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Original article

Population dynamics of aphids and its predators alongwith its management

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ABSTRACT

In Pakistan, oilseed cultivations belonging to Brassica genus (Rapeseed, Mustard and Canola) are the most essential crops with respect to eatable oil production. In Indo-Pak, such cultivations have considered as chief oil origins over centuries. This trail was executed at the Ghazi University, D. G. Khan, and Air-Port Campus farming area. The outcomes revealed that insecticidal based treatments significantly reduced the aphid population by the application Bifenthrin and Acetamaprid. In case of botanical extracts, *Allium cepa* and *Moringa oleifera* induced mortality of aphid. Moreover, insecticide based treatments reduced percent predator population increasingly than botanical extracts.

1. Introduction

Agricultural department in Pakistan plays a role as backbone for economy in both direct as well as indirect way. Pakistan wastes a lot of money for the importation of oils just because of its lack in eatable oil extraction (Ahmad et al., 2013). The requirement of eatable oil about 20% is attained with local production while the remaining is taken from various foreign states (Pakistan Oil Seed Products, 2010). In Pakistan, oilseed cultivation belonging to Brassica genus (Rapeseed, Mustard and Canola) which are the most essential crops with respect to eatable oil production. In Indo-Pak, such cultivations have considered as chief oil origins over centuries. Mustard and Rapeseeds are good origin of oil having 44 to 46 percent high grade oil. Furthermore, it comprised of protein (38 to 40%) with amino acids profile like cysteine, lysine and methionine.

Canada initiated the selection and breeding of canola from many years ago and finally produced the canola with less erucic

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acid (in the oil) as well as less glucosinolate level (in the meal) (Abbas et al., 2017). In this way, it becomes most useful as cooking oil and superb meal for birds and animals particularly for poultry. Now, canola cultivation is the main origin of vegetable oil globally after soybean. The canola/rapeseed total world production was 33.86 million tonnes in 2000–2001 with 13 percent of oilseeds developed (ERS, 2001). Canola pre-mature swathing has been stated to minimize yield (Brown et al., 1999), weight (Ogilvy, 1989), protein content (Bowren and Kirkland, 1975) and oil content (Bowren and Kirkland, 1975; Ogilvy, 1989) of the seed.

Mustard and Rapeseed cultivars for oil production are not utilized in the vegetable oil or ghee production process due to increase level of erucic acid in oil (40–70%) and that is injurious to health (Vermorel et al., 1986). In this regard, the most healthful and cost-effective oil for cooking is canola and it also provides protein comprised feed for animals after oil extraction (Syed et al., 1999). Further advancement in refining and manufacturing strategies may increase the utilization of mustard and rapeseed oil as source of cooking. Recently improvements in mustard cultivars have increased the application of mustard oil in cooking.

Brassica napus (Canola) is one of the extremely important oil crop (Miri, 2007) and now such crop is the 3rd main source of vegetable oil globally (Kandil and Gad, 2012). According to Anonymous 2015, in Sindh and Punjab the canola crop is cultured on 0.207 acres area annually.

Canola provides energy (884 calories from 100 g oil) with health benefits. Canola oil comprised of good profile of lipid with healthful proportion of saturated, mono-unsaturated, and poly-unsaturated fats (8:61:31), respectively. At seedling phase the greenish leaves are utilized as vegetable. Cultivated crop produced a delicious green feed for livestock particularly after mixing into fodder crops which enrich deliciousness. Seeds possess oil (40 percent) that is essential part of human feed in the form of cooking medium, preparation of pickle, flavoring, frying as well as several preservatives. Oil is utilized in different ways like medicine in case of digestion and swelling problems, in tanning industry for leather softening and oil cakes as cattle meal (Arain, 2013).

Usually plants can tolerate a broad spectrum of abiotic stresses (flooding, heat, drought, extreme light intensity, salinity, cold and mechanical infestation) as same as biotic stresses (insects and pathogens infestation) (Buchanan et al., 2000).

Canola cultivation is highly vulnerable to infestation through a broad array of insect pests from emergence of seedling to maturation. In Pakistan, the key factor which liable for minimum average production of canola of about 700–900 Kg per ha comprise insect pests activities especially aphids (Mahmoud and Shebl, 2014), that responsible for significant reduction of the crop production (Lamb, 1989). Canola crop is mainly damaged by 3 aphid species such as *Brevicoryne brassicae* (cabbage aphid), *Lipaphis erysimi* (turnip aphid) and *Myzus persicae* (green peach aphid). In southern Punjab region of Pakistan, *Brevicoryne brassicae* and *Lipaphis erysimi* (aphid species) are major alarming pests of canola cultivation stated by Aslam and Razaq, 2007. *Brevicoryne brassicae* (cabbage aphid) is well-known harmful specie of aphididae family on canola cultivation during flowering as well as podding phase (Mahmoud and Shebl, 2014; Sayed and Teilep, 2013; Aslam et al., 2007). Shah et al., 2017 stated that in Pakistan wheat as major food crop is continually infested with different wheat aphid species (*Sitobion avenae, Rhopalosiphum padi* and *Schizaphis graminum*).

Aphids infest canola cultivation by sucking cell sap from leaves, secreting honeydew, transferring viral agents (Berlandier *et al.,* 2010). In serious cases, deficits may exceed from 75 percent of the entire crop production (Abbas et al., 2012). Sucking mouthpart insect pests may or may not influence photosynthesis action as well as internal CO_2 of the damaged plants (Lin et al., 1999) reported that the late sowing of *B. napus* may increase the rate of infestation (75%) because of aphid activity.

Amer et al., 2009 stated that some present cultivars showed considerable failure in resistance against aphid attack. Due to this reason, application of insecticides against aphid on canola cultivation is necessary. The application of insecticide is most frequent against aphid among farmers (Akbar et al., 2016). Insecticides possessed residual effect, hazardous for health, degrading the environment and requires substitute control of aphids (Hill, 1989).

Currently, management techniques regarding insects rely greatly upon insecticides. Seed treated into insecticide (systemic) is an essential element of pest control schemes, that is relatively least contaminant for the ecosystem, selective, inexpensive and found to regulate the balance of nature (Nault et al., 2004). The rapid multiplication of *B. brassicae* shows the main risk for canola cultivations, thus it requires efficient management with substitute approach as insecticides (neo-nicotinoid) seed dressing as well as plant resistance as a feasible choice for minimizing aphid infestation and avoiding outbreaks. Neo-nicotinoids are primarily employed as seed treating for wide range of cultivations i.e. potatoes, cereals, oilseed rape, cotton, corn, sunflower and sorghum. The seed treating first neo-nicotinoid (insecticide) was Imidacloprid that applied on commercial basis for securing the seeds as same as seedlings to infestation by early-season insects (El-Naggar and Zidan, 2013; Wilde et al., 2000). It is potent against sucking mouthpart insect pests (aphids, true bugs, jassids, thrips, mites and wireworms) especially when applied as foliar, as seed treatment and soil usages (El-Naggar and Zidan, 2013; Marghub et al., 2010; Naveed et al., 2010; Prasana *et al.,* 2004). The 2nd generation neo-nicotinoid (insecticide) is Thiamethoxam which gives superb management against wide range of insect pests on diversified crops. After seed dressing, neo-nicotinoid (insecticide) represents residual as well as systematic potency and interrupt in the transferring of stimuli/impulses in the herbivorous insect's nervous system and provide superb management toward a wide array of sucking insects (Zhang et al., 2011).

Focusing on all points discussed in previous studies, the existing study was performed to evaluate the effectiveness of both insecticides as well as biocides on aphid population and predators.

2. Material and methods

2.1. Trail locality

This trail was executed at the Ghazi University, D. G. Khan, Air-Port Campus farming area and the main aim of this trail was to assess the aphid as well as predator population on canola cultivation, along with insecticidal and bio-extracts application on canola cultivation. So, Canola was sown during its seeding season of the year (2019–2020).

2.2. Sowing of canola cultivars

Two canola cultivars namely Rainbow and Oscar were sown separately in different plots of the trail area. Sound seeds of such cultivars were seeded with drill method @ two kg/acre. Recommended cultivation practices were endorsed for the canola raising.

2.3. Plotting

Canola cultivars were cultivated in plots (2.5 square m. each). In all plots, P $\times$ P (10 cm) and R $\times$ R distance was maintained. About 1 m and 2 m path between treatments and replications was retained as neutral zone, respectively.

2.4. Trail design

This trail was performed in RCBD (Randomized Complete Block Design) design under thrice repetitions.

2.5. Treatments

This trail was comprised of five treatments including control (untreated). Other treatments were two insecticides (Bifenthrin and Acetamaprid) and two botanical extracts (Onion and Sohanjna).

2.6. Treatments preparation

Initially appropriate calibration of the trailed area was performed to measure how much water quantity was needed in case of treatments application. Treatments were sprayed on both canola cultivars separately through knapsack sprayer machine. Insecticidal based treatments were applied at their suggested concentrations. In case of botanical extractions, leaves of *M. oleifera* were taken from the D. G. Khan locality, whereas onion was bought from the vegetable market of D. G. Khan. Both botanical materials of about 50 g (powdered leaves of *M. oleifera* and crushed onion bulb) were filtered with muslin cloth and then mixed in water (1 lit.) for 24 h for obtaining 5% concentration.

2.7. Aphid scouting

In both cultivars of canola cultivation, aphid scouting was performed after 2 weeks intervals for estimating the outbreak of aphid population. When aphid reached at their ETL, the treatments were applied on both canola cultivars plots. Aphid scouting were done randomly by choosing five plants (top 10 cm)/plot. This scouting was performed before spraying (Pre-Treatment) and after 1, 2, 3, 4 and 5 days of spraying. For the aphid counting, a white sheet was used. The % reduction of aphid count in relation to before spraying data (Pre-Treatment) was recorded by the given formula.

Percent Reduction = (Pre-Treatment population – Post-Treatment population / Pre-Treatment population) $\times$ 100.

2.8. Predators population

Before treatments spraying, the population of predators was recorded from each canola cultivated plot of the trail. Then after treatments application, the percent reduction in population of predators was observed from all plots of the trail by the percent reduction formula.

2.9. Statistical analysis

The observed data (before and after treatments spraying in case of aphid population as well as predator population) was subjected to one way ANOVA. Moreover, LSD Test was implemented for mean comparing.

3. Results

The consequences of field trail based study along statistical interpretation are illustrated and deliberated in given chapter.

Results of Canola Cultivar 1 (Rainbow).

3.1. Pre-treatment aphid population

Statistically similar results were found among all treatments except T_2 (Acetamaprid) in case of aphid population before treatment application as given in Table 4.1 (b). The maximum (111.66) population of aphid was observed in the plot of T_3 (*Allium cepa*) followed by T_5 (Control), T_1 (Bifenthrin) and T_4 (*Moringa oleifera*) while minimum population (99.66) of aphid was noticed in the plot of T_2 (Acetamaprid).

3.2. Aphid population reduction (%) 1 day after treatment (DAT) application

Highly significant variation was noted in all treatments except T_1 (Bifenthrin) and T_2 (Acetamaprid) plots which demonstrate non-significant variation for aphid population reduction percent (Table 4.2). The maximum reduction percent in aphid population (49.91 and 44.86%) was observed by spraying (T_1 Bifenthrin and T_2 Acetamaprid) insecticides while minimum aphid reduction percent was noticed by botanical extract application T_4 *Moringa oleifera* (25.16%) followed by T_3 *Allium cepa* (35.5%) as displayed in Table 4.2. Control treatment (T_5) was not demonstrated any reduction (%) in aphid population.

3.3. Aphid population reduction (%) 2 DAT application

All applied treatments displayed highly significant consequence as given in Table 4.3 (a). Among treatments, insecticide based treatments like Bifenthrin showed increase (67.26%) reduction percent in aphid population followed by Acetamaprid (63.21%) after 2 days of spraying while decrease reduction (%) was recorded after applying *Moringa oleifera* (32.3%) and *Allium cepa* (44.46%) as shown in Table 4.3.

3.4. Aphid population reduction (%) 3 DAT applications

Statistically significant variation was recorded by the application of treatments as displayed in Table 4.4 (a). Insecticidal based treatments exhibited significant reduction percent of aphid population. The increase aphid reduction percent was also demonstrated by the botanical extracts (treatments) application (Table 4.4).

3.5. Aphid population reduction (%) 4 DAT application

After 4 days of treatment application, maximum aphid reduction percent (96.02 and 90.32%) was observed by the spraying of insecticides (Bifenthrin and Acetamaprid), respectively as shown in Fig. 5****. Also, increase rate of aphid reduction percent (70.77 and 62.73%) was demonstrated by the bio-extracts spraying (*Allium cepa* and *Moringa oleifera*), respectively. The aphid reduction (%) was progressively increased by the application of treatments (from 1 day to 4 days) as displayed in Table 4.5 (b).

Table 4.1
Mean Comparison Table for Aphid Population in Pre-Treatment (Before Treatments application).

Treatment #	Treatments	Predator Population Reduction % Before Spraying
T1	Bifenthrin	109 a
T2	Acetamaprid	99.66b
T3	*Allium cepa*	111.66 a
T4	*Moringa oleifera*	107.33 a
T5	Control	110.33 a

Table 4.2
Mean Comparison Table for Aphid Population Reduction (%) 1 DAT Application.

Treatment #	Treatments	Predator Population Reduction % After Spraying
T1	Bifenthrin	67.26 a
T2	Acetamaprid	63.21b
T3	*Allium cepa*	44.46c
T4	*Moringa oleifera*	32.3 d
T5	Control	0 e

Table 4.3
Mean Comparison Table for Aphid Population Reduction (%) 2 DAT Application.

Treatment #	Treatments	Predator Population Reduction % After Spraying
T1	Bifenthrin	67.26 a
T2	Acetamaprid	63.21b
T3	*Allium cepa*	44.46c
T4	*Moringa oleifera*	32.3 d
T5	Control	0 e

Table 4.4
Mean Comparison Table for Aphid Population Reduction (%) 3 DAT Applications.

Treatment #	Treatments	Predator Population Reduction % After Spraying
T1	Bifenthrin	85.05 a
T2	Acetamaprid	80.26b
T3	*Allium cepa*	57.60c
T4	*Moringa oleifera*	47.49 d
T5	Control	0 e

Table 4.5
Mean Comparison Table for Aphid Population Reduction (%) 4 DAT Applications.

Treatment #	Treatments	Predator Population Reduction % After Spraying
T1	Bifenthrin	96.02 a
T2	Acetamaprid	90.32b
T3	*Allium cepa*	70.77c
T4	*Moringa oleifera*	62.73 d
T5	Control	0 e

3.6. Aphid population reduction (%) 5 DAT application

Statistically significant result was noticed by the application of treatments (Table 4.6 a). All treatments were varied from each other for aphid population reduction percent after 5 days of treatments application. The maximum reduction (%) in aphid count was observed by Bifenthrin treatment while minimum reduction (%) was found in plot of *Moringa oleifera* treatment as shown in Table 4.6.

Table 4.6
Mean Comparison Table for Aphid Population Reduction (%) 5 Days AT Application.

Treatment #	Treatments	Predator Population Reduction % After Spraying
T1	Bifenthrin	94.5 a
T2	Acetamaprid	85.96b
T3	*Allium cepa*	78.24c
T4	*Moringa oleifera*	67.38 d
T5	Control	0 e

3.7. Aphid Mean reduction (%) after Treatment application

All treatments demonstrated statistically significant outcome with respect to aphid mean reduction (%) after treatment application (Table 4.7). Insecticidal based treatments showed increase rate of aphid mean reduction (%) as compared to botanical extracts treatments and control treatment not represented any aphid mean reduction (%) (Table- 7).

3.8. Predator population before Treatment application

Statistically similar outcome was observed in all plots of treatments with respect to predator population (Table 4.8 b). The maximum predator population (6.0 and 5.66) was recorded in plots of T_2 (Acetamaprid) and T_5 (Control), respectively. Non-significant difference was observed between T_1 (Bifenthrin) and T_3 (*Allium cepa*) for predator population (4.66). The decrease predator population (3.33) was observed in T_4 (*Moringa oleifera*).

3.9. Predator population reduction % after Treatment application

Statistically same result was demonstrated between T_1 Bifenthrin (86.66%) and T_2 Acetamaprid (84.91%) and between T_3 *Allium cepa* (52.22%) and T_4 *Moringa oleifera* (38.88%) in case of predator population after treatment application. T_5 Control treatment showed significantly different predator population reduction percent (5.55%) from other treatments as displayed in Table 4.9.

Results of Canola Cultivar 2 (Oscar).

Table 4.7
Mean Comparison Table for Aphid Mean Reduction (%) after Treatments.

Treatment #	Treatments	Predator Population Reduction % After Spraying
T1	Bifenthrin	78.55 a
T2	Acetamaprid	72.92b
T3	*Allium cepa*	57.31c
T4	*Moringa oleifera*	47.01 d
T5	Control	0 e

Table 4.8
Mean Comparison Table for Predator Population before Treatment Application.

Treatment #	Treatments	Predator Population Reduction % After Spraying
T1	Bifenthrin	4.66 ab
T2	Acetamaprid	6.0 a
T3	*Allium cepa*	4.66 ab
T4	*Moringa oleifera*	3.33b
T5	Control	5.66 a

Table 4.9
Mean Comparison Table for Predator Population Reduction % after Treatment Application.

Treatment #	Treatments	Predator Population Reduction % After Spraying
T1	Bifenthrin	86.66 a
T2	Acetamaprid	84.91 a
T3	*Allium cepa*	52.22b
T4	*Moringa oleifera*	38.88b
T5	Control	5.55c

3.10. Pre-Treatment aphid population

Before treatments spraying, statistical similar consequence was recorded among all treatments regarding aphid population Table 4.10 (a). The increase population of aphid was observed in plots of T_4 (*Moringa oleifera*) and T_3 (*Allium cepa*) while decrease aphid population was recorded in plots of T_1 (Bifenthrin) followed by T_5 (Control) and T_2 (Acetamaprid) as given in Table 4.10.

3.11. Aphid population reduction (%) 1 day after Treatment application

Highly significant differences were observed among all treatments application after 1 day as given in Table 4.11 (a). The highest aphid population reduction (46.26 and 39.87%) was demonstrated by the insecticidal treatments (T_1 Bifenthrin and T_2 Acetamaprid) while the lowest aphid reduction (29.73%) was recorded by T_4 *Moringa oleifera* application (Table 4.11).Table 4.12.Table 4.13..

Table 4.10
Mean Comparison Table for Aphid Population in Pre-Treatment.

Treatment #	Treatments	Predator Population Reduction % Pre Spray
T1	Bifenthrin	98c
T2	Acetamaprid	102 bc
T3	*Allium cepa*	107 ab
T4	*Moringa oleifera*	111 a
T5	Control	99c

Table 4.11
Mean Comparison Table for Aphid Population Reduction Day after Treatment (Application.

Treatment #	Treatments	Predator Population Reduction % After Spraying
T1	Bifenthrin	46.26 a
T2	Acetamaprid	39.87b
T3	*Allium cepa*	37.06c
T4	*Moringa oleifera*	29.73 d
T5	Control	0 e

Table 4.12
Mean Comparison Table for Aphid Population Reduction 2 Days after Treatment Application.

Treatment #	Treatments	Predator Population Reduction % After Spraying
T1	Bifenthrin	85.70 a
T2	Acetamaprid	74.81b
T3	*Allium cepa*	57.01c
T4	*Moringa oleifera*	51.04 d
T5	Control	0 e

Table 4.13
Mean Comparison Table for Aphid Population Reduction (%) 3 Days after Treatment Application.

Treatment #	Treatments	Predator Population Reduction % After Spraying
T1	Bifenthrin	85.70 a
T2	Acetamaprid	74.81b
T3	*Allium cepa*	57.01c
T4	*Moringa oleifera*	51.04 d
T5	Control	0 e

3.12. Aphid population reduction (%) 2 days after Treatment Application:

After 2 days of treatments application, insecticidal based treatments (T_1 and T_2) represented non-significant difference for aphid reduction percent while remaining treatments (T_3, T_4 and T_5) exhibited statistical significant variations for aphid reduction (percent).

3.13. Aphid population reduction (%) 3 days after Treatment application

After 3 days of insecticidal as well as bio-extracts based treatments application on canola cultivar (2) demonstrated highly significant variations among treatments for aphid population reduction percent. Maximum aphid population (85.70%) was reduced by the application of T_1 Bifenthrin. In case of bio-extracts based treatments, increase rate of aphid reduction (57.01%) was noted by the spraying of T_3 *Allium cepa*. All treatments continuously raised the reduction (%) of aphid population from 1 day to 3 days of spraying.

3.14. Aphid population reduction (%) 4 days after Treatment application

According to Table 4.14, highly significant differences were observed among all tested treatments for aphid population reduction (%). All treatments progressively raised their aphid population reduction percent (Table 4.14). Maximum aphid reduction (%) was observed by the application of T_1 (92.2%) followed by T_2 (83. 9%), T_3 (73.2%) and T_4 (65.4%).

3.15. Aphid population reduction (%) 5 days after Treatment application

Statistically same result was recorded between T_1 (90.53%) and T_2 (87.58%) (Insecticidal treatments) after 5 days of spraying (Table 4.15). Among bio-extracts based treatments, *Allium cepa* (T_3) represented increase reduction percent of aphid (80.96%) while decrease aphid population declining (71.45%) was noticed by *Moringa oleifera* (T_4).

Table 4.14
Mean Comparison Table for Aphid Population Reduction (%) 4 Days after Treatment Application.

Treatment #	Treatments	Predator Population Reduction % After Spraying
T1	Bifenthrin	92.2 a
T2	Acetamaprid	83. 973b
T3	*Allium cepa*	73.206c
T4	*Moringa oleifera*	65.49 d
T5	Control	0 e

Table 4.15
Mean Comparison Table for Aphid Population Reduction (%) 5 Days after Application.

Treatment #	Treatments	Predator Population Reduction % After Spraying
T1	Bifenthrin	90.53 a
T2	Acetamaprid	87.58 a
T3	*Allium cepa*	80.96b
T4	*Moringa oleifera*	71.45c
T5	Control	0 d

Table 4.16
Mean Comparison Table for Aphid Mean Reduction (%) after Treatment Application.

Treatment #	Treatments	Predator Population Reduction % After Spraying
T1	Bifenthrin	75.25 a
T2	Acetamaprid	69.07b
T3	*Allium cepa*	59.36c
T4	*Moringa oleifera*	51.71 d
T5	Control	0 e

Table 4.17
Mean Comparison Table for Predator Population before Treatment Application.

Treatment #	Treatments	Predator Population Reduction % before Spraying
T1	Bifenthrin	5.66 a
T2	Acetamaprid	4.33 a
T3	*Allium cepa*	6 a
T4	*Moringa oleifera*	5.66 a
T5	Control	6 a

Table 4.18
Mean Comparison Table for Predator Population Reduction % after Treatment Application.

Treatment #	Treatments	Predator Population Reduction % After Spraying
T1	Bifenthrin	89.68 a
T2	Acetamaprid	86.66 a
T3	*Allium cepa*	44.44b
T4	*Moringa oleifera*	45.71b
T5	Control	0c

3.16. Aphid Mean reduction (%) after Treatment application

In case of aphid mean reduction (%), highly significant variations were demonstrated among treatments. Table 4.16 (b) revealed that T_1 Bifenthrin (75.25%) and T_2 Acetamaprid (69.07%) increasingly decline the population of aphid. Mean reduction of aphid 59.36% and 51.71% was observed by the application of *Allium cepa* and *Moringa oleifera*, respectively.Table 4.17..

3.17. Predator population before Treatment application

Non-significant differences were noticed among all applied treatments as represented in Table 4.17(a). Statistically same outcome was recorded between T_5 (Control) and T_3 (*Allium cepa*) as well as T_1 (Bifenthrin) and T_4 (*Moringa oleifera*) as depicted in Table 4.17(b). Among all treatments, the decreased predator population was observed in the plot of T_2 Acetamaprid treatment.

3.18. Predator population reduction % after Treatment application

The insecticidal based treatments significantly decreased the predator population as compared to bio-extracts treatments as given in Table 4.18 (b). The maximum predator was reduced by the application of Bifenthrin (89.68%) and Acetamaprid (86.66%). The minimum predator declining was recorded by the application of *Allium cepa* (44.44%) and *Moringa oleifera* (45.71%).

4. Discussion

This field trail based investigation revealed that in both cultivars of canola cultivation, insecticidal based treatments exhibited significant mean reduction percent of aphid population with more than 75% in exposure time of 5 days. Among insecticidal based treatments, Bifenthrin and Acetamaprid exhibited high potency (94 and 85% in Rainbow canola cultivar and 90 and 87% in Oscar canola cultivar) towards aphid population of exposure time of 5 days, respectively. Such observation are in agreement of Arif et al., 2012 who stated that aphid percent population reduction on canola reached to 82 to 94% (in 2010) and 83 to 93 (in 2011) by the application of insecticides after exposure of 7 days. Our results are encouraged by the investigation of Arshad et al., 2016 who checked the effectiveness of various insecticides towards *Lipaphis erysimi* (aphid) on *Camelina sativa* (oilseed crop) of Australian and Canadian cultivars and noticed 98.7 and 98.26% of aphid mortality in Canadian cultivar and Australian cultivar, respectively by the application of Acetamiprid after 5 days.

Maximum aphid population declining was observed by the use of insecticides in existing study. This was in accordance to Ahmad et al., 2007 who investigated the efficacy of various products (*Bacillus thuringiensis,* Abamectin, chlorpyrifos and megamos) against *Lipaphis erysimi* (aphids) on *Brassica campestris* (rapeseed) and after initial spray of the pesticides the considerable management of aphid was observed than control. Lashkari et al., 2007 assessed the potential of insecticides (Pymetrozine and Imidacloprid) towards *Brevicoryne brassicae* (Cabbage aphid) and concluded that insecticidal treatment declined the aphid multiplication as compared to control treatment. Saljoqi et al., 2009 assessed the seasonal outbreak of aphids and various insecticides (Monocrotophos, Imidacloprid, Methamedophos, Cypermethrin + Dimethoate and methyl Parathion) effectiveness toward *Lipaphis erysimi* (aphid) in *Brassica napus* cultivation under field trail and concluded that all aphidicides application after 24 to 72 h depicted better management but after some days (10–15 days gap) their potency reduced. This statement also promoted to our findings because in this trail, aphid population reduction was progressively raised from 1 to 5 days. Zafar et al., 2016 determined the influence of 3 insecticides (methamidophos, fenpropathrin and metasystox at the rates of 1.01, 1.21 and 1.41 per hectare, respectively) against aphid infestation in *Brassica campestris* cultivation and found methamidophos as effective insecticide toward aphids than other trailed insecticides. Khan et al., 2017 performed a field based trail and recorded maximum mortality of aphid by Carbosulfan (96.7%), Nitenpyram (96.4%), Pryriproxyfen (91.6%) and Chlorpyrifos (67.8%) on *Brassica juncea* cultivation after 3 days of application.

Among bio-extracts treatments, *Allium cepa* induced great mortality of aphid population (78% in Rainbow canola cultivar and 80% in Oscar canola cultivar) after exposure of 5 days. Mwanarusi and Itulya, 2008 reported that intercropping of *B. oleracea* into either *Phaseolus vulgaris* (beans) or *Allium cepa* (onions) greatly decreased aphid count in Collard cultivation than singly cropping of Collard (unsprayed). Fraide et al., 2016 stated that (*Allium cepa*) onion may be taken as good tool in intercropping for managing the *Agrotis ipsilon* (insect pest) in *Lactuca sativa* (lettuce) crop. Akbar et al., 2017 reported that aphid attack may be reduced by the sowing of onion, fennel seeds and garlic as companion crops in canola cultivation.

In our findings, *Moringa oleifera* exhibited aphid population reduction percent of 67% in Rainbow (canola cultivar) and 71% in Oscar (canola cultivar) after 5 days of spraying. Similar outcomes were stated by Ojiako et al., 2013 who revealed that *Moringa* seeds extraction decreased the field pest population such as *Maruca vitrata, Megalurothrips sjostedti* and *Aphis crassivora* and resultantly raised the productivity rate with pods formation. Futhermore, our results are favored by Farooq et al., 2016 who stated that *Moringa oleifera* (Sonjna) leaves induced 31.88% *Sitobion avenae* (wheat aphid) mortality by the application of 5% solution. Damilola and Temitope, 2020 said that *M. oleifera* leaves water based extraction in different formulations demonstrated considerable control potential against *Podagrica spp*. Some works of different researchers promotes the biocides like Shannag et al., 2014 who observed fifty percent decline in *Myzus persicae* (green peach aphid) population by the application of Azatrol and Triple action neem oil with double concentration in comparison to untreated (control). Sarwar, 2013 stated that at 10 percent formulation, bio-extracts i.e. *Aloe vera* and tobacco were found as better botanicals for reducing the aphid population on *B. napus* cultivation. Shah et al., 2017 determined the relative potential of Neem seed and *Moringa* leaf extractions and Imidacloprid in late sown wheat cultivations for controlling aphids and minimizing the productivity deficits. The less count of bio-agents on imidacloprid applied plots provided less chance of aphid predation. It is concluded that NSE can be taken as most effective alternative bio-insecticide than synthetic insecticide. Such observations are more or less promotes to our findings.

This investigation also focused on the impact of insecticides as well as bio-extracts on predators. Before treatment spraying, the predator population on all treatment plots was statistically similar including control. Whereas, after treatment spraying, the maximum predator population decline (%) was assessed in those plots where insecticides were applied as compared to bio-extracts treated plots. The maximum predator reduction percent (86% in Rainbow cultivar and 89% in Oscar cultivar) was assessed after Bifenthrin spraying followed by Acetamaprid (84% in Rainbow cultivar and 86% in Oscar cultivar). While in case of bio-extracts, increase reduction in predator population was noticed by the *Allium cepa* (52% in Rainbow cultivar and 44% in Oscar cultivar) subsequent to *Moringa oleifera* (38% in Rainbow cultivar and 45% in Oscar cultivar). The decreased predator population reduction was observed by control treatment (5.55% in Rainbow cultivar and 0.0% in Oscar cultivar). The present results are in accordance to Atta et al., 2019 who stated that bio-agents (*Chrysoperla carnea, Coccinella septempunctata* and *C. undecimpunctata*) were found in canola cultivation and their count was directly proportional to the count of aphids. Those plots where insecticides were applied attained maximum aphid reduction percent as well as predator mortality than bio-extracts. The application of bio-extracts induced less mortality of predator population. Elliott et al., 2014 reported the influence of parasitoid species observed in canola cultivation against aphids from seedling to pod formation stages. Abbas et al., 2017 observed the aphid species richness, population trends as well as bio-agents from 4 regions of Punjab (D. G. Khan, Faisalabad, Khanpur and Bahawalpur) in two years (2014 and 2015) and recorded the increased population among bio-agents was of ladybird beetle, green lacewing and syrphid fly, respectively.

5. Conclusion

It is concluded that aphid population significantly reduced by the application of insecticidal treatments. Among insecticidal treatments, Bifenthrin increasingly decline the aphid population after 5 days of exposure time. Among botanical extraction, *Allium cepa* (onion) induced maximum mortality of aphid after 5 days of exposure time.In case of predator population reduction, all treatments including insecticides (Bifenthrin and Acetamaprid) and bio-extracts (*Allium cepa* and *Moringa oleifera*) caused maximum mortality of predators, respectively. But the rate of predator reduction percent was less by the application of bio-extracts.

Conflicts of Interest

All authors declare that they have no conflict of interests in this manuscript

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