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Full Length Research Paper

The Inhibitory Properties of Organic Pest Control Agents against Aphid (Aphididae: Homoptera) on Canola *Brassica napus* L. (Brassicaceae) Under Field Environment

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Abstract. Resistance in aphid to pesticides appears to have been the cause of failure in controlling this pest in certain cropping systems. This study is to report the insecticidal property of botanicals and their potential as organic pest control agents for field management of aphid on Canola *Brassica napus* L. (Brassicaceae). Aphid species *Myzus persicae* (Sulzer) (Homoptera: Aphididae) was frequently found in large number or of major agronomical importance at the experimental place. The effectiveness of four botanical pest control agents such as, Tobacco *Nicotiana tabacum* L., Garlic *Allium sativum* L., Goosefoot *Chenopodium album* L., and *Aloe vera* L., was assessed through foliar applications on canola (*B. napus*) crop. The toxicity of botanicals differed significantly depending upon the treatment applied. The *A. vera* (Aloeaceae) and to a greater extent *N. tabacum* at 10% concentration were the most effective botanicals and rated parallel for effectiveness in treated crop and had the least aphid's damage and enhanced yield across all the season followed by *C. album* and *A. sativum* relative to the untreated control that had the most damaged plants by pest resulting in reduced yield. Consequently, the performances of *A. vera* and *N. tabacum* as botanical pesticides were observed the best in reducing pest and seed damage, as these did not induce any adverse effect on plant and showed that there is a prospective to use them in an integrated pest management system, being safe and economical for oilseeds production and protection.

Key words: Aphid, Botanicals, *Brassica*, Infestation, Organic Pest Control Agents.

1. INTRODUCTION

Canola, *Brassica napus* L., belongs to the family Cruciferae (also known as the mustard family Brassicaceae), which is a modified form of rapeseed or brown mustard using traditional plant breeding methods. Canola is a major oil-producing crop that is widely grown across winter season in various regions of Pakistan. The accessibility to improved varieties, adoption of better crop production and protection packages, and excellent prices made canola a truly striking to growers leading to its speedy expansion (Sarwar, 2008). There are several species of aphids that are found clustering around the new shoots and buds on canola crop to enjoy during the cooler season causing extremely high damage throughout the growth period (Sarwar, 2011).

Daebeler (1981) studied the harmfulness of the aphid to winter rape and showed that losses of 20-30% could be expected if plants were attacked early in the autumn at a rate of at least 100 aphids/ plant, while, infestation in spring by the period of flowering resulted in the complete failure of the crop. Due to this pest, there is an extensive use of insecticides for its management which resulted in significant reductions of its natural enemies, resurgence of minor pests into major problem, ecological contamination and amplification of resistance to the majority of the synthetic insecticides. Delorme (1998) investigated possible insecticide resistance in different populations of aphid *Myzus persicae* (Sulzer) and to a lesser extent in *Brevicoryne brassicae* (L.) abundant in winter rape. The aphid *Myzus persicae* (Sulzer) (Homoptera: Aphididae) is a major pest in field crops, where its management still depends upon the utilization of insecticides (Wei et al., 2003). The aphid *M. persicae* is an imperative insect pest of canola and occurs frequently in all crop-growing regions of this country. They cause direct feeding damage to plant and transmit different viruses to particular crop. Nevertheless, by colonizing crops, their pace of evolution has hastened to compete with the chemical control strategy intended against these pests. This practice has resulted in the expansion of insecticide resistance in aphid species (Sarwar et al., 2011; Sarwar, 2013).

In recent years, organic pest control agents have been proved successful for pest management strategy (Sarwar, 2010; Ahmad et al., 2011; Sarwar et al., 2012). Arancon et al., (2007) tested the capability of vermicomposts, formed commercially from food wastes, to restrain populations and injure to plants, by two-spotted spider mites [*Tetranychus urticae* Koch (Acari: Tetranychidae)], mealy bugs [*Pseudococcus* sp. (Hemiptera: Pseudococcidae)] and aphid (*M. persicae*). Almost all of the mixtures concealed the arthropod pest populations and reduced pest injure considerably in comparison to the untreated controls.

Feasible methods for the inhibition of insect and pests argued were comprised; the form of nitrogen existing in the leaf tissues, the effects of organic resources on micronutrient availability and the potential creation of phenols by the plants after applications of organic materials, thus making the tissues unpalatable to the pests. The management of aphid pest's population on rapeseeds has been largely dependent on the availability of a diversity of some insecticides. Presently, new dimensions in crop protection are to provide chemical free commodity from seed sowing to plant cultivation, maturity and harvest. This requires the exploration of alternating techniques of pests' managing that are not only efficient, but specific, and safe and sound as well.

One of the pest control progresses is the exploitation of botanicals in aphid management strategy. Botanical components are very suitable in comparison to synthetic insecticides for the reason that of an understood repute for being environmentally harmless and with a reduction of dangerous to humans and other non-target organisms (McCloskey et al., 1993). The need for a greater diversity of effective compounds against insects can be met by the introduction of several pesticides with new mode of action, which is less affected by existing resistance mechanism. Therefore, effectiveness of four selected botanicals against aphid was carried out in field location. Botanicals were used as crude concoction in water as solvent. The objectives were to evaluate the efficacy of candidate botanicals in controlling aphid damage in an effective and low cost friendly manner to avoid dependency on excessive usage of synthetic insecticides.

2. MATERIALS AND METHODS

2.1. Experimental Station and Procedure

The existing study was conducted on experimental station at Nuclear Institute of Agriculture, Tandojam, Pakistan. The research trial was conducted under field conditions on well managed and fine soil. The study period was winter season during the first weak of November, 2004 to second week of April 2005. A canola cultivar "Waster" was used locally for trail in that location. The seeds were obtained from the crop grown and harvested during the previous season. The crop planting date was in synchronized with timing followed by other farmers in the locality. The crop was grown at a distance of 30 cm among rows and 9 cm between plants in 1 × 2.5 m^2 plots that were 1 m spaced. Randomized complete block design (RCBD), was the layout of experiment and five treatments were incorporated including the check, all replicated on three blocks. The botanicals appraised included formulations of Tobacco *Nicotiana tabacum*, Garlic *Allium sativum*, Goosefoot *Chenopodium album* and *Aloe vera* at 10% concentration. The controls plots were kept untreated without any botanicals, but, a simple crop spraying done with water only. Prior to treatment applications, no any pesticides were applied after crop planting. This was to ensure proper pests protection efficiency only from plant origin natural materials.

All botanical formulations were made from newly collected leaves of the participator species of plants. The leaves of all plants were weighed into 500 gm samples separately and using pestle and mortar pulverized into a thin paste. By mixing 500 gm of the leaves paste with 1 liter of water, the formulation of every contestant botanical was prepared. Following setting of plant materials for a time of 10 hours, by means of a fine mesh of cotton cloth, the crude extract was filtered. The spray formulation of each plant product was made by adding 5 liters of water to the filtrate, and as a surfactant 50 ml of liquid soap was added to each sample. The pest management action and treatments application commenced when crop was at least at flowering stage of the plants and aphid had developed at economic injury level. The spraying operation was repeated at weekly period upto 3 weeks and these corresponded with pest severity, crop ripeness and reap time. Each botanical formulation was used at crop @ 50 ml per 2.5 m^2 plot. The diluted plant extracts were applied to plants through foliar application. For the application of various plant products, a 10 liters knapsack sprayer was used. Prior to field application, the sprayer was carefully washed with clean water and soap, and then subsequently washed before being re-filled with a new botanical formulation.

Following the commencement of each treatment applications, the data on aphid incidence were taken on a weekly interval basis. A total of 5 plants constituted sampling unit that were selected randomly and examined starting from the central rows of treated and untreated plants in each replicate. At crop maturity, all plants were harvested from each plot and dried up individually in the sun to bring the moisture content of canola pods ranging within 12 and 13%, and then weighed to find out grain yield. Afterward, the pods were manually threshed and grains were acquired through the coning and quartering technique to find out yield variability owing to pest damage and plant protection measure put into practice from each replicate of a treatment. The seed samples were put into cloth bags, weighed and stored on elevated racks to ensure appropriate aeration and keep away from ground moisture movement into grains.

2.2. Data Analysis

Aphid mortality and crop yield were converted to mean values prior to statistical analysis to stabilize error variance. For further statistical analysis, the data were examined using the MSTAT-C statistical package (Panse and Sukhatme, 1985) to construct ANOVA for comparing means of each treatment. The means of all treatments were affirmed considerably diverse when the differences between these at probability level of 0.05% were larger than the computed LSD value.

3. RESULTS

3.1. Aphid Population

Aphid species *M. persicae* was frequently found insect pest in large number or of major agronomical importance at the experimental place. All dilutions of plants caused significant control of aphid, reduced crop damage and maintained pest population below those of the non-treated control plants in the entire trial. Pest and seed yield levels investigated differed significantly ($P< 0.05$) based on the type of treatments applied in the field location. There was a positive and strong relationship among aphid population's damage by sucking cell sap in the field and seed yield harvested. As such, the treatment that reduced or controlled pest damage in the field significantly also privileged the grain output (Table 1).

Among the different treatments, sucking pest aphid was the highest in control treatment (190.5/ plant) and *A. vera* was significantly more effective and proved to be very toxic (90.13 aphid per plant) than other botanicals and the control treatments. With the *N. tabacum* treatment, it was as effective as insecticidal property of *A. vera*, but, more effective than other treatments in managing upto 96.73 aphid per plant. On the other hand, in case of *C. album* and *A. sativum* treatments, these products maintained 140.1 and 153.3 aphid population per plant, respectively, than control treatment. Additionally, it was noted that plant growth and stand, especially due to botanical treatments owing to their organic nature, remained invariably higher than in non-treated crop growing area.

3.2. Crop Yield

Grain yield levels due to aphid's invasion differed significantly depending upon the treatment applied across the location and season. Crop treated with *A. vera* and to a greater extent by *N. tabacum* were rated just about similar in case of yield which had the very good quantity of produce showing 433.3 and 390.0 gm/ 2.5 m^2 plot (1733.2 and 1560.0 kg/ hec), respectively. With the above treated botanicals, the crop had the best yield across all the season followed by *C. album* and *A. sativum* encompassing 356.7 and 286.7 gm/ 2.5 m^2 plot (1426.8 and 1146.8 kg/ hec), respectively, relative to the untreated control. Untreated crop was observed the most damaged by pest and conferred bare minimum yield of 207.0 gm/ 2.5 m^2 plot (828.0 kg/ hec). Consequently, *A. vera* evaluated was the best botanical, the performances of *A. vera* and to a larger extent *N. tabacum* were rated similar, and was followed by *C. album* and then *A. sativum* in intensifying seed yield as compared with control.

Table 1: Inhibitory effects of organic pest control agents against aphid and resulting seed yield in canola crop.

S. No.	Treatments	Aphid population/ plant	Yield/ plot (2.5 m^2) (gm)	Yield/ Hectare (Kg)
1.	T1= *Nicotiana tabacum* L. (Tobacco)	96.73 cd	390.0 ab	1560.0
2.	T2= *Allium sativum* L. (Garlic)	153.3 ab	286.7 c	1146.8
3.	T3= *Chenopodium album* L. (Goosefoot)	140.1 bc	356.7 b	1426.8
4.	T4= *Aloe vera* L. (Aloe)	90.13 d	433.3 a	1733.2
5.	T5= Control	190.5 a	207.0 d	828.0
LSD value		47.06	63.50	

In each column, the means tracked by the identical letters are not significantly dissimilar ($P< 0.05$).

4. DISCUSSIONS

This document provides the results of general understanding in the progress and encouragement of plant based insecticides to control the aphid in canola field crop that is particularly vulnerable to pest attack. The results suggested that even crude botanical formulations had a significant benefit on pest intensity and yield. The efficiency of the contestant botanicals to manage the target pest aphids differed appreciably in most cases as compared to untreated control that did not obtain any type of plant protection measure and was damaged the most at investigational site. Many scientists have developed low in cost ways of making their own sprays, extracts or natural insecticide products from locally available plants, which have proved to be very effective for the control of certain insect pests (Iqbal et al., 2011; Sarwar et

al., 2013). From the present study, it may be satisfied that the application of natural plant product *A. vera* on canola crop reduced the aphid population. Similar to current findings, some earlier researchers indicated a possible synergistic effect of *A. vera*, which is an important member of the family Lily and have very succulent-like in manifestation. The *A. vera* gel used, is the leaf soft tissue or mucilage thin clear jelly-like substance acquired from the parenchyma tissue that builds up the internal fraction of the leaves. Saoo et al., (1996) determined antiviral activity of Aloe extract. Saccu et al., (2001) from the leaves of Aloe investigated bittering agents such as isoaloeresin, aloins and anisole. Hu et al., (2005) determined trolox and ethanol components showing stronger antioxidant activities in extracts of *A. vera*. Rodriguez et al., (2005) reported Aloe liquid fraction activity against plant pathogens (bacteria and fungi).

Other researchers detailed less or more analogous findings like contemporary observations; Morse et al., (2002) suggested that as an integrated pest management program using a botanical such as tobacco plants could effectively control infestations of major pests, while, having a negligible effect on biological control agents. Opolot et al., (2006) studied that application of tobacco at the stage of podding considerably condensed pod pests in field and storage, and botanical pesticides may possibly replace with synthetic pesticides where complete pest control is not imperative. Chiasson et al., (2004) based on an essential oil extract from Chenopodium to control aphid *M. persicae*, determined it significantly more effective than the control (water only). Kasali et al., (2006) analyzed the composition of essential oil from the leaves of Chenopodium and identified major compound alpha-terpinene. Samuel et al., (2000) reported the aqueous extract of *A. sativum* bulbs showing an antifungal effect against the fungal pathogen. Melaku (2004) tested potentially some botanicals for further sustainable and safe alternatives to the generally used insecticides in terms of both aphid population as well as ultimate grain yield. Predator density, in particular of ladybird beetles (*Adonia* sp.), was especially higher on garlic-treated plants.

Over the last several decades, the technical explorations on *A. vera* have gained much consideration by reason of its trustworthy medicinal properties. Within some reputable scientific journals, several publications have come into view, which have made significant contributions to the invention of the roles and exploitations of Aloe, and found it as "nature's gift". Chemical analysis revealed that *A. vera* holds different carbohydrate polymers, remarkably glucomannans, along with a variety of other organic and inorganic components (Eshun and He, 2004). Serrano et al., (2006) showed *A. vera* gel as non-contaminating treatment, and maintained the functional properties of produce. Further research is needed to be carried out to unravel the myth surrounding the biological actions and the practical properties of *A. vera.* Suitable processing skills ought to be employed throughout the stabilization of the gel in order to influence and expand its field of deployment. Because of a naturally occurring pesticide, *A. vera* material could be useful as a new preventive agent against damage caused by aphid and potential candidate as new organic insecticide. As a result of minimum input cost, elevated gross benefits and net turnover in pest control treatment along with the economic saving associated with the utilization of *A. vera*, it can be even more favorably used in the integrated pest management program.

5. CONCLUSION

This study proffered an opportunity of managing aphid pest in the field with some botanicals. Even though botanicals have given away higher to modest efficiency against aphid pest, but, the search for atmosphere pleasant techniques and availability in the vicinity, make them hopeful substitutes to the synthetic chemicals. Due to the application of botanicals to protect canola against aphid, the experimental site was wiped out from pest incidence during crop season. Yet in order to progress their effectiveness, the subsequent implications are made; application of botanical treatment may be started before time when aphids invasion is still small, prescribed amount rates can be improved, synergism among botanicals may be assessed, spraying frequency should be based on economic thresholds of pest, and lastly the incorporation of admixtures with other control actions are recommended for entirety crop fortification. It is accomplished that while scientific efficiency of botanicals is a vital component, there are others such factors for instance, the logistics of manufacturing and preparation are needed to be measured. An improved understanding of the equilibrium among these factors and how perspective precise they may be, are auxiliary steps obligatory in order to take advantage of their implementation by farmers.

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I, Dr. Muhammad Sarwar, started service career as Agricultural Officer (Plant Protection) from 16. 05. 1991 to 31. 05. 2001, Directorate of Pest Warning & Quality Control of Pesticides, Department of Agriculture, Punjab, which was exclusively deployed on research work for better crop protection. Specialized in the field of Entomology (Insects) and Acarology (Mites) and significantly contributed in the field of crop protection. Worked on vertebrate pests management especially controls of rodents in field crops and storage. Explored, hitherto the unexplored 36 species of stored grain & stored products mites, which were new additions to Acarology, by conducting extensive survey of different localities in Pakistan & Azad Kashmir. These species were belonging to 8 genera viz., *Forcellinia*, *Lackerbaueria*, *Acotyledon*, *Caloglyphus* and *Troupeauia* of family Acaridae; *Capronomoia*, *Histiostoma* and *Glyphanoetus* in family Histiostomatidae. Identification keys, taxonomical observations, differentiation remarks, comparison of characters, similarity matrices, Phenograms and Geographical maps of new species along with 48 alien species had been prepared. Conducted research work on Integrated Management of Cotton Leaf Curl Disease, Pest scouting, Pest monitoring and forecasting; planning, designing and layout of different research trials and data recording for integrated pest management on different crops, vegetables and orchards. Imparted training to the farmers and Field Staff, and provision of advisory services to the farmers regarding plant protection practices. Instructed training to the pesticide's dealers for proper handling, distribution and storing of pesticides, their legal aspects and sampling of pesticides for the purpose of quality control. Joined Pakistan Atomic Energy Commission, as Senior Scientist, on 1st June 2001 and involved in the research Projects, viz., Studies on the ecology, behavior and control of rice stem borers, Insect pests management of Brassica crops, Ecology and control of gram pod borers, and Management of post-harvest food losses. Currently, conducting research work on IPM of Mosquitoes, Cotton insect pests and Fruit flies.