 5th February in Pea (a) with mean number of aphids 15±4.33 per 100 plants which continued to enhance till 12th March with mean number of aphids 2205±510.75 per 100 plants, while, aphids population on pea (c) also enhanced from 28th January with mean number of aphids 40±14.14 per 100 plants and continued to enhance till 12th March with mean number of aphids population 3035±215.56 per 100 plants in same pattern. On the other hand, wheat (b) aphids population increased from 5th February in spring with mean number of aphids population 30±16.25 per 100 tillers which continue to enhance till 5th March in summer with mean number of aphids 405±63.79 per 100 tillers and from here population continued dropped to zero till 10 April in last observation. Aphids population was found on highest peak as compared to Pea (c) with mean number of aphids 7980±758.78 per 100 plants on 26th March while in pea (c), highest peak was also found on 26th March with mean number of aphids 6000±388.78 per 100 plants. Aphids population in both pea (a) and (c) dropped to April 2nd 1185±48 and 705±399.02 per 100 plants. Population of aphids remained lowered in wheat (b) while remain highest in pea (a) and higher in pea (c).

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COMPARISON OF POPULATION DYNAMICS OF COCCINELLIDS ON PEA-WHEAT TRAP CROP

According to Fig. 5g, population dynamics of pea and wheat coccinellids were compared in trap crop (Pea (a), Wheat (b) and Pea (c)), during late spring from 28th January to summer 10th April in 2019. It could be concluded that aphids population was lower in initial dates of observation, then sudden raised in population occurred in summer season in both pea (a) and (b). While the population of aphids was lower in wheat as compared to pea blocks during the entire sampling dates. By having the detailed analysis of the graph, it was concluded that the population of the coccinellids was nil in the early dates of sampling in both trap crop of pea (a) and pea (c) started from 28th January till 5th March. Sudden rise in the population of the aphids occurred in the 5th March, slight decline occurred on 12th March with number 10±5 on pea (a). On the other hand, wheat (b) population started to enhance from 28th January with mean number of coccinellids 15±8.29 and continued to decline till 12th March which indicated the lowest population. While on pea (c), population started to increase from 5th March and reached to its peak point on 12th March with mean number of coccinellids population 25±4.33. Pea (a) achieved the highest population of coccinellids on 26th march with mean number 30±16.58 and population started to decline to lowest level on 6th April. Wheat (b) population again enhanced from 12th March and reached to peak point on 26th March 55±19.20 mean number of coccinellids and declined to lowest level to 6th April. Population of coccinellids sudden declined on 26th March to 10±8.66 and this population maintained till 6th April, while the total number of (Insect pests and natural enemies) per 100 tillers and plants observed in the Wheat-Pea field during the growing season 2019 shown in Table I.

Table I. Total number of Insects (Insect pests and natural enemies) per 100 tillers and plants observed in the Wheat-Pea field during the growing season 2019

Guild	Insects	2019	Percentage % 2019
Insect Pests	Aphids	171740	86.14
	Agromyzids	25940	13.01
	Lepidopterans	80	0.04
	Thrips	140	0.07
	Coccinellids	1100	0.5
Natural Enemies	Syrphids	80	0.04
	Parasitized Aphids	280	0.14
	Others	20	0.01
	Total Sum	199380	100

POPULATION ABUNDANCE OF INSECTS PEST APHIDS IN TRAP CROP

Population abundance of insect pest aphids studied on pea (a) wheat (b) and pea (c) in an open field survey under natural environmental conditions during different time interim in 2019. Aphids' population abundance studied per 100 plants for 10 weeks. Aphids was abundantly found in pea (a) associated with mean number of 1400 per 100 plant, pea (c) have mean number of aphids 1300 per 100 plant, and wheat (b) have small population of aphids with mean number of aphids 200 per 100 tillers. Population abundance of aphids was highest in pea (a) as compared to pea (b) and lowest in wheat (c) as shown in Fig. 5h.

POPULATION DENSITY OF INSECT PEST IN PEA (a)

Pests studied on pea (a) within trap crop in an open field survey under natural environmental conditions during different time interim in 2019 which had indicated the highest mean number of aphids indicated ±1400 while agromyzids ±350. Population of thrips was lowest in comparison with aphids and agromyzids as shown in Fig. 5i. The Population of lepidopterans is after the coccinellids with mean number ±3 per 100 plants considered as the lowest.

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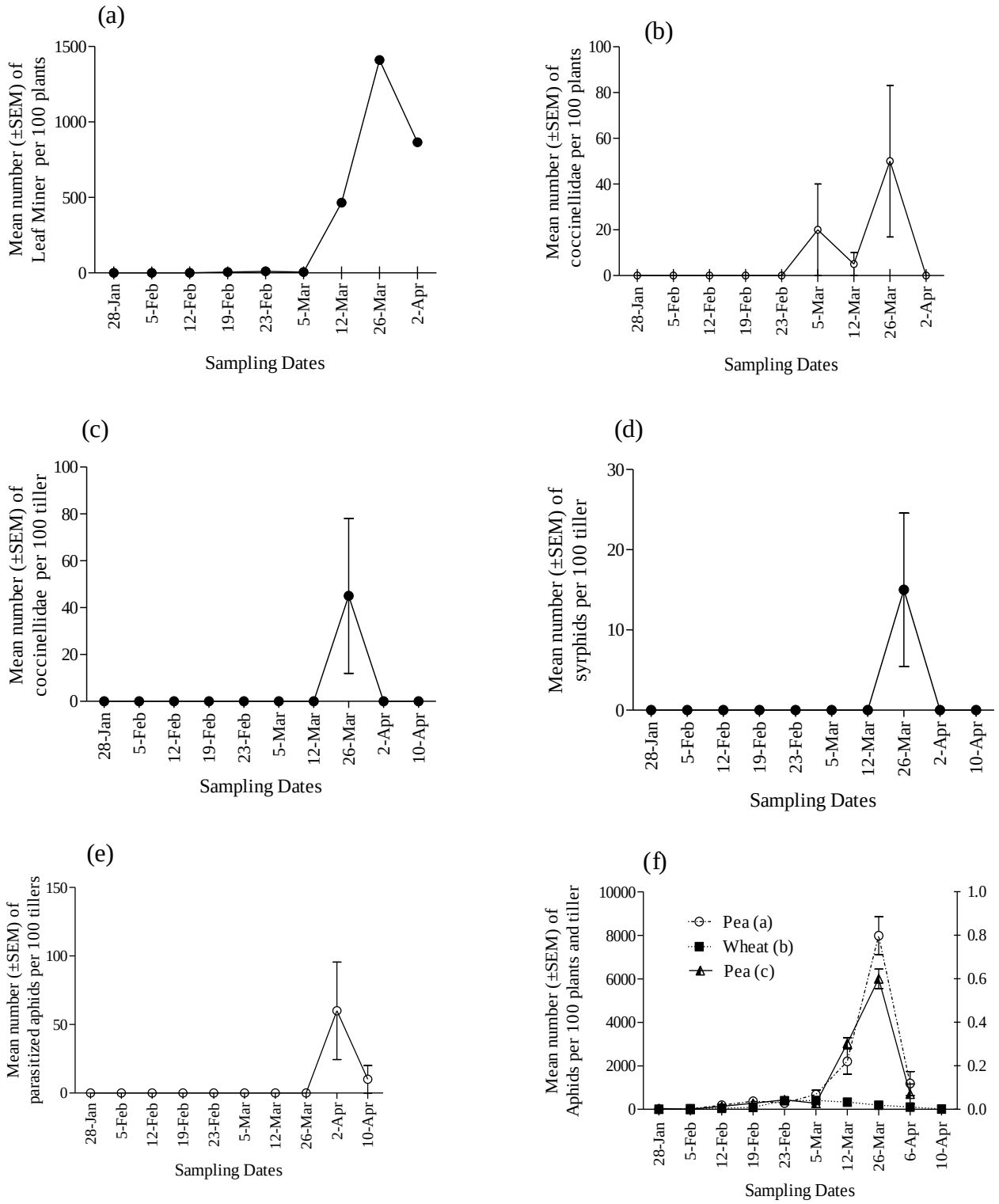
POPULATION DENSITY OF NATURAL ENEMIES IN PEA (a)

The Natural enemies studied on pea (a) within trap crop in an open field survey under natural environmental conditions during different time interim in 2019 which had indicated the highest population of the coccinellids ±8 per 100 plants indicated the mean number as shown in Fig. 5j. The Population of parasitized aphids and other natural enemies has the lowest population.



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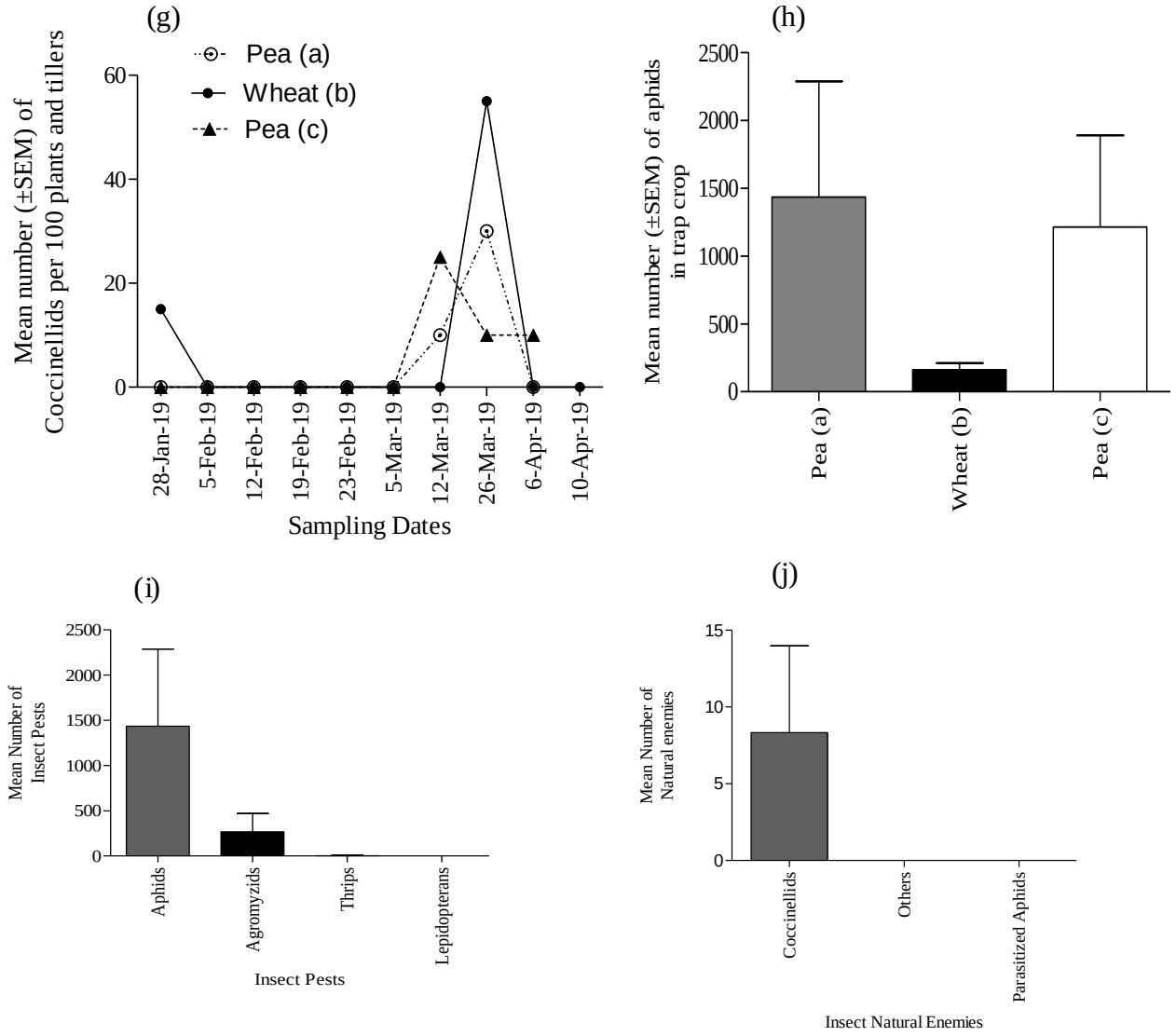

Fig. 5a. Mean number (± SEM) of population dynamics of insect pest agromyzids surveyed in end of 28th January to early 2nd April 2019 in pea (c) field per 100 plants. **Fig. 5b.** Mean number (± SEM) of population dynamics of predator coccinellids surveyed in end of 28th January to early 2nd April 2019 in pea field per 100 plants. **Fig. 5c.** Mean number (± SEM) of population dynamics of predator coccinellids surveyed in end of 28th January to early 10th April 2019 in wheat field per 100 tillers. **Fig. 5d.** Mean number (± SEM) of population dynamics of predator syrphids surveyed in end of 28th January to early 10th April 2019 in wheat field per 100 tillers. **Fig. 5e.** Mean number (± SEM) of population dynamics of parasitized aphids surveyed in end of 28th January to early 10th April 2019 in wheat field per 100. **Fig. 5f** Mean number (± SEM) of population dynamics of insect pest aphids surveyed in end of 28th January to early 10th April 2019 in Pea (a) and (c) and Wheat (b) trap crop per 100 plants and tillers. **Fig. 5g.** Mean number (± SEM) of population dynamics of insect predator's coccinellids surveyed in end of 28th January to early 10th April 2019 in pea (a) and (c) and wheat (b) trap crop per 100 plants and tillers. **Fig. 5h**. Mean number (± SEM) of population abundance of insect pest aphids surveyed in 10 weeks in 2019 in pea (a), wheat (b) and pea (c) trap crop per 100 plants and tillers. **Fig. 5i.** Mean number (± SEM) of population density of insect pests surveyed in 10 weeks in 2019 in pea (a) per 100 plants. **Fig. 5j.** Mean number (± SEM) of population density of natural enemies surveyed in 10 weeks in 2019 in pea (a) per 100 plants

DISCUSSION

The aphids are recognized as the important pests of the chief crop especially wheat. Wheat is considered as the chief crop as the increasing demand of food relays on wheat. Trap crops are regarded as the fundamental aspect to lower down pest population among the major crops (22). Most devastating damage caused to the crop are by the aphids, as already mentioned, to lower pest population in wheat by using the pesticides and weedicides will add more contamination to ecosystem as well as to the human health. Main purpose of planting the trap crop is to lower the aphid population by cultivating another crop which is much more attractive to the pests for foraging purpose (23). The research is based on the assessment of peas in the trap crop that it rather acts as alluring agent to the pests in wheat ecosystem. Main objectives of the trial was the determination of natural abundance of aphids in pea and wheat ecosystem,

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population abundance of predators in peas-wheat and comparison of abundance of natural enemies and aphids in pea and wheat ecosystem. Having overview of trial results, demonstrated that peas were responsible for the lowering the aphid population in wheat without using insecticides and weedicides and peas also responsible for attracting more predators due to higher population of aphids as compared to wheat. It was concluded that aphids and natural enemies had the higher population in peas as compared to wheat.

Natural abundance of aphids in peas and wheat ecosystem was determined in the trap crop which had indicated the lower population of the aphids in wheat as compared to Peas according to Figure 20 and results indicated that natural abundance of Aphids in peas was 937.83 and wheat was 54.77 in control while in experimental zone aphid mean number population in peas and wheat was 1147.56 and 63.79 respectively indicated that aphid population was lower in wheat as compared to peas. Similarly, it was described that aroma from healthy seedlings of maize were proved to be more attracted to leafhopper, Cicadulina storey China as compared to the fragrance from C. storeyi-infested seedlings (24). On determination of the physiological behavior, VOCs from *C. storeyi* attacked tiny plant such as methyl salicylate, (E) caryophyllene, and (E)-β-farnesene proved as resistant to *C. storeyi*. While tests indicated that various VOCs emitted by herbivore-induced plants especially at night duration are significantly deter female lepidopterans from *Heliothis virescens* (25,26). On same lines, research was carried out for on what basis aphid population was abundant on peas as compared to other main crop. It was concluded that peas acted as the strong obstacle and inhibit passage of cereal aphids around the wheat crops. Peas and wheat ejected the volatile compounds that inhibit the signals for both pea and wheat infesting aphids, and this caused the alternations in the aphid's behavior to identify the host plant (27).

Population abundance of predators was determined in peas and wheat which indicted the higher population was observed in wheat as compared to the peas according to figure 4.23 and the research results indicated that population abundance of predators with mean number in control peas was 33.05 and wheat had 67.72 while in experimental zone 8.66 in peas and in wheat 82.99 attacking aphids in peas and wheat ecosystem. Indicated that natural enemies were abundant in wheat as compared to peas. Root's hypothesis on natural enemies, predator population is more abundant in polycultures and hence proved to be highly beneficial to polycultures as compared to the monocultures (28). On the basis of findings that intercropping plants natural surroundings the executives methodology can be fascinating to diminish aphid population and increment aphidophagous beneficials. While the trap crop of wheat and peas, with or without affiliated to aphid species, enhanced the number of adaptation and oviposition of *E. balteatus* females and proved beneficial in reducing the desirability of *S. avenae*. Results from conducted measures were steady with those from the field preliminary, supporting that wheat-pea affiliations are an effective instrument for aphid biological control. Thus, this can be concluded that various methods are needed to employ the utilization of insecticides in agro ecosystem. Aphid and predator population abundance was determined in both peas and wheat ecosystem as a trap crop, results indicated that aphid population was observed greater in peas as compared to wheat according to Figure 21 and predator population abundance was greater in wheat as compared peas according to Figure 22 Comparison of abundance of natural enemies and aphids in peas and wheat indicated the highest abundance of aphids was found in peas and natural enemies were in wheat. This comparison indicated that peas were attracted for the aphids as compared to wheat thus lowering the aphid population. Coccinellids was found in higher number in peas and wheat as a trap crop in late stages of development as compared to early stages of growth. Herbivore-induced plant volatiles are additionally significant foraging signals for predators (29). The lacewings, hoverflies and ladybird beetles were abundant and improved when pea were accompanied with wheat. This could mostly clarify why the populaces of grain and pea aphids were both diminished essentially when contrasted with monocultures. Moreover various physical obstacles and visual camouflage of the main crop has added in reduction of aphids in wheat-pea trap crop. While other related trials have indicated that cultivating peas in rows among wheat can significantly lower the population of *S. avenae* and increased the natural enemies. Another research indicated that wheat and pea when employed as the intercrop not only preserved but enhanced the predator

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and parasitoid populations like ladybeetle and braconid wasps (30). Another research represented that, ladybirds, their increased population go hand in hand with the appearance of *Acyrthosiphon pisum* on pea plants. Around then, this species was the main food source, and no elective prey was accessible to wheat tillers in the mix and strip cropping conditions (31).

CONCLUSION

In conclusion this research showed that peas can effectively reduce the number of aphids in primary crops without the use of pesticides and supports the body of knowledge on trap crops in integrated pest management. Thus, it is proved that peas are beneficial in reducing aphid population from main crop without aid of pesticides, thus on the basis of present research underpin the existing knowledge on Trap crop in IPM

Authors Contribution:

FKC & BK conducted the experimental work; PK collected the data; AH & FL prepared the draft of the manuscript; SS analyzed the data; ASUD conceived this study and checked the final draft.

Conflict of interest:

Authors have no conflict of interest.

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