



MANAGEMENT OF APHID BORNE POTATO VIRUS Y (PVY) THROUGH CHEMICAL AND BIO-CHEMICAL METHODS

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ABSTRACT

The aim of this study was the management of potato virus Y (PVY) in the susceptible potato cultivar Desiree through chemical and bio-chemical methods. The experiment was carried out at the New Developmental Farm (NDF), the University of Agriculture, Peshawar during the spring season, 2014 under field conditions. One of the major objectives of the experiment was to assess the effectiveness of the treatment application in their individual state as well as in combinations under field conditions. The treatments were mineral oil, insecticide, neem extract and their combinations. Among various treatments, Diver was effective with disease severity level 1 and percentage disease incidence (40%) in individual state and in combination (Diver + Confidor) and (Diver + Confidor + Neem extract) gave good results with disease incidence (33.33%) and with a disease severity level 1. Neem extract was found to be less effective when used individually with disease incidence (56.66%) and with a disease severity level 3, whereas Confidor when applied individually was more effective than Neem extract with disease incidence (50%) and with a disease severity level 2. Moreover Diver in combination with Neem extract was found to be less effective in management of PVY as compared to Diver in combination with Confidor with disease incidence (40%) and disease severity level 1. Three aphid species were found in the field, i.e. *Myzus persicae* (Sulzer), *Aphid gossypii* (Glover) and *Macrosiphum euphorbiae* (Thomas). In case of aphid's population, Confidor was more effective in reducing aphid's population as compared to Diver and Neem extract. Finally, it can be concluded that Diver alone was more effective in the management of PVY. However, in combination, Diver with Confidor significantly managed PVY under field conditions

**Key word:** PVY, chemical method, non-chemical method, management.

INTRODUCTION

The cultivated potato (*Solanum tuberosum* L.) is the world's most important food and vegetable crop and rate fourth in production. It contains 78% water, 18% starch, 2% protein, 1% vitamins and several trace elements. It is the world's leading crop and grown in approximately 140 countries (Haase, 2007). Potato originated from the mountain regions of South America and has spread to many countries of the world, including Pakistan, Bangladesh, India, North America and South America and China in recent years (Beukema and van der Zaag, 1990).

In Pakistan, it is used because of its nutritious value, accessibility and low price when compared with other vegetables. That is why the area under potato farming has progressively increased since independence (Bhutta, 2008). In Pakistan, potato is grown over an area of 174.4 thousand hectares with a total production of 3802.3 thousand tons and the average yield was recorded 22 tons per hectares (GOP, 2016). Most of the potato in Pakistan is cultivated in Central and Northern plains of Punjab. Major areas of potato production in the Khyber Pakhtunkhwa province are Swat, Dir, Kaghan and Peshawar valley. Total productions of 120.5 tons from 10.2 hectares with an average yield of 14.52 tons per hectare were recorded from Khyber Paktunkhwa province (GOP, 2016).

Since potatoes are vegetative propagated, this creates exclusive opportunities for pathogens to establish and spread

several diseases (Khurana, 2004). Among them, more than 37 viruses are infecting potato crops. Three potato crops are grown during a year; autumn, spring and summer crops in the plains and the hilly areas of Pakistan (Abbas et al., 2012). In Pakistan high yielding foreign varieties of potato drastically increased the yield, but new plant pathogens also emerged as a results of these foreign varieties, including viruses such as potato virus Y (PVY) (Abbas et al., 2014; Hussain et al., 2016), potato leaf roll virus (PLRV), potato virus A (PVA), potato virus M (PVM), potato virus S (PVS) (Abbas et al., 2012) and potato virus X (PVX) (Hameed et al., 2014), Potato mop-top virus (Abbas and Madadi, 2016) which had been reported in spring, autumn and summer potato crops in Pakistan.

These viruses cause mild to severe diseases which result in huge losses. Mughal et al. (1986) reported that up to 83% yield losses occur in Pakistan, due to viruses. PVY and PLRV are the most damaging pathogens and are found all over the world (Thomas et al., 2000). Both viruses are transmitted through infected tubers from one growing season to another, while during the season, they are transmitted from infected plants within the crop and from plants in the surroundings (source of infection) by various species of aphids (family: Aphididae) (Mansour et al., 2008; Kirchner et al., 2009). PVY is among one of the major problems in seed production in many countries worldwide, including Pakistan (Basky, 2006; Kirchner et al., 2009). Crop management against plant viruses during seed potato reduction involves the use of a number of

practices, which often include insecticide treatments, as their integral part, since aphid transmission is the most important mode of virus transmission in a field during a growing season (Kotzampigikis *et al.*, 2008; Nolte *et al.*, 2009). Aphids are the most important and the most harmful as vectors of potato viruses (Sigvald and Hulle, 2004). More than 40 species of aphids are transmitting PVY in natural conditions (Sigvald and Hulle, 2004). *Myzus persicae* alone is a vector of more than 150 types of viruses (Saucke and Döring, 2004). It is the most efficient aphid vector of PVY (King *et al.*, 2011). Mineral oils are widely used to reduce transmission of PVY, because these oils change aphid's feeding behavior. Moreover aphid's stylet penetrations in a plant host could also be late when plants are treated with mineral oil (Hussain *et al.*, 2016). Moreover, mineral oil had been revealed for having a repulsive effect on aphids, however the repulsive effect remains only for a short period of time (30 min after treatment) (Ameline *et al.*, 2010).

Insecticides such as confidor can be effective in preventing potato virus transmission from contaminated plants to healthy plants within a crop, which can have on the whole positive effect only if seed potato is grown in areas that have no outside source of infection (Abbas *et al.*, 2016). Further systemic insecticides are useful to reduce the transmission of PVY by its vectors in the field (King *et al.*, 2011). Different techniques were used for the confirmation of viruses (Qamar *et al.*, 2016; Urooj *et al.*, 2016; Khan *et al.*, 2017) Continuous application of insecticides contaminates the environment, increase the cost of production and as well as increases resistance in aphids against such insecticides. In comparison to insecticides, mineral oils are less harmful to the environment and more significant in the reduction of PVY transmission by aphids. The neem extract also reduces the aphid population and PVY incidence, however their performance was found to lower compared to insecticides. The reason is neem is slow acting and this delayed action may be very critical for non-persistent viruses like PVY, which is transmitted in seconds by viruliferous aphids (Sastry and Zitter, 2014; Abbas *et al.*, 2016). Therefore, there is a need to promote rational use of insecticide, mineral oil and neem extract, which has been a great incentive to manage aphids and PVY under field conditions. The present study was initiated to assess the individual and combined effects of mineral oil, insecticide and neem extract for the control of PVY.

## MATERIALS AND METHODS

**Experimental design and field experimentation:** The experiment was designed to determine the individual and combined effects of mineral oils, insecticides and neem extracts for the management of PVY under natural field conditions, at the New Developmental Farm (NDF), University of Agriculture, Peshawar. Randomized complete block design (RCBD) was used in the experiment. The field was prepared and the tubers of susceptible potato cultivar Desiree were grown on ridges. Standard agronomic practices such as weeding as well as plant to plant distance was maintained 30

cm and row to row distance was maintained at 60cm (Ahmad *et al.*, 2011). Moreover irrigation was done based on the requirement of potato crop. The crop was sown in February, 2014. Seven treatments of the experiment were as follows:

T1 = Mineral oil (Diver)

T2 = Insecticide (Confidor)

T3 = Neem extract

T4 = Mineral oil+ Insecticide

T5 = Mineral oil+ Neem extract

T6 = Mineral oil+ Insecticide + Neem extract

T7 = Control (Untreated)

There were three replications of each treatment. Each treatment was applied to a ridge consist of 10 potato plants.

**Collection of data:** Data on aphid population were recorded by using sample monitoring chart by visual counts per 100 leaf method (Arif and Rizvi, 2006) at weekly interval and plants were randomly selected from each ridge. 3 fully expanded leaves such as from the top, middle and lower parts of the plants were investigated and numbers of winged and wingless aphids were recorded. Aphids were collected in petri dishes and were brought to the laboratory for further identification. Data on yield was recorded such as tuber yield (Kg) per ten plants was calculated by weighing tubers from individual plant. Moreover, plant height (cm) and as well as tuber size was also measured. Disease severity was recorded by using a disease rating scale reported by (Mughal and Khan, 2001).

Disease severity scale

0 = No symptoms

1 = Blackening and banding of vein on a small number of leaves. Mosaic started on all leaves.

2 = Blackening and banding of veins on the entire leaves, narrowing of leaves, venial necrosis.

3 = Severe mosaic, leaf crinkling, rugosity and leaf drop streak, dwarfing.

4 = Lower leaves dead, drooping collapse of plants with very undersized tubers.

5 = All leaves dead, stem dead or drying.

Potato tubers of the susceptible cultivar Desiree infected with potato virus Y (PVY) as proved by Enzyme Linked Immunosorbent assay (ELISA) were collected for the field experiment. These potato tubers were grown in the field and percentage disease incidence of PVY was recorded by using the following formula:

% incidence of PVY= Number of infected plants / Total number of plants x 100

**Identification of aphid's species:** Aphids were collected from the potato field, preserved in 70% ethyl alcohol and brought to the entomology laboratory for further identification. Species were identified with the help of existing laboratory collection and entomological keys based on morphological features such as body color, cornicle length and length of antenna as described by Martin (1983) and Blackman and Eastop (2000).

## RESULTS AND DISCUSSION

**Effect of treatments on aphid population:** Three aphid

species were found in the field, i.e *Myzus persicae* (Sulzer), *Aphid gossypii* (Glover) and *Macrosiphum euphorbiae* (Thomas). Table 1 and figure 1 reveals a mean number of aphids in the experimental field from March - May 2014.

Table 1: Population of aphid after treatment applications from March to April 2014 in potato field UAP\*

S. No	Treatment	Mean No: of aphids
1	T1 = Diver	11.2bc
2	T2 = Confidor	10.3bc
3	T3 = Neem extract	12.22b
4	T4 = Diver + Confidor	9.33c
5	T5 = Diver + Neem extract	11.35bc
6	T6 = Diver + Confidor + Neem extract	9.41c
7	T7 = Control	21.85a
LSD (0.05)		2.27
CV		10.43

\*Means followed by the same letter within the columns are not significantly different at  $P < 0.05$ .

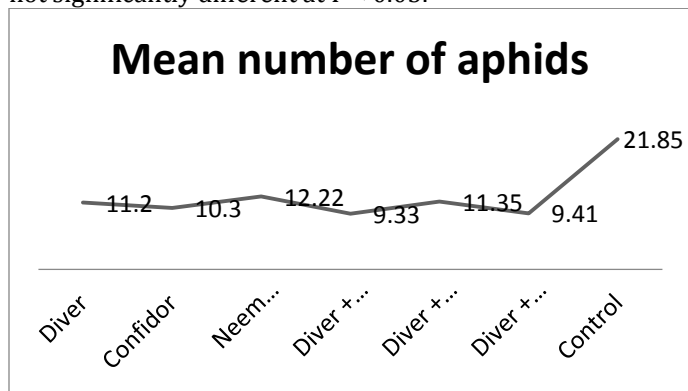


Figure 1: Population of aphids after treatment applications in potato field UAP\*

The highest number of aphids (vectors) population was recorded in T7 (21.85 aphids per 100 leaves) where in this treatment no Diver, Confidor and Neem extract was applied. The lowest number of vector population was observed in T4 (9.33) followed by T6 (9.41), T2 (10.3), T1 (11.2), T5 (11.35) and T3 (12.22) respectively. Among the treatments T6 (Diver + Confidor + Neem extract) and T4 (Diver + Confidor) were found to be more effective against aphid than the rest of the treatments. Analysis of variance shows that there is a significant difference at ( $P < 0.05$ ) regarding the number of aphids among all the treatments. Among the treatments T1 (Diver), T5 (Diver + Neem extract) and T2 (Confidor) statistically were not significantly different from each other. Moreover, the number of aphids was statistically same in the treatments T4 and T6.

**The incidence and severity of PVY affected by the treatment applications:** The percent incidence and severity level of PVY in the field during the spring, 2014 was recorded (Table 2). The maximum % incidence was found in T7 (66.66) with severity level 4 which was control followed by T3

(56.66) with severity level 3 and the lowest percentage incidence was found in T4 (33.33) with severity level 1 and T6 (33.33) and a severity level 1. Among the treatments T1 (Diver) with 40% incidence and a severity level 1 was more efficient as compared to T2 (Confidor) with 50% incidence and a severity level 2 in the management of PVY. Neem extract (T3) was less effective with 56.66% incidence and a severity level 3 when used individually and there was 40% incidence when used in combination with Diver (T5) in treatment with severity level (1) in managing PVY in a potato field. Analysis of variance indicates that the mean percent incidence was significantly different among the treatments at 0.05 level of probability (Table 2). The percent incidence in the treatments T1 and T5 was found to be statistically same. The treatments T4 and T6 were also found to have statistically same percent incidence.

Table 2: Disease incidence and Severity of PVY affected by different treatments during spring, 2014 at the experimental field of UAP

S. No	Treatment	Tested Plants	Infected plants	% Disease incidence	Severity Scale
1	T1 = Diver	30	12	40.00d	1
2	T2 = Confidor	30	15	50.00c	2
3	T3 = Neem extract	30	17	56.66b	3
4	T4 = Diver + Confidor	30	10	33.33e	1
5	T5 = Diver + Neem extract	30	12	40.00d	1
6	T6 = Diver + Confidor+ Neem extract	30	10	33.33e	1
7	T7 = Control	30	20	66.66a	4
LSD (0.05)				4.81	
CV				5.92	

**Effect of treatments on various yield parameters of potato cv. Desiree:**

Table 3 shows plants height and tuber size. Maximum plant height was recorded from the treatment T6 (43.33 cm) followed by T4 (40 cm), T5 (37 cm) and T1 (36 cm) while the minimum height was obtained from the treatment T2 (34 cm), T3 (32 cm) and in control (30 cm). In case of tuber size the treatment (T6) was found to have maximum tuber size with (6 cm) followed by T4 (5.85 cm), T5 (5.80 cm), T1 (5.80 cm) respectively, while lowest tuber size was reported from the treatment T2 (5.1 cm) and T3 (4.60 cm) which was slightly higher than control T7 (4.1 cm).

**Effect of various treatments on potato yield:** The results regarding the yield are presented in Table 4. Between various treatments, the treatment T6 (Diver + Confidor + Neem extract) was found effective in performance as compared to rest of the treatments and gave a yield of (6.05 kg) per 104 plants. Promising yield was also achieved from T4 (6 Kg) followed by T5 (5.96 Kg), T1 (5.95 Kg), T2 (5 kg) and T3 (4.30 Kg) respectively. Lowest yield was obtained from the

treatment T7 (3.21 Kg) which was controlled.

Table 3: Effect of PVY on various yield parameters of potato cultivar Desiree.

S. No	Treatment	Height (cm)	Tuber size (cm)
1	T1 = Diver	36bcd	5.80a
2	T2 = Confidor	34cde	5.1b
3	T3 = Neem extract	32de	4.60bc
4	T4 = Diver + Confidor	40ab	5.85a
5	T5 = Diver + Neem extract	37bc	5.80a
6	T6 = Diver + Confidor + Neem extract	43.33a	6a
7	T7 = Control	31e	4.1c
LSD (0.05)		4.84	0.64
CV		7.49	6.81

Table 4: Effects of various treatments on potato yield.

Sr. No	Treatment	Mean Yield
1	T1 = Diver	5.95ab
2	T2 = Confidor	5.00bc
3	T3 = Neem extract	4.30c
4	T4 = Diver + Confidor	6.00a
5	T5 = Diver + Neem extract	5.96ab
6	T6 = Diver + Confidor + Neem extract	6.05a
7	T7 = Control	3.21d
LSD (0.05)		0.47
CV		5.16

Disease Severity scale (Mughal and Khan, 2001).

0 = No symptoms

1 = Blackening and banding of vein on a small number of leaves. Mosaic started on all leaves.

2 = Blackening and banding of vein on the entire leaves, narrowing of leaves, venial necrosis, Severe mosaic, leaf crinkling.

3 = Severe mosaic, leaf crinkling, rugosity and leaf drop streak, dwarfing.

4 = Lower leaves dead, drooping collapse of plants with very undersized tubers.

5 = All leaves dead, stem dead or drying.

Present study indicated that a combined application of Diver and Confidor was quite effective. The results revealed that after the combined application of Diver and Confidor, 30 % disease incidence with severity level (1) were recorded and mean number of aphid population was recorded as 9.33 per hundred compound leaves. This is in agreement with the findings of Radcliffe and Ragsdale (2002), who reported that a combined application of insecticide and mineral oil were effective in managing PVY in planted field. Our results were further in agreement with Olubayo *et al.* (2010) who reported that combination of mineral oil and synthetic insecticide might play a significant role in the management of plant

viruses and their associated vectors. In case of Neem extract treatment, % disease incidence was recorded as (56.7 %) with disease severity level (3) and mean number of aphid population was 12.2 per hundred compound leaves which is lower than then the control (66.7 %) disease incidence with severity level (4) and 21.9 aphids per hundred compound leaves). In the present study Neem extract was less effective individually as well in combination. These results are in agreement with those of Handizi and Legorburu (2002), who reported an incomplete management of PVY by applying Neem extract and concluded that the Neem extract is not effective in managing non-persistent viruses such as PVY. The present study also indicated that aphid the population varied during the cropping season and our results support the findings of Saljoqi (2009) who obtained similar results.

Our findings were also in accordance with the finding of Green *et al.* (2017) whom they reported that current infection of potato virus Y (PVY) cause miner yield losses in the potato crop, if the initial infection occurs after flowering. Further studies are needed to find out the mode of action of various oils in connection with the management of non-persistent plant viruses in potato and other crops. It is also required to investigate that how single aphid species such as Myzus persicae can acquire and transmit non-persistent plant viruses such as PVY, and at the same time other viruses such as PLRV, through circulative persistent manner.

#### CONCLUSIONS

1. Diver (mineral oil) is effective in the management of PVY under natural field conditions.
2. The combination of Diver and Confidor was also effective to manage PVY, but Neem extract alone was not effective to manage PVY under field conditions.

#### RECOMMENDATION

Mineral oil (Diver) could be used for the management of PVY and its associated vectors in potato field.

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