

Insect Biodiversity in Different Varieties of Linseed

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Abstract:

The experiment was conducted during winter season 2015 on experimental field of Oil Seed Section, Agriculture Research Institute, Tandojam. Linseed varieties namely L-42.8, B-5656, 11.106, Faisalabad, Munkusmil, Alsi-90 were cultivated on an area of 108 square meter. RCBD layout was maintained with 4 replications. The

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population counts of insects were made from January 23, 2015 to February 26, 2015. The results show that out of 15 insect species, 8 insect species were pests and 7 were pollinators and predators. The total number of insets found was 21132 out of which gall-midge, thrips and army worm were 3427, 1653 and 1356, respectively. Maximum number of insects was found on variety L-42.8 (2935) followed B-5656 (2897). While, variety 11.106, Faisalabad, Munkusmil and ASLI-90 had 2635, 2431, 2099 and 1699 insects, respectively. Diversity, diversity maximum, species richness and species evenness were calculated weekly by using Shannon-Weiner diversity index. During observations, the diversity (H) remained same as (1.79). However, diversity maximum and maximum evenness was calculated as ($H' = 0.06$) and ($J' = 0.03$), respectively on 23-01-2015. Whereas, maximum richness ($D = 0.96$) was recorded on 09-02-2015. All pests were found active throughout the cropping season.

Key words: Insects biodiversity, varieties, richness, evenness, agroecosystem, Linseed crop

INTRODUCTION:

In Pakistan the agriculture plays a vital role and still it remains the largest contributor in the economics of the Pakistan about 25.6% of the GDP and employing 44% of the labor force. (GOP, 2014). For this purpose many crops are cultivated round the year. Linseed crop is one of them. Linseed (*Linumu sitatissimum* L.) known locally as "ALSI" is the growth of fiber and oil plants in winter every year. It is also known as linseed. It has been grown for thousands of years (Genser & Morris, 2003). It is grown as a commercial crop or survival in more than 30 countries (Marchenkov *et al.*, 2003). It has a high concentration of linolenic acid (50%), which makes it highly susceptible to oxidation oils. Linseed is generally considered to be a self-fertile and self-pollinated crop but owing to the structure and mechanism of the flowers, cross pollination

to varying percentage, have been observed (Sundararaj and Thulasidas, 1993). Species richness and biomass of terrestrial insects constitute a considerable proportion of ecosystem functions and play a significant role (McGeogh, 1998). Although the number of insect species described are uncertain, due to the lack of a global list of synonyms and most authorities recognize the species 900000-1000000 named form inside, on behalf of all known species on Earth 56% (Anon, 2003). A reasonable estimate of the number of insect species have not been found to range from five million to 30 million species, in the basis molecular marker (Odegaard, 2000). Agricultural ecosystems, including a large proportion of the world's biodiversity (Pimentel *et al.*, 1992). For this reason, insects that inhabit agricultural land can be used as indicators of the disturbance associated with these environments. Insects are often used as a biological indicator species for monitoring and detecting changes in the environment. It is possible through the use of biological indicators evaluated, instead of checking the influence of the entire biota human activities. Particularly useful it is to provide early warning of changes in species (Spellerberg, 1993). Insects are the most commonly occurring herbivores, carnivores, scavengers and pollinators of many agricultural and horticultural crops. In ecology, a new idea is that stability in the function of natural ecosystems and multitrophic community directly affects plant diversity. Plant species diversity may strongly impact on the abundance and distribution of other creatures, in order to increase the number of plant species, promote individual herbivorous and predatory arthropod species diversity in higher (Memon, 2011). Biological often broadly defined as the presence of different forms of plants, animals and micro-organisms, they appear at that level (for example, species, populations and ecosystems) and different ways of living, climate and geology combined to form ecological functions system. Of which about 1.8 million species have been

named and described the existing, ten thousand insects (May 2002). Insects are ubiquitous in the environment, play an important role through the part of the food chain, and maintain the stability of the ecosystem, mediation decomposition process, through a variety of ecological relationships, such as pollination, predation and feeding. Large-scale human activities such as deforestation eliminate insect species, destruction of the ecological system dynamics and interaction has been used for thousands of years. According to another estimate, invertebrates representing more than 90% of the Earth about 10 million animal species (Erwin 1983, Wilson, 1992). Biodiversity variety of life on Earth, by providing vital goods and services directly and indirectly contribute to human well-being and survival on this planet (Palmer *et al.*, 2004). Biodiversity is the variation of life. In agro-ecosystems, biodiversity is often a measure of the relative number of types exist organisms. When considering the impact on biodiversity of a system, the two concepts are particularly important consideration: the stability and productivity (Schowalter, 2006). Most agricultural ecosystems tend to be highly disturbed. Like plowing, planting, fertilizing, pesticides, irrigation, harvesting and common practice may lead to changes in ecosystem functions under ambient conditions is temporary or more lasting change (Altieri *et al.*, 2005). Rich diversity of agricultural ecosystems get greater flexibility and, therefore, can more easily recover from stresses. When ecosystems are diverse, there are a range of ways to the major production and ecological processes, such as nutrient cycling, therefore, if one is damaged or destroyed, another way, you can use and ecosystems can continue to play a role in normal levels. The best evidence to date of species -rich ecosystems are more stable than species -poor ecosystems, it is possible by providing Tillman and Downing (1994). Diversity from local to global scale and different, and can be defined in many ways. Because

of the difficulty of learning the invisible organisms in the soil matrix, diversity on the ground, especially the abundance of a number of measures, cannot easily use the underground. Although both species richness (number of species) and diversity (number of species and number), it is easy to measure the ground, until recently, the only species richness is most commendable underground creatures. Here, when the concept of diversity as a discussion will include the richness and diversity of the measures the two species. Plant and insect diversity patterns and changes in the latitudinal gradient. Latitudinal gradient in species diversity of a satisfactory explanation has not yet been identified, and can vary by group (De Deyn & Van der Putten, 2005). Climatic changes may also affect insect diversity and subsequently Threaten ecosystems, such as crop pollination or natural enemies of pests and diseases prevention and treatment services provided. These changes not only affect insects and plants, and the overall interaction between natural and agricultural ecosystems (Theurillat & Guisan, 2001). Since insects are playing importance role in maintaining various ecosystem. Therefore present study will be carried out to determine the role of different insects in a agro-ecosystem of linseed. The study will also ascertain insect interaction with one another as pollinators, predators, parasitoids, herbivores and scavengers. Beside that their biodiversity, diversity maximum, species eveners and richness will also be ascertained. The information gained through the study will be utilized in developing IPM strategies against helpful and harmful insect with in linseed agro-ecosystem. The objectives of the research experiment is to evaluate insect species and their role in linseed crop and to evaluate diversity, diversity maximum, species evenness and species richness in agro ecosystem of linseed.

MATERIALS AND METHODS

The experiment was conducted during winter season 2015 on experimental field of Oil Seed Section, Agriculture Research Institute, Tandojam. A field of 108 square meter was selected to conduct the experiment. CRBD layout was mentioned with 6 varieties and 4 replications. The varieties cultivated were:

V1 = L-42.8

V2 = B-5656

V3 = 11.106

V4 = Faisalabad

V5 = Munkusmil

V6 = ALSI-90

Periodical observations on the population of different insects were taken at weakly intervals for this purpose on 50 plants, were which randomly selected and tagged. Meanwhile, an iron frame was also placed at 5 different places on soil in each sub plot. Insects present within the frame were counted and recorded at species level. Periodic and phonological insect diversity was ascertained. Influence of abiotic and biotic factors of the environment on insect diversity was also ascertained. The insect species were found in the linseed field were identified at species level. Methodological data were recorded during course of the study. Shannon biodiversity indices were used to determine diversity parameters. The data thus collected was subjected to statistical analysis to derive conclusion of the research work.

RESULTS

The population of different insects (pests pollinator and predators) belonging to different orders was recorded from January to February, 2015. The collected insects were

bellowing to orders Diptera, Lepidoptera, Hemiptera, Thysanoptera and Homoptera. The details of insects species their taxonomic status is given in Table-1 and seasonal population abundance of insect species of different orders is presented in Table 2-7.

Table-1: Taxonomic position and status of insects collected from linseed Insect biodiversity at Tandojam during January to February, 2015

Common name	Technical name	Family	Order	Status
Gall-midge:	<i>Orseolia oryzae</i> , Wood-Mason	Cecidomyiidae	Diptera	Pest
Army worm	<i>Spodoptera frugiperda</i> , JE Smith	Noctuidae	Lepidoptera	Pest
Mirid bug	<i>Creontiades biseratense</i> , Distant	Capsidae	Hemiptera	Predator
White fly	<i>Bemisia tabaci</i> , Genn.	Aleyrodidae	Hemiptera	Pest
Jassids	<i>Amrasca biguttula</i> , Ishida	Cicadellidae	Homoptera	Pest
Stink bug	<i>Halyomorpha halys</i> , Stål	Pentatomidae	Hemiptera	Predator
Thrips	<i>Thrips tabaci</i> , Lind	Thripidae	Thysanoptera	Pest
Cotton Aphid	<i>Aphis gossypii</i> , Glover	Aphididae	Homoptera	Pest
Green lacewing	<i>Chrysoperla carnea</i> , Stephens	Chrysopidae	Neuroptera	Predator
Minute pirate bug	<i>Orius insidiosus</i> , Say	Anthicoridae	Hemiptera	Predator
Seven spotted beetle	<i>Coccinella septempunctata</i> , L.	Coccinellidae	Coleoptera	Predator
Zigzag beetle	<i>Cheilomenes sexmaculata</i> , Fabricius	Coccinellidae	Coleoptera	Predator
Apis flora	<i>Apis mellifera</i> , L.	Apidae	Hymenoptera	Pest
Bumble bee	<i>Bombus terrestris</i> , L.	Apidae	Psithyrus	Predator
White-tailed bumblebee	<i>Bombus lucorum</i> , L.	Apidae	Hymenoptera	Pest

DIFFERENT INSECTS ON LINSEED OF L-42.8 VARIETY

The data in Fig 1 and 2 depict that gall midge were recorded on linseed L-42.8 variety from 23-01-2015 with initial mean population 2.80% to 26-02-2015 with a population of 4.07% per plant. It maximum population 4.93% was recorded on 09-02-2015 during the course studies with overall average was found 3.65 ± 0.77 . Similarly, army worm were 23-01-2015 with initial mean population 1.07% to 26-02-2015 with a population of 1.40% per plant. It maximum population 2.33% was recorded on 02-02-2015 with overall average was 1.65 ± 0.41 . The mired bug was 23-01-2015 with initial mean population 1.13% to 26-02-2015 with a population of 1.07% per plant. It maximum population 2.60% was recorded on 02-02-2015 with overall average was 1.60 ± 0.47 . Similarly, whitefly, jassids, sting bug, thrips and cotton aphid from 23-01-2015 with initial mean population 1.73, 1.40, 1.13, 2.13% and 2.00 to 26-02-2015 with a population of 1.28, 1.05, 0.98, 1.76 and 1.45% respectively, with overall averages and standard errors were 1.28 ± 0.52 , 1.05 ± 0.42 , 0.98 ± 0.45 , 1.76 ± 0.84 and 1.45 ± 0.82 respectively.

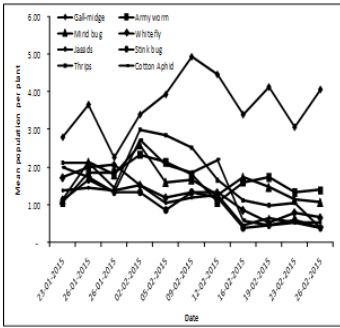


Fig. 1: Mean population per plant of Gall-midge, Army worm, Mirid bug, White fly, Jassids, Stink bug, Thrips and Cotton Aphid L-42.8 variety of linseed

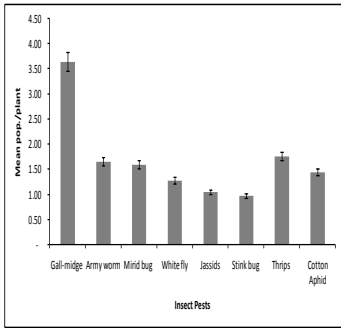


Fig. 2: Overall mean population per plant of Gall-midge, Army worm, Mirid bug, White fly, Jassids, Stink bug, Thrips and Cotton Aphid L-42.8 variety of linseed

DIFFERENT PREDATORS ON LINSEED OF L-42.8 VARIETY

The data in Fig 3 and 4 depict that green lacewing were recorded on linseed L-42.8 variety from 23-01-2015 with initial mean population 1.20% to 26-02-2015 with a population of 0.53% per plant. It maximum population 1.47% was recorded on 12-02-2015 during the course studies with overall average was found 0.88 ± 0.49 . Similarly, minutes pirate bug were 23-01-2015 with initial mean population 1.67% to 26-02-2015 with a population of 0.67% per plant. It maximum population 1.67% was recorded on 23-01-2015 with overall average was 0.92 ± 0.37 . The seven spotted beetle was 23-01-2015 with initial mean population 1.27% to 26-02-2015 with a population of 1.07% per plant. It maximum population 1.27% was recorded on 26-01-2015 with overall average was 0.70 ± 0.43 . Similarly, zigzag beetle, apis flora, bumble bee and white tailed bumble bee from 23-01-2015 with initial mean population 1.20, 1.20, 1.13 and 1.20 to 26-02-2015 with a population of 1.00, 0.40, 0.07 and 0% respectively, with overall averages and standard errors were 0.52 ± 0.52 , 0.40 ± 0.41 , 0.42 ± 0.41 and 0.52 ± 0.44 respectively.

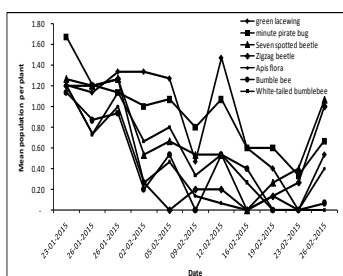


Fig. 3: Mean population per plant of green lacewing, minute pirate bug, seven spotted beetle, zigzag beetle, Apis flora, Bumble bee and white-tailed bumblebee L-42.8 variety of linseed

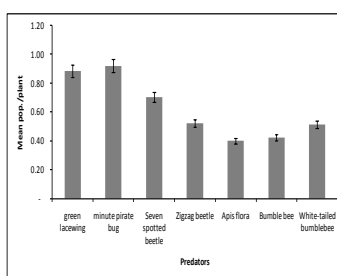


Fig.4: Overall mean population per plant of green lacewing, minute pirate bug, seven spotted beetle, zigzag beetle, Apis flora, Bumble bee and white-tailed bumblebee L-42.8 variety of linseed

DIFFERENT INSECTS ON LINSEED OF B-5656 VARIETY

The data in Fig 5 and 6 depict that gall midge were recorded on linseed B-5656 variety from 23-01-2015 with initial mean population 3.40% to 26-02-2015 with a population of 4.93% per plant. It maximum population 4.93% was recorded on 26-02-2015 during the course studies with overall average was found 4.01 ± 0.79 . Similarly, army worm were 23-01-2015 with initial mean population 2.00% to 26-02-2015 with a population of 1.40% per plant. It maximum population 2.47% was recorded on 26-02-2015 with overall average was 1.70 ± 0.47 . The mired bug was 23-01-2015 with initial mean population 2.27% to 26-02-2015 with a population of 1.07% per plant. It maximum population 2.60% was recorded on 26-01-2015 with overall average was 1.53 ± 0.55 . Similarly, whitefly, jassids, sting bug, thrips and cotton aphid from 23-01-2015 with initial mean population 1.80, 1.33, 1.53, 2.20% and 1.80 to 26-02-2015 with a population of 0.73, 0.53, 0.60, 0.67 and 0.85% respectively, with overall averages and standard errors were 1.21 ± 0.42 , 1.00 ± 0.40 , 0.98 ± 0.38 , 1.56 ± 0.67 and 1.32 ± 0.61 respectively.

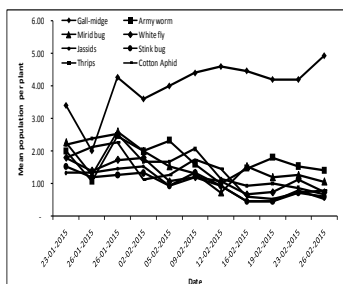


Fig. 5: Mean population per plant of Gall-midge, Army worm, Mirid bug, White fly, Jassids, Stink bug, Thrips and Cotton Aphid B-5656 variety of linseed

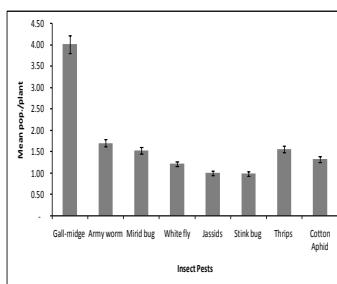


Fig. 6: Overall mean population per plant of Gall-midge, Army worm, Mirid bug, White fly, Jassids, Stink bug, Thrips and Cotton Aphid B-5656 variety of linseed

DIFFERENT PREDATORS ON LINSEED OF B-5656 VARIETY

The data in Fig 7 and 8 depict that green lacewing were recorded on linseed B-5656 variety from 23-01-2015 with initial mean population 1.53% to 26-02-2015 with a population of 0.73% per plant. It maximum population 1.53% was recorded on 23-01-2015 during the course studies with overall average was found 0.84 ± 0.43 . Similarly, minutes pirate bug were 23-01-2015 with initial mean population 1.67% to 26-02-2015 with a population of 0.93% per plant. It maximum population 1.67% was recorded on 23-01-2015 with overall average was 0.92 ± 0.45 . The seven spotted beetle was 23-01-2015 with initial mean population 1.33% to 26-02-2015 with a population of 0.67% per plant. It maximum population 1.33% was recorded on 23-02-2015 with overall average was 0.64 ± 0.40 . Similarly, zigzag beetle, apis flora, bumble bee and white tailed bumble bee from 23-01-2015 with initial mean population 1.20, 0.93, 1.13 and 0.80 to 26-02-2015 with a population of 0.33, 0, 0 and 0.07% respectively, with overall averages and standard errors were 0.54 ± 0.38 , 0.45 ± 0.38 , 0.45 ± 0.37 and 0.43 ± 0.36 respectively.

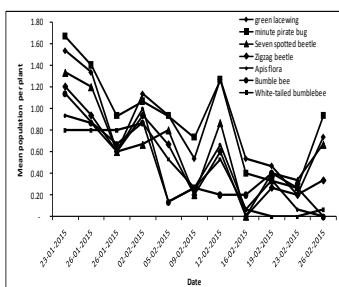


Fig. 7: Mean population per plant of green lacewing, minute pirate bug, seven spotted beetle, zigzag beetle, Apis flora, Bumble bee and white-tailed bumblebee B-5656 variety of linseed

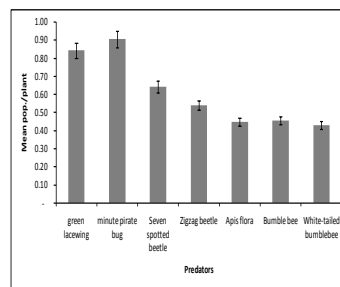


Fig. 8: Overall mean population per plant of green lacewing, minute pirate bug, seven spotted beetle, zigzag beetle, Apis flora, Bumble bee and white-tailed bumblebee B-5656 variety of linseed

DIFFERENT INSECTS ON LINSEED OF 11.106 VARIETY

The data in Fig 9 and 10 depict that gall midge were recorded on linseed 11.106 variety from 23-01-2015 with initial mean population 1.87% to 26-02-2015 with a population of 4.20% per plant. It maximum population 4.80% was recorded on 12-02-2015 during the course studies with overall average was found 3.77 ± 0.92 . Similarly, army worm were 23-01-2015 with initial mean population 1.07% to 26-02-2015 with a population of 1.40% per plant. It maximum population 2.53% was recorded on 02-02-2015 with overall average was 1.64 ± 0.52 . The mired bug was 23-01-2015 with initial mean population 1.13% to 26-02-2015 with a population of 1.07% per plant. It maximum population 2.47% was recorded on 02-02-2015 with overall average was 1.44 ± 0.52 . Similarly, whitefly, jassids, sting bug, thrips and cotton aphid from 23-01-2015 with initial mean population 1.40, 1.20, 1.07, 2.40% and 2.07 to 26-02-2015 with a population of 0.63, 0.27, 0.47, 0.33 and 0.47% respectively, with overall averages and standard errors were 1.05 ± 0.44 , 0.84 ± 0.47 , 0.85 ± 0.41 , 1.62 ± 0.91 and 1.24 ± 0.72 respectively.

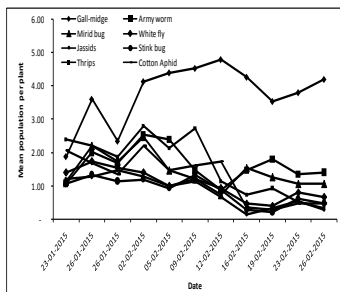


Fig. 9: Mean population per plant of Gall-midge, Army worm, Mirid bug, White fly, Jassids, Stink bug, Thrips and Cotton Aphid 11.106 variety of linseed

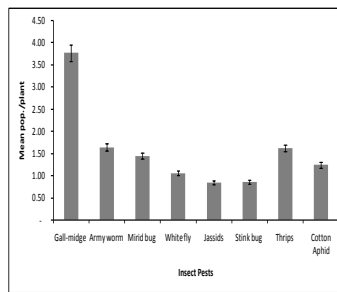


Fig. 10: Overall mean population per plant of Gall-midge, Army worm, Mirid bug, White fly, Jassids, Stink bug, Thrips and Cotton Aphid 11.106 variety of linseed

DIFFERENT PREDATORS ON LINSEED OF 11.106 VARIETY

The data in Fig 11 and 12 depict that green lacewing were recorded on linseed 11.106 variety from 23-01-2015 with initial mean population 1.27% to 26-02-2015 with a population of 0.47% per plant. It maximum population 1.33% was recorded on 26-01-2015 during the course studies with overall average was found 0.70 ± 0.47 . Similarly, minutes pirate bug were 23-01-2015 with initial mean population 1.33% to 26-02-2015 with a population of 0.40% per plant. It maximum population 1.60% was recorded on 26-01-2015 with overall average was 0.75 ± 0.55 . The seven spotted beetle was 23-01-2015 with initial mean population 1.07% to 26-02-2015 with a population of 0.47% per plant. It maximum population 1.33% was recorded on 26-01-2015 with overall average was 0.50 ± 0.45 . Similarly, zigzag beetle, apis flora, bumble bee and white tailed bumble bee from 23-01-2015 with initial mean population 0.87, 0.80, 0.80 and 0.67 to 26-02-2015 with a population of 0.13, 0, 0 and 0% respectively, with overall averages and standard errors were 0.42 ± 0.44 , 0.38 ± 0.43 , 0.40 ± 0.42 and 0.38 ± 0.36 respectively.

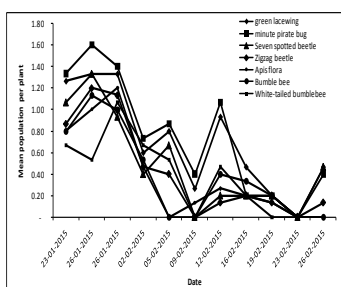


Fig. 11: Mean population per plant of green lacewing, minute pirate bug, seven spotted beetle, zigzag beetle, Apis flora, Bumble bee and white-tailed bumblebee 11.106 variety of linseed

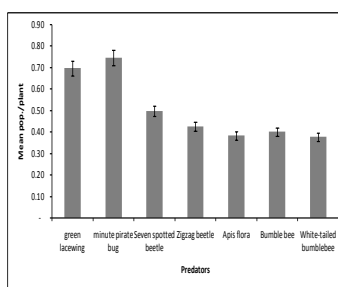


Fig. 12: Overall mean population per plant of green lacewing, minute pirate bug, seven spotted beetle, zigzag beetle, Apis flora, Bumble bee and white-tailed bumblebee 11.106 variety of linseed

DIFFERENT INSECTS ON LINSEED OF FAISALABAD VARIETY

The data in Fig 13 and 14 depict that gall midge were recorded on linseed Faisalabad variety from 23-01-2015 with initial mean population 2.07% to 26-02-2015 with a population of 3.60% per plant. It maximum population 4.47% was recorded on 12-02-2015 during the course studies with overall average was found 3.36 ± 0.79 . Similarly, army worm were 23-01-2015 with initial mean population 0.93% to 26-02-2015 with a population of 0.73% per plant. It maximum population 2.53% was recorded on 02-02-2015 with overall average was 1.37 ± 0.55 . The mired bug was 23-01-2015 with initial mean population 0.93% to 26-02-2015 with a population of 0.53% per plant. It maximum population 2.47% was recorded on 02-02-2015 with overall average was 1.37 ± 0.53 . Similarly, whitefly, jassids, sting bug, thrips and cotton aphid from 23-01-2015 with initial mean population 1.47, 1.40, 0.93, 2.47% and 1.93 to 26-02-2015 with a population of 0.27, 0.13, 0.20, 0.20 and 0.20% respectively, with overall averages and standard errors were 0.95 ± 0.54 , 0.81 ± 0.55 , 0.70 ± 0.43 , 1.84 ± 1.04 and 1.28 ± 0.90 respectively.

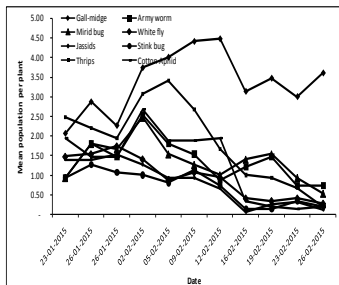


Fig. 13: Mean population per plant of Gall-midge, Army worm, Mirid bug, White fly, Jassids, Stink bug, Thrips and Cotton Aphid Faisalabad variety of linseed

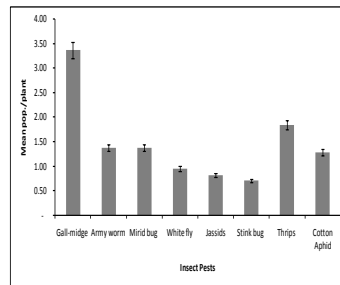


Fig. 14: Overall mean population per plant of Gall-midge, Army worm, Mirid bug, White fly, Jassids, Stink bug, Thrips and Cotton Aphid Faisalabad variety of linseed

DIFFERENT PREDATORS ON LINSEED OF FAISALABAD VARIETY

The data in Fig 15 and 16 depict that green lacewing were recorded on Faisalabad variety from 23-01-2015 with initial mean population 1.00% to 26-02-2015 with a population of 0.27% per plant. It maximum population 1.27% was recorded on 26-01-2015 during the course studies with overall average was found 0.50 ± 0.41 . Similarly, minutes pirate bug were 23-01-2015 with initial mean population 1.13% to 26-02-2015 with a population of 0.40% per plant. It maximum population 1.20% was recorded on 26-01-2015 with overall average was 0.70 ± 0.36 . The seven spotted beetle was 23-01-2015 with initial mean population 1.07% to 26-02-2015 with a population of 0.40% per plant. It maximum population 0.73% was recorded on 26-01-2015 with overall average was 0.40 ± 0.35 . Similarly, zigzag beetle, apis flora, bumble bee and white tailed bumble bee from 23-01-2015 with initial mean population 0.80, 0.93, 0.80 and 0.73 to 26-02-2015 with a population of 0.27, 0.13, 0 and 0.20% respectively, with overall averages and standard errors were 0.31 ± 0.43 , 0.28 ± 0.40 , 0.39 ± 0.28 and 0.47 ± 0.34 respectively.

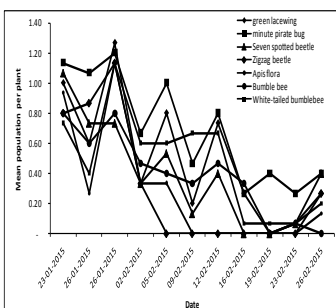


Fig. 15: Mean population per plant of green lacewing, minute pirate bug, seven spotted beetle, zigzag beetle, Apis flora, Bumble bee and white-tailed bumblebee Faisalabad variety of linseed

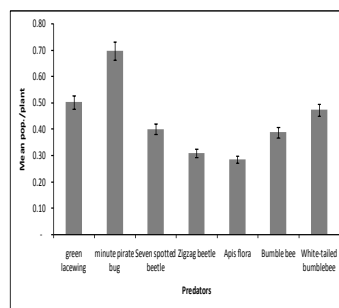


Fig. 16: Overall mean population per plant of green lacewing, minute pirate bug, seven spotted beetle, zigzag beetle, Apis flora, Bumble bee and white-tailed bumblebee Faisalabad variety of linseed

DIFFERENT INSECTS ON LINSEED OF MUNKUSMIL VARIETY

The data in Fig 17 and 18 depict that gall midge were recorded on linseed Munkusmil variety from 23-01-2015 with initial mean population 1.73% to 26-02-2015 with a population of 2.93% per plant. It maximum population 4.07% was recorded on 12-02-2015 during the course studies with overall average was found 3.13 ± 0.74 . Similarly, army worm were 23-01-2015 with initial mean population 0.87% to 26-02-2015 with a population of 0.60% per plant. It maximum population 1.60% was recorded on 02-02-2015 with overall average was 1.05 ± 0.33 . The mired bug was 23-01-2015 with initial mean population 0.53% to 26-02-2015 with a population of 0.53% per plant. It maximum population 1.73% was recorded on 02-02-2015 with overall average was 1.12 ± 0.40 . Similarly, whitefly, jassids, sting bug, thrips and cotton aphid from 23-01-2015 with initial mean population 1.27, 1.27, 0.60, 2.27% and 1.67 to 26-02-2015 with a population of 0.07, 0, 0, 0.07 and 0% respectively, with overall averages and standard errors were 0.81 ± 0.61 , 0.62 ± 0.51 , 0.44 ± 0.34 , 1.73 ± 1.02 and 1.18 ± 0.84 respectively.

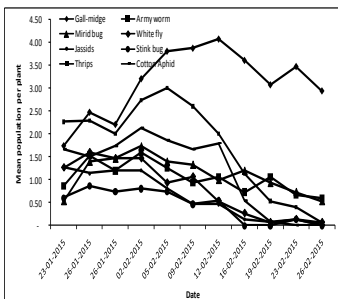


Fig. 17: Mean population per plant of Gall-midge, Army worm, Mirid bug, White fly, Jassids, Stink bug, Thrips and Cotton Aphid Munkusmil variety of linseed

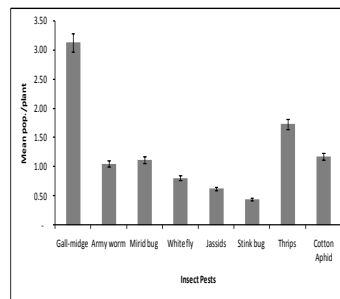


Fig. 18: Overall mean population per plant of Gall-midge, Army worm, Mirid bug, White fly, Jassids, Stink bug, Thrips and Cotton Aphid Munkusmil variety of linseed

DIFFERENT PREDATORS ON LINSEED OF MUNKUSMIL VARIETY

The data in Fig 19 and 20 depict that green lacewing were recorded on Munkusmil variety from 23-01-2015 with initial mean population 0.87% to 26-02-2015 with a population of 0% per plant. It maximum population 0.87% was recorded on 23-01-2015 during the course studies with overall average was found 0.37 ± 0.28 . Similarly, minutes pirate bug were 23-01-2015 with initial mean population 0.60% to 26-02-2015 with a population of 0.13% per plant. It maximum population 0.80% was recorded on 26-01-2015 with overall average was 0.57 ± 0.23 . The seven spotted beetle was 23-01-2015 with initial mean population 0.67% to 26-02-2015 with a population of 0% per plant. It maximum population 0.67% was recorded on 23-01-2015 with overall average was 0.21 ± 0.22 . Similarly, zigzag beetle, apis flora, bumble bee and white tailed bumble bee from 23-01-2015 with initial mean population 0.33, 0.80, 0.67 and 0.53 to 26-02-2015 with a population of 0, 0, 0 and 0% respectively, with overall averages and standard errors were 0.24 ± 0.22 , 0.38 ± 0.29 , 0.41 ± 0.28 and 0.46 ± 0.33 respectively.

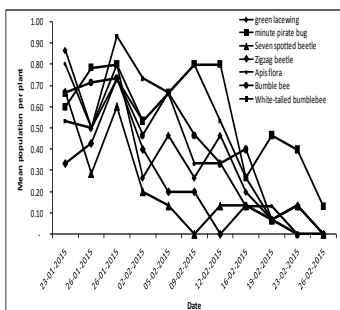


Fig. 19: Mean population per plant of green lacewing, minute pirate bug, seven spotted beetle, zigzag beetle, Apis flora, Bumble bee and white-tailed bumblebee Munkusmil variety of linseed

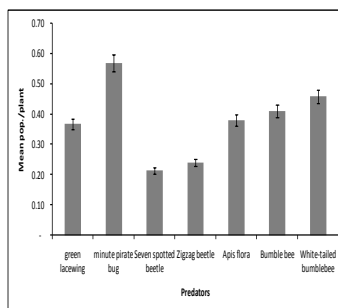


Fig. 20: Overall mean population per plant of green lacewing, minute pirate bug, seven spotted beetle, zigzag beetle, Apis flora, Bumble bee and white-tailed bumblebee Munkusmil variety of linseed

DIFFERENT INSECTS ON LINSEED OF ASLI-90 VARIETY

The data in Fig 21 and 22 depict that gall midge were recorded on linseed Asli-90 variety from 23-01-2015 with initial mean population 1.67% to 26-02-2015 with a population of 2.80% per plant. It maximum population 3.73% was recorded on 09-02-2015 during the course studies with overall average was found 2.85 ± 0.64 . Similarly, army worm were 23-01-2015 with initial mean population 0.87% to 26-02-2015 with a population of 0.27% per plant. It maximum population 1.40% was recorded on 02-02-2015 with overall average was 0.81 ± 0.37 . The mired bug was 23-01-2015 with initial mean population 0.47% to 26-02-2015 with a population of 0.40% per plant. It maximum population 1.33% was recorded on 02-02-2015 with overall average was 0.91 ± 0.35 . Similarly, whitefly, jassids, sting bug, thrips and cotton aphid from 23-01-2015 with initial mean population 0.87, 0.27, 1.93, 1.53% and 0.40 to 26-02-2015 with a population of 0.40, 0.22, 1.53, 0.07 and 1.10% respectively, with overall averages and standard errors were 0.65 ± 0.58 , 0.48 ± 0.47 , 0.22 ± 0.20 , 1.53 ± 0.89 and 1.10 ± 0.81 respectively.

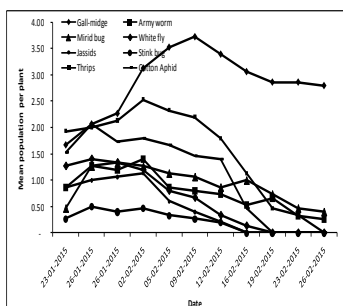


Fig. 21: Mean population per plant of Gall-midge, Army worm, Mirid bug, White fly, Jassids, Stink bug, Thrips and Cotton Aphid ALSI-90 variety of linseed

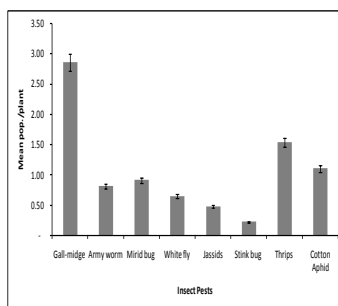


Fig. 22: Overall mean population per plant of Gall-midge, Army worm, Mirid bug, White fly, Jassids, Stink bug, Thrips and Cotton Aphid ALSI-90 variety of linseed

DIFFERENT PREDATORS ON LINSEED OF ASLI-90 VARIETY

The data in Fig 23 and 24 depict that green lacewing were recorded on Asli-90 variety from 23-01-2015 with initial mean population 0.40% to 26-02-2015 with a population of 0% per plant. It maximum population 0.40% was recorded on 26-01-2015 during the course studies with overall average was found 0.16 ± 0.15 . Similarly, minutes pirate bug were 23-01-2015 with initial mean population 0.53% to 26-02-2015 with a population of 0.13% per plant. It maximum population 0.67% was recorded on 26-01-2015 with overall average was 0.45 ± 0.19 . The seven spotted beetle was 23-01-2015 with initial mean population 0.20% to 26-02-2015 with a population of 0% per plant. It maximum population 0.33% was recorded on 23-01-2015 with overall average was 0.08 ± 0.12 . Similarly, zigzag beetle, apis flora, bumble bee and white tailed bumble bee from 23-01-2015 with initial mean population 0.33, 0.47, 0.60 and 0.40 to 26-02-2015 with a population of 0, 0, 0 and 0% respectively, with overall averages and standard errors were 0.14 ± 0.17 , 0.24 ± 0.23 , 0.34 ± 0.28 and 0.38 ± 0.32 respectively.

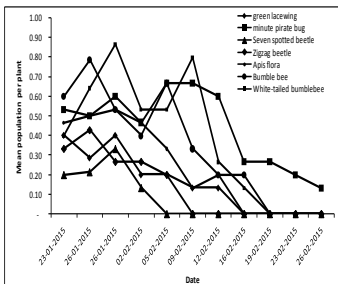


Fig. 23: Mean population per plant of green lacewing, minute pirate bug, seven spotted beetle, zigzag beetle, Apis flora, Bumble bee and white-tailed bumblebee ALSI-90 variety of linseed

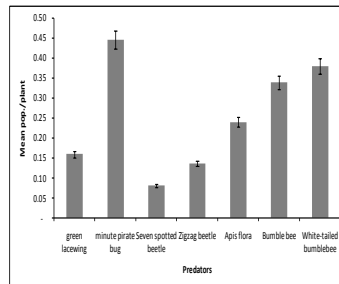


Fig. 24: Overall mean population per plant of green lacewing, minute pirate bug, seven spotted beetle, zigzag beetle, Apis flora, Bumble bee and white-tailed bumblebee ALSI-90 variety of linseed

The abiotic factors such as mean temperature range of 14.32 to 29.64 °C and relative humidity percentage 37.00 to 59.00 were conducive for the multiplication of availability of richness of species in the linseed diversity. The details of meteorological record is given in Table-2.

Table-2: Average weekly metrological data during experimental during 2015

Observation date	Temperature °C			Mean relative humidity (%)
	Minimum	Maximum	Mean	
23-01-2015	17	32	17.64	58.00
26-01-2015	19	32.5	19.65	42.00
26-01-2015	15	29.5	15.59	53.00
02-02-2015	18	30	18.6	59.00
05-02-2015	15	31	15.62	50.00
09-02-2015	13	30	13.6	42.00
12-02-2015	12	29.5	12.59	43.00
16-02-2015	13	28	13.56	48.00
19-02-2015	12.5	29	13.08	40.00
23-02-2015	11	28	11.56	37.00
26-02-2015	12	26.5	12.53	49.00

BIODIVERSITY OF INSECT

The population counts different insect and related arthropods were made from January 23, 2015 to February 26, 2015. A total of 20279 specimens was recorded on 50 randomly selected plants of linseed for 12 observations. Fifteen species were collected belonging to different insect order and classes of arthropoda. Diversity, diversity maximum, species richness and species evenness were calculated weekly by using Shannon-Weiner diversity index. During observations, the diversity maximum (H' max) remained same (1.79). During observation period maximum diversity ($H' = 0.06$) was calculated on 23-01-2015 and maximum evenness ($J' = 0.03$) was recorded. However, maximum richness ($D = 0.96$) was recorded on 09-02-2015. The overall diversity (0.06), diversity maximum (1.79), evenness (0.03) and richness (0.97), respectively were recorded in agro-ecosystem of linseed from 23-01-2015 to 26-02-2015 (Fig. 25)

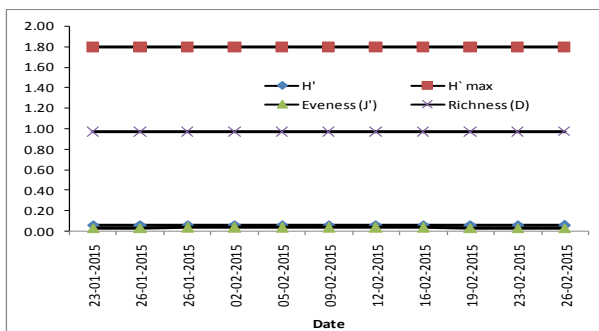


Figure 25: Diversity indices of insect pests in linseed insect biodiversity.

DISCUSSION

Species richness and biomass of terrestrial insects constitute a considerable proportion of ecosystem functions and play a significant role (McGeogh, 1998). Agricultural ecosystems, including a large proportion of the world's biodiversity (Pimentel *et al.*, 1992). Insects are often used as a biological indicator species for monitoring and detecting changes in the environment. It is possible through the use of biological indicators evaluated, instead of checking the influence of the entire biota biota human activities. Particularly useful it is to provide early warning of changes in species (Spellerberg, 1993). Biological often broadly defined as the presence of different forms of plants, animals and micro-organisms, they appear at that level (for example, species, populations and ecosystems) and different ways of living, climate and geology combined to form ecological functions system. Of which about 1.8 million species have been named and described the existing, ten thousand insects (May 2002). Biodiversity variety of life on Earth, by providing vital goods and services directly and indirectly contribute to human well-being and survival on this planet (Palmer *et al.* 2004). Biodiversity is the variation of life. In agro-ecosystems, biodiversity is often a measure of the relative number of types exist organisms. When considering the

impact on biodiversity of a system, the two concepts are particularly important consideration: the stability and productivity (Schowalter, 2006). The findings of present study represent that gall midge were recorded on linseed L-42.8 variety from 23-01-2015 with initial mean population 2.80% to 26-02-2015 with a population of 4.07% per plant. Similarly, army worm were 23-01-2015 with initial mean population 1.07% to 26-02-2015 with a population of 1.40% per plant. Similarly, whitefly, jassids, sting bug, thrips and cotton aphid from 23-01-2015 with initial mean population 1.73, 1.40, 1.13, 2.13% and 2.00 to 26-02-2015 with a population of 1.28, 1.05, 0.98, 1.76 and 1.45% respectively, with overall averages and standard errors were 1.28 ± 0.52 , 1.05 ± 0.42 , 0.98 ± 0.45 , 1.76 ± 0.84 and 1.45 ± 0.82 respectively. Further green lacewing were recorded on linseed L-42.8 variety from 23-01-2015 with initial mean population 1.20% to 26-02-2015 with a population of 0.53% per plant. Similarly, zigzag beetle, apis flora, bumble bee and white tailed bumble bee from 23-01-2015 with initial mean population 1.20, 1.20, 1.13 and 1.20 to 26-02-2015 with a population of 1.00, 0.40, 0.07 and 0% respectively, with overall averages and standard errors were 0.52 ± 0.52 , 0.40 ± 0.41 , 0.42 ± 0.41 and 0.52 ± 0.44 respectively. Similarly, Patel and Thakur (2005) conducted during 1995-96, in Raipur, Chhattisgarh, India, to evaluate the seasonal incidence of the different insect pests of linseed and to evaluate the relationship between the prevailing environmental factors and the populations of the insect pests and their natural enemies. The following insect pests were observed: thrips (*Caliothrips indicus*), semilooper (*Plusia ori chalcea* [*Thysanoplu siaorichalcea*]), pod borer (*Heliothi sarmigera* [*Helicoverpa armigera*]), whitefly (*Bemisia tabaci*), aphid (*Myzus persicae*), linseed caterpillar (*Spodopter aexigua*), leaf miner (*Phytomyz ahorticola* [*Chromatomy iahorticola*]), jassid (*Amrasca* spp.) and bud fly (*Dasineuralini*). Thrips showed the highest incidence

(0.04-12.94 per bud), followed by the bud fly (0.05-2.88 per bud). Further the gall midge were recorded on linseed B-5656 variety from 23-01-2015 with initial mean population 3.40% to 26-02-2015 with a population of 4.93% per plant. The mired bug was 23-01-2015 with initial mean population 2.27% to 26-02-2015 with a population of 1.07% per plant. Similarly, whitefly, jassids, sting bug, thrips and cotton aphid from 23-01-2015 with initial mean population 1.80, 1.33, 1.53, 2.20% and 1.80 to 26-02-2015 with a population of 0.73, 0.53, 0.60, 0.67 and 0.85% respectively, with overall averages and standard errors were 1.21 ± 0.42 , 1.00 ± 0.40 , 0.98 ± 0.38 , 1.56 ± 0.67 and 1.32 ± 0.61 respectively. However, green lacewing were recorded on linseed B-5656 variety from 23-01-2015 with initial mean population 1.53% to 26-02-2015 with a population of 0.73% per plant. Similarly, minutes pirate bug were 23-01-2015 with initial mean population 1.67% to 26-02-2015 with a population of 0.93% per plant. It maximum population 1.67% was recorded on 23-01-2015 with overall average was 0.92 ± 0.45 . The seven spotted beetle was 23-01-2015 with initial mean population 1.33% to 26-02-2015 with a population of 0.67% per plant. It maximum population 1.33% was recorded on 23-02-2015 with overall average was 0.64 ± 0.40 . Similarly, zigzag beetle, apis flora, bumble bee and white tailed bumble bee from 23-01-2015 with initial mean population 1.20, 0.93, 1.13 and 0.80 to 26-02-2015 with a population of 0.33, 0, 0 and 0.07% respectively, with overall averages and standard errors were 0.54 ± 0.38 , 0.45 ± 0.38 , 0.45 ± 0.37 and 0.43 ± 0.36 respectively. Patel and Thakur (2005) observed populations of these natural enemies generally coincided with those of the insect pests. Maximum and minimum temperatures of 28.1 and 12°C were found suitable for pest multiplication. The present findings shows that that gall midge were recorded on linseed 11.106 variety from 23-01-2015 with initial mean population 1.87% to 26-02-2015 with a population of 4.20% per plant. Similarly, army

worm were 23-01-2015 with initial mean population 1.07% to 26-02-2015 with a population of 1.40% per plant. Similarly, whitefly, jassids, sting bug, thrips and cotton aphid from 23-01-2015 with initial mean population 1.40, 1.20, 1.07, 2.40% and 2.07 to 26-02-2015 with a population of 0.63, 0.27, 0.47, 0.33 and 0.47% respectively, with overall averages and standard errors were 1.05 ± 0.44 , 0.84 ± 0.47 , 0.85 ± 0.41 , 1.62 ± 0.91 and 1.24 ± 0.72 respectively. Further green lacewing were recorded on linseed 11.106 variety from 23-01-2015 with initial mean population 1.27% to 26-02-2015 with a population of 0.47% per plant. Similarly, minutes pirate bug were 23-01-2015 with initial mean population 1.33% to 26-02-2015 with a population of 0.40% per plant. It maximum population 1.60% was recorded on 26-01-2015 with overall average was 0.75 ± 0.55 . Similarly, zigzag beetle, apis flora, bumble bee and white tailed bumble bee from 23-01-2015 with initial mean population 0.87, 0.80, 0.80 and 0.67 to 26-02-2015 with a population of 0.13, 0, 0 and 0% respectively, with overall averages and standard errors were 0.42 ± 0.44 , 0.38 ± 0.43 , 0.40 ± 0.42 and 0.38 ± 0.36 respectively. Worku, *et al.* (2006) Factor analysis showed that of the total variation (73.86%) 30.04% and 27.29% were accounted for by first and second principal components, respectively. The highest Shannon diversity index (0.322 ± 0.039) was recorded for boll size and Shannon diversity index for overall pooled mean was 0.223 ± 0.063 . Different insects on linseed of Faisalabad variety mired bug were 23-01-2015 with initial mean population 0.93% to 26-02-2015 with a population of 0.53% per plant. Similarly, whitefly, jassids, sting bug, thrips and cotton aphid from 23-01-2015 with initial mean population 1.47, 1.40, 0.93, 2.47% and 1.93 to 26-02-2015 with a population of 0.27, 0.13, 0.20, 0.20 and 0.20% respectively, with overall averages and standard errors were 0.95 ± 0.54 , 0.81 ± 0.55 , 0.70 ± 0.43 , 1.84 ± 1.04 and 1.28 ± 0.90 respectively. Similarly, minutes pirate bug were 23-01-2015 with initial mean population 1.13% to 26-

02-2015 with a population of 0.40% per plant. Similarly, zigzag beetle, apis flora, bumble bee and white tailed bumble bee from 23-01-2015 with initial mean population 0.80, 0.93, 0.80 and 0.73 to 26-02-2015 with a population of 0.27, 0.13, 0 and 0.20% respectively, with overall averages and standard errors were 0.31 ± 0.43 , 0.28 ± 0.40 , 0.39 ± 0.28 and 0.47 ± 0.34 respectively. Navatha *et al.* (2012) observed insect visitors, Diptera order constituted the major chunk of pollinators (32.00%) followed by Hymenoptera (31.36%), Lepidoptera (21.98%), Hemiptera (10.66%), Orthoptera (0333%) and Coleoptera (0.67%). Of the total insect visitor population, muscid fly constituted maximum proportion (32.00 %), followed by *Halictus* sp. (24.70%). The peak foraging activity of frequent insect visitors was observed between 08.00 and 09.00 h. Different insects on linseed of Faisalabad variety mired bug was 23-01-2015 with initial mean population 0.93% to 26-02-2015 with a population of 0.53% per plant. Similarly, whitefly, jassids, sting bug, thrips and cotton aphid from 23-01-2015 with initial mean population 1.47, 1.40, 0.93, 2.47% and 1.93 to 26-02-2015 with a population of 0.27, 0.13, 0.20, 0.20 and 0.20% respectively, with overall averages and standard errors were 0.95 ± 0.54 , 0.81 ± 0.55 , 0.70 ± 0.43 , 1.84 ± 1.04 and 1.28 ± 0.90 respectively. Similarly, minutes pirate bug were 23-01-2015 with initial mean population 1.13% to 26-02-2015 with a population of 0.40% per plant. Further 26-01-2015 with overall average was 0.40 ± 0.35 . Similarly, zigzag beetle, apis flora, bumble bee and white tailed bumble bee from 23-01-2015 with initial mean population 0.80, 0.93, 0.80 and 0.73 to 26-02-2015 with a population of 0.27, 0.13, 0 and 0.20% respectively, with overall averages and standard errors were 0.31 ± 0.43 , 0.28 ± 0.40 , 0.39 ± 0.28 and 0.47 ± 0.34 respectively. Workuet *al.* (2015) results show the range of characters which can be exploited in breeding lines appropriate for smallholder and commercial farmers in Ethiopia, producing a sustainable, secure, high-value crop meeting agricultural, economic and

cultural needs. Different insects on linseed of Faisalabad variety mired bug was 23-01-2015 with initial mean population 0.93% to 26-02-2015 with a population of 0.53% per plant. Similarly, whitefly, jassids, sting bug, thrips and cotton aphid from 23-01-2015 with initial mean population 1.47, 1.40, 0.93, 2.47% and 1.93 to 26-02-2015 with a population of 0.27, 0.13, 0.20, 0.20 and 0.20% respectively, with overall averages and standard errors were 0.95 ± 0.54 , 0.81 ± 0.55 , 0.70 ± 0.43 , 1.84 ± 1.04 and 1.28 ± 0.90 respectively. Similarly, minutes pirate bug were 23-01-2015 with initial mean population 1.13% to 26-02-2015 with a population of 0.40% per plant. Similarly on 26-01-2015 with overall average was 0.40 ± 0.35 . Similarly, zigzag beetle, apis flora, bumble bee and white tailed bumble bee from 23-01-2015 with initial mean population 0.80, 0.93, 0.80 and 0.73 to 26-02-2015 with a population of 0.27, 0.13, 0 and 0.20% respectively, with overall averages and standard errors were 0.31 ± 0.43 , 0.28 ± 0.40 , 0.39 ± 0.28 and 0.47 ± 0.34 respectively.

CONCLUSION

The results show that 15 insects species of different orders were found from the linseed agro ecosystem from January to February 2015. Out of 21 insects species, 8 insects species were pests, 7 were predators the total number of insects found was 36504 out of which thrips and mites were 51.81% and 36.00%, respectively whereas chewing insects appeared with 1.15% and 1.13% respectively. All pests were found active throughout the cropping season.

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