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Epidemiological studies of Okra Yellow Vein Mosaic Virus (OYVMV) and its management strategies

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ABSTARCT

Okra (*Abelmoschus esculentus*) is known as lady finger and is an important vegetable crop in Pakistan. In this experiment twelve (12) different varieties Ok-4108, Rohi-211, Ok-suraksh, Sabz pari, Patal, Pusa Makhmali, Bhindi Punjab, /Rupa-14, Ok-404, Ok-Nayab, OH-8418, G-Ho were screened against OYVMV. No variety showed resistant response against OYVMV, while three (03) showed moderately resistant response, four (04) varieties showed moderately susceptible response and five (05) varieties showed susceptible response against OYVMV. There was a close relationship between disease and environment, climate change effect the increase or decrease of disease under field conditions. For disease development, temperature has a great influence and addition of stress may led to the reduction of host immunity against okra yellow vein mosaic virus. In case of rainfall non-significant correlation was observed and increase in disease was observe with the minimum temperature, maximum temperature, wind speed and relative humidity and significant correlation was observed. Two plant extracts Neem (*Azedarchta Indica)* @ 500ml, Bakain (*Melia azedarch)* @500ml and one insecticide imadicloprid with one control were assessed against OYVMV on four cultivars i.e. Bhindi Punjab, Rupa- 14, Rohi- 211, Sabz pari which were sown in the research area of Department of Plant Pathology, University of Agriculture Faisalabad. Imadicloprid showed best results to manage OYVMV followed by neem and bakain extracts. While neem extract also showed good results to manage the disease.

Key words: Okra, plant extracts, insecticide, okra yellow vein mosaic virus (OYVMV)

INTRODUCTION

Okra (*Abelmoschus esculentus*) is known as lady finger and is an important crop all over the world including Pakistan and India. Mostly it is used in cocked form but it is being used in fresh form in different areas of world. Immature pods are used as salad, soups stews and boiled vegetable as well. Coastal areas are the most cultivated areas of okra where small land holders grow it for food and marketing in local urban population. Okra has been using as medicine against controlling diabetes (Lengsfield *et al*.,

2004). In okra, viral diseases are considered less important or even exited from the diseases of plant. (Simone, 1999). Okra mosaic virus and Okra leaf curl virus are the most studied and common diseases. Okra is susceptible to atleast 20 different plant viruses (Swanson and Harrison, 1993). The virus causes mosaic, plant stunting, budding and vein chlorosis. Different parts of Middle East and West Africa, Okra yellow vein mosaic virus is the most important disease of okra caused by OYVMV (Lana, 1976). In tropical areas, the extent of yield loss caused by viral disease syndrome have not been well established (Thottappilly, 1992). Okra is rainy season crop and requires hot environment and long days and normal temperature at night. Growers cultivate it in early season like in January when temperature is below 37^0F so that crop produces good quality and quantity of fruits (Simonne *et al,* 2004). Crop gets maturity in about 60 days and becomes ready to harvest fruits. Pods must be harvested right after 3 to 5 days after flowering of plants; pods size must be low from 10 cm as well as skin of fruits should be soft at the time of harvesting (Tonhasca *et al.,* 1994). Fruit picking can be done on daily basis during fruiting season and several times if crop is mowed (Rusike *et al.,* 2010).

Various insect pests attack on crop in different stages and cause diseases in plants (Fasunwon &Banjo 2010). OYVMV is one of the main factor in producing disease in okra crop (Fajinmi and Fajinmi, 2010). Great number of chemical are biosynthesized in natural laboratories and several plants have established biochemical and natural mechanism to protect itself from weeds, animals, insects, and Fungal attack (Bpia 2009). By studying the interactions of various plant varieties, scientists have successfully discovered beneficial substances that can be applied as bio-pesticide (Bpia 2009). Higher plant products (oils and extracts) have been reported in exhibiting antifungal, insecticidal, antimicrobial properties (Bouamama *et al., 2006;*). Plant era xtracts have been found controlling fungal, viral and bacterial diseases. Plants immune system is trigged against biotic diseases (Bpia 2009). The most destructive insect pests are Thrips, Jassid, whitefly, spotted bollworm and aphid etc. The vector of OKYVMV, *B. tabaci* is the most destructive one pest, by sucking it destroys sap inside leaves of plants and transmit viral disease (Patil *et al.,* 2011). Whitefly is the most important pest in worldwide in Greenhouse production system as well as in tropical and sub-tropical (Pypers *et al.,* 2011). Variety, which has highly resistance or susceptible against pests demand less or prevent the application of control strategies in the field (Gebhardt and Valkonen, 2001). Plant based pesticide & plant metabolites were found one of the good alternatives than the synthetic pesticides (Varma and Dubey, 1999). Higher plants extracts were found helpful in reducing the papulation of insect because it exhibits insecticidal properties. (Okigbo and Ogbonnaya, 2006). Sometime symptoms of Okra yellow vein mosaic make confusion because different types of symptoms appeared on infected plants (Luan *et al.,* 2012). In older leaves plants shows interveinal chlorosis due to the deficiency of magnesium. In young leaves turn yellow in color due to the deficiency of Ferrous oxide. Zinc deficiency causes irregular chlorotic mottling symptoms and younger leaves restricted shoot growth and chlorotic (Liu *et al.,* 2007).

The newly developed leaves show network of yellow vein and leaves encloses dark green patches of the leaf (Toscano *et al.,* 1998). The fruit of infected plant shows longitudinal alignment followed by yellow spots (Gold *et al.,* 1990). The fruits reduced in size and malformed. The fruit do not give good price in the market and the loss may be goes up to 95% (Traboulsi 1994).

Minimizing nutrient deficiency is very important to all because plants become susceptible to diseases, insect's pests and weak (Watson *et al.,* 1992). Application of required nutrient in the form of synthetic fertilizer as well as manures with optimum dose and correct time and method will resistance against diseases and insects (Varma *et al.,* 1992). Excessive use of nitrogenous fertilizer makes possibilities to increase susceptible to the diseases and lower the insect pest papulation (Wang and Tsai 1996). The papulation of *Bemicia tabaci* can be reduce by reducing disease severity which helpful in good harvest, but it must be understood that the use of insecticide commodities against *Bemicia tabaci* are likewise toxic to all livings and increase the rate of pollution in the environment of that area, hence use of insecticide should be avoided as far as possible (Viscarret *et al.,* 2000). Less hazards like plant extract maybe used instead of insecticide/ pesticides (Vetten *et al.,* 1996). For the management of Okra yellow vein mosaic virus briefly study of epidemiological factors is very helpful and important.

OBJECTIVES

- Screening of okra lines/varieties against OYVMV.
- Determination of impact of epidemiological factors with OYVMV and its vector (*Bemicia tabaci)*.
- Evaluation of different plant extracts and an insecticide against the OKYVMV in the field conditions.

MATERIALS AND METHODS

Screening of okra lines/varieties against Okra yellow vein mosaic virus

In the Research area of Department of Plant Pathology, University of Agriculture Faisalabad an experiment was conducted under filed conditions. The following verities were sown in the experiment viz Ok-4108, Rohi-211, Ok-suraksh, Sabz pari, Patal, Pusa Makhmali, Bhindi Punjab, /Rupa-14, Ok-404, Ok-Nayab, OH-8418, G-Ho. Seeds were obtained from vegetable Directorate, Ayub Agriculture Research Institute Faisalabad. Each variety was sown in Blocks in field, three replications maintaining row to row and plant spacing 60 cm and 20 cm respectively.

Table 1. Disease infection in plants will be recorded by following 0-7 Disease Rating scale:

Sr. No.	Disease incidence %	Rating	Response
1	0	0	Immune
2	1-10	1	Highly resistant
3	11-25	2	Moderately resistant
4	26-50	3	Toler Tolerant
5	51-60	4	Moderately tolerant
6	61-70	5	Susceptible
7	71-100	6	Highly susceptible

(Bashir *et al*., 2004)

The data of infection in plants was recorded on the basis of above mentioned disease rating scale. The data of different environmental (Temperature and Rain Fall) factors was recorded during the crop growth period.

$$\text{Disease incidence \%} = \frac{\text{Total infected plants observed}}{\text{Total observed plants}} \times 100$$

PLANT MATERIALS

Twelve okra lines/ varities (Ok-4108, Ok- suraksh, Rohi- 211, Sabz pari, Patal, Pusa Makhmali, Bhindi Punjab, Rupa-14, Ok- 404, Ok- Nayab, OH-8418, G-Ho) were collected from vegetable Directorate, Ayub Agriculture Institute Faisalabad (AARI). All lines/verities were sown under the field conditions in the research area of Department of Plant Pathology, University of Agriculture Faisalabad on 29 March 2017. Experiment was done on a 14-meter width and 18-meter length with 60cm (Rx R) and 20cm (Px P). Conventional agronomic practices, were followed and the data was recorded on 7 days interval during crop growth period. The disease on to each examination entry was checked by using disease rating scale (Bashir et al., 2004).

Collection of epidemiological data:

Epidemiological data consisting of minimum temperature, maximum temperature, relative humidity (%), rainfall (mm) and wind speed (km/h) was obtained from meteorological section, Department of Crop Physiology, University of Agriculture Faisalabad. In July and August, environmental data was recorded, and the data regarding OYVMV was recorded after every 7-days and subjected to regression and correlation (Steel *et al*., 1997).

Use of plant extract and chemical against Okra yellow vein mosaic virus (OYVMV).

Two plant extracts Neem (*Azedarchta Indica) @* 500ml and Bakain (*Melia azedarch)* @500ml with one control was assessed against OYVMV on four cultivars i.e. Bhindi Punjab, Rupa- 14, Rohi- 211, Sabz pari which were sown in the research area of Department of Plant Pathology, University of Agriculture Faisalabad. Each variety was sown in Randomized complete clocked design (RCBD), and with three replications with 20cm (P x P) and 60cm (R x R).

For preparation of standard dose of extract, 25 ml of water was taken and 75gm of leaves of plants as well (Ilyas *et al.,* 1997). Plants leaves were soaked in the sodium hypochalorate (1%) for 3 minutes and then mixed in the diluted water (25ml) in order to get plant extracts, after these extracts were passed through three layers of muslin cloth for filtration and removing of large particles in the liquid. The prepared solution stored at 4^{o} C to inhibit the activities of microbes in the solution. The data recording of OYVMV every after 15 days were subjected statistical analysis. Interaction between all of the treatments were determined through ANOVA and means of actions were compared by LSD at 5% level of probability (Steel *et al*., 1997).

T_1 *Melia azedarch (*S/20)
T_2 *Azadirachta indica (S/20)*
T_3 Imadacloporid (600gm/acre)
T_4 Control

Figure 1. Plant extracts for management of OYVMV

RESULTS AND DISCUSSION

Screening of Okra lines/varieties against yellow vein mosaic virus under field conditions

The data recoded at 14 days of interval for mosaic infection on Okra varieties caused by OYVMV are given in (table. 2). None of the line/variety was found to be resistant against Okra yellow vein mosaic virus, response of varieties varied regarding their level of susceptibility and resistance against mosaic infection (table. 2). Less infected varieties were Ok-4108, Ok- Suraksh, Rohi- 211, Pusa Makhmali and Ok-4108 which gave 55.77%, 50.1%, 51.1 and 60.90 plant infection, and categorized as moderately tolerant. Patel, Bhindi Punjab and Rupa-14 showed 30.25, 25.1% and 35.4% plant infection and classified as tolerant. OH-4108 and Ok-Nayab showed 80.3% and 90% plant infection and categorized highly susceptible. Only Sabz pari categorized susceptible because showed 705 plant infection. OH-4108 classified moderately susceptible because 60% plant infection showed.

Table 2. Response of okra varieties to OYVMV

Serial No.	Cultivars	Means of disease rating	Severity Rating	Level of resistance/susceptibility
1	OK-4108	60.90	5	Moderately tolerant
2	Ok-Suraksh	55.77	4	Moderately tolerant
3	Rohi-211	50.1	4	Moderately tolerant
4	Pusa Makhmali	51.2	4	Moderately tolerant
5	Patel	30.2	3	Tolerant
6	Bhindi Punjab	25.1	3	Tolerant

7	Rupa-14	35.4	3	Tolerant
8	Sabz pari	70	6	Susceptible
9	G-HO	80.3	7	Highly susceptible
10	OH-4108	60	5	Moderately susceptible
11	Ok-Nayab	90	9	Highly susceptible
12	Ok-404	65	6	Susceptible

Correlation of epidemiological factors with whitefly population

Effect of minimum temperature on whitefly population:

The value of r indicates that there is strong relationship exists between minimum temperature and whitefly population.

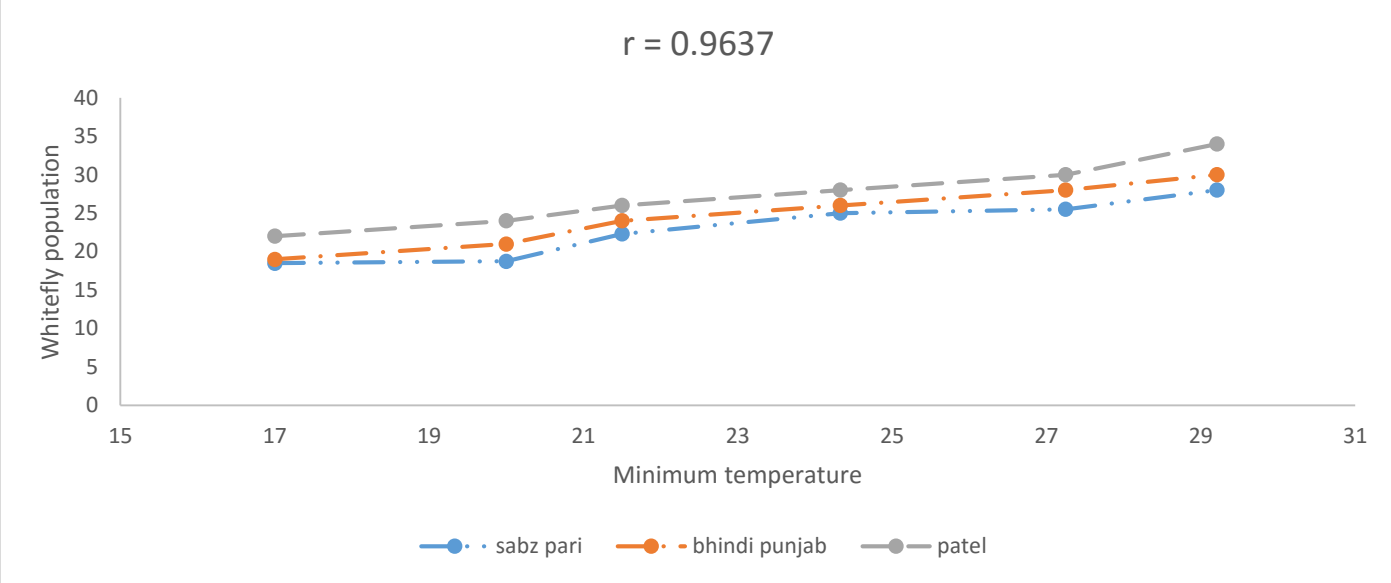

Figure. 2: Effect of minimum temperature on whitefly population

Effect of maximum temperature on whitefly population

The value of r indicates that there is strong relationship exists between maximum temperature and whitefly population.

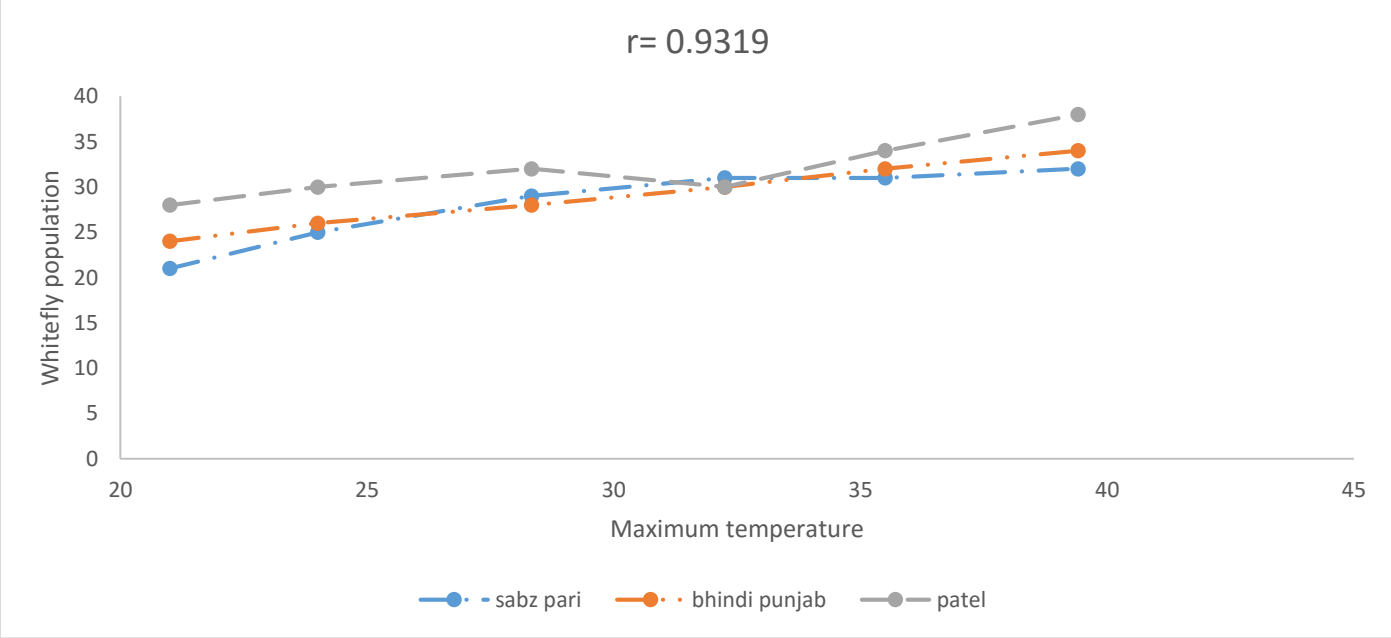

Figure.3: Effect of maximum temperature on whitefly population

Effect of rainfall on whitefly population

The value of r indicates that there is strong relationship exists between rainfall and whitefly population. As rainfall increases, the population of whitefly was also increased.

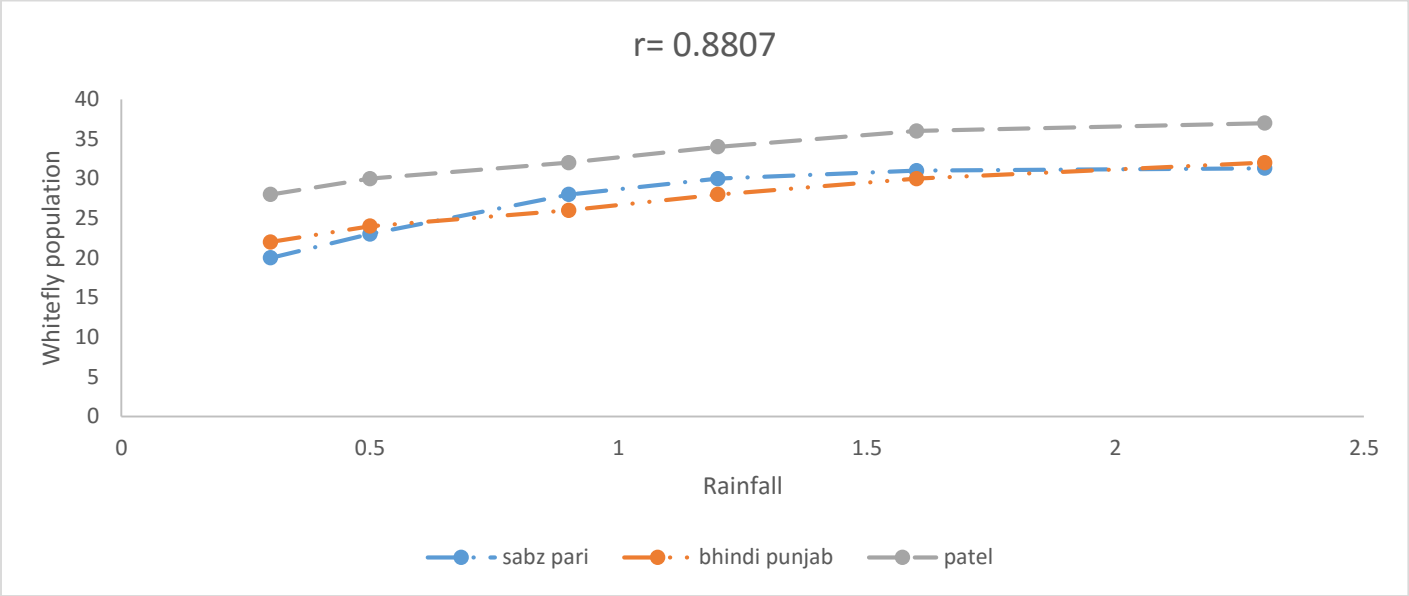

Figure. 4: Effect of rain fall on whitefly population

Effect of relative humidity on whitefly population

The value of r indicates that there is strong relationship exists between relative humidity and whitefly population. As relative humidity increases, the population of whitefly was also increased.

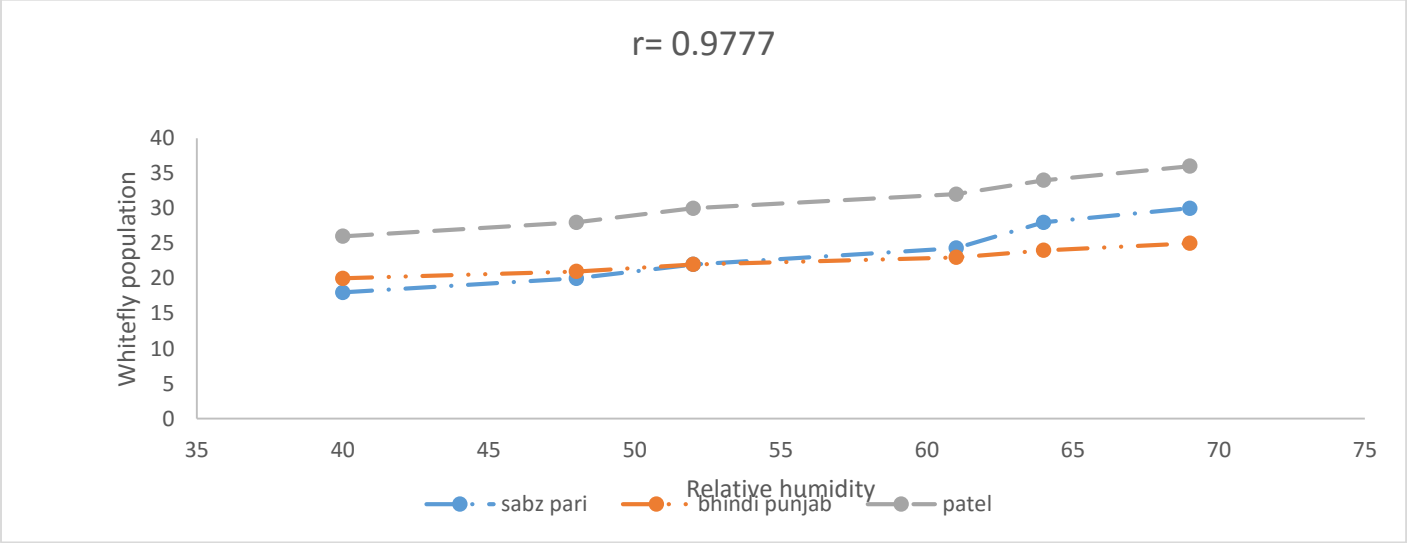

Figure 5: Effect of relative humidity on whitefly population

Effect of wind speed on whitefly population

The value of r indicates that there is strong relationship exists between wind speed and whitefly population. As wind speed increases, the population of whitefly was also increased.

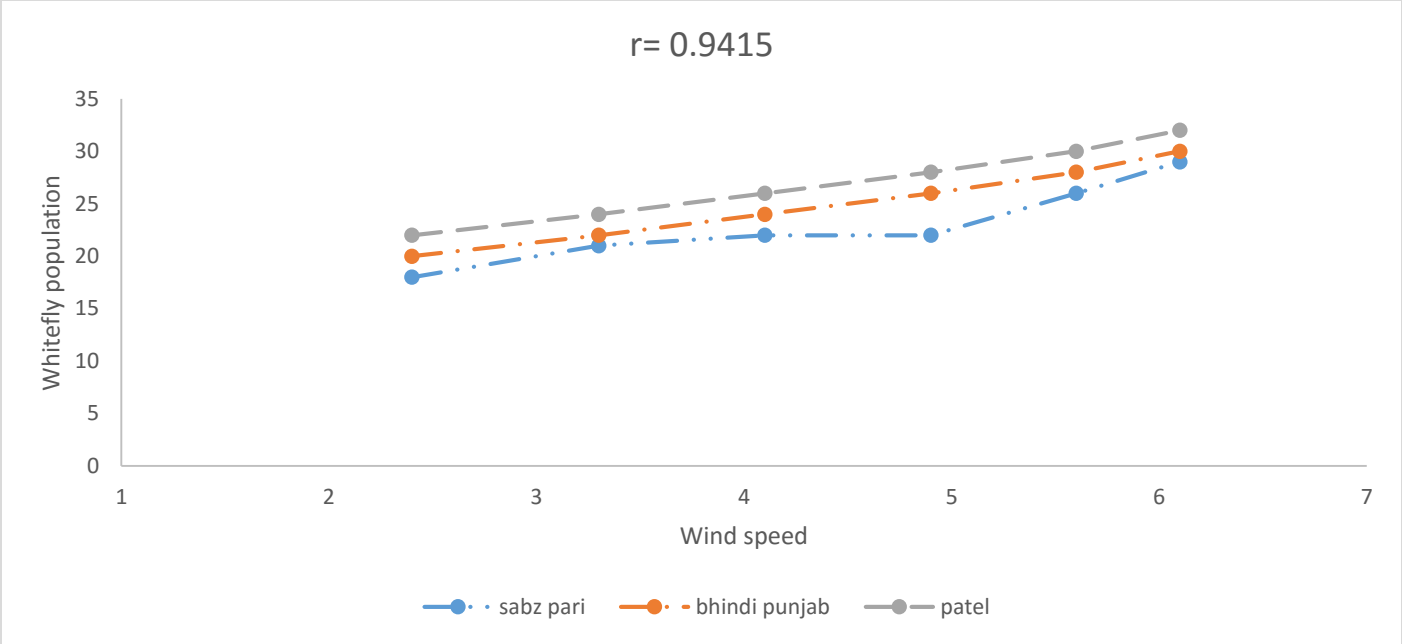

Figure. 6: Effect of wind speed on whitefly population

Correlation of epidemiological factors with disease severity:

Effect of wind speed on disease severity:

The value of r indicates that there is strong relationship exists between wind speed and disease severity. As wind speed increased, the disease severity was increased.

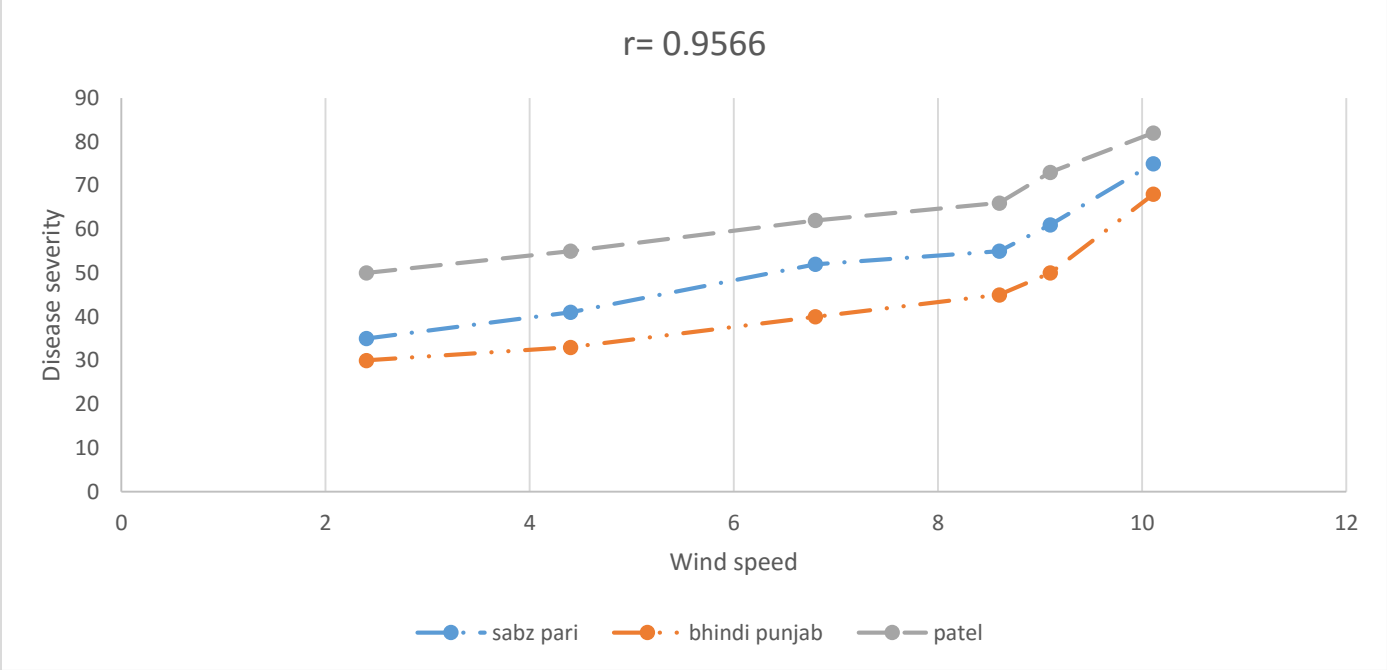

Figure 7: Effect of wind speed in disease severity

Effect of relative humidity in disease severity:

The value of r indicates that there is strong relationship exists between relative humidity and disease severity. As relative humidity increased, the disease severity was increased.

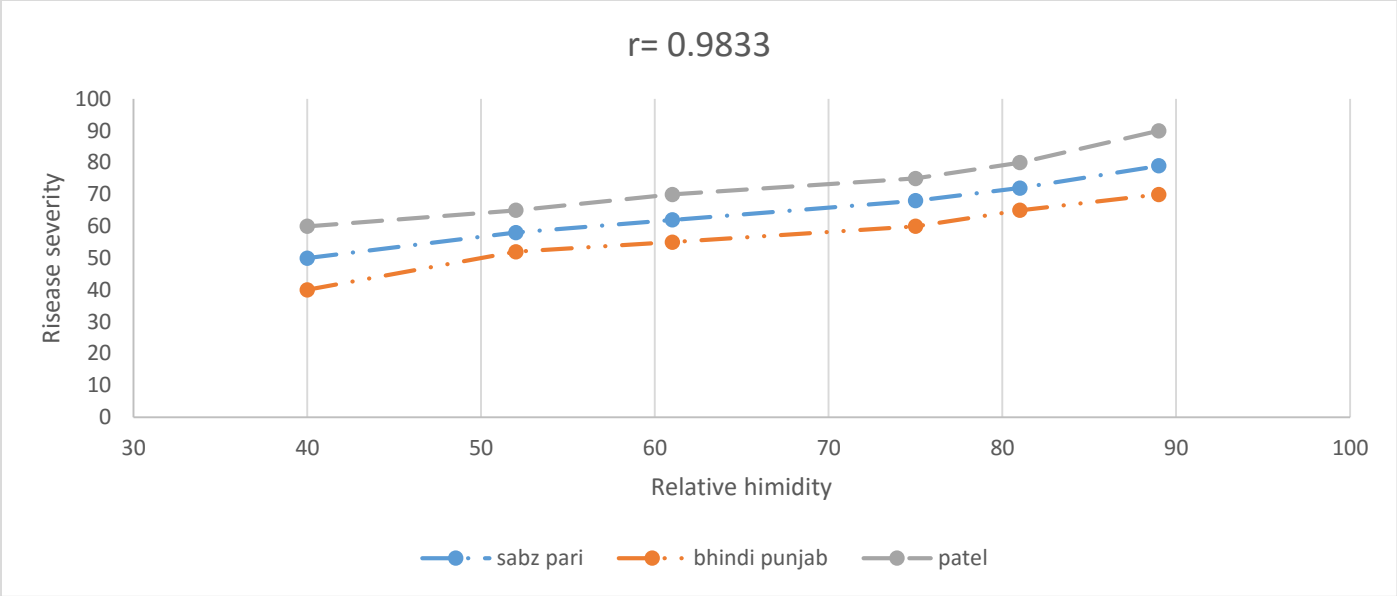

Figure 8: Effect relative humidity in disease severity

Effect of rainfall in disease severity:

The value of r indicates that there is strong relationship exists between rainfall and disease severity. As rainfall increased, the disease severity was decreased.

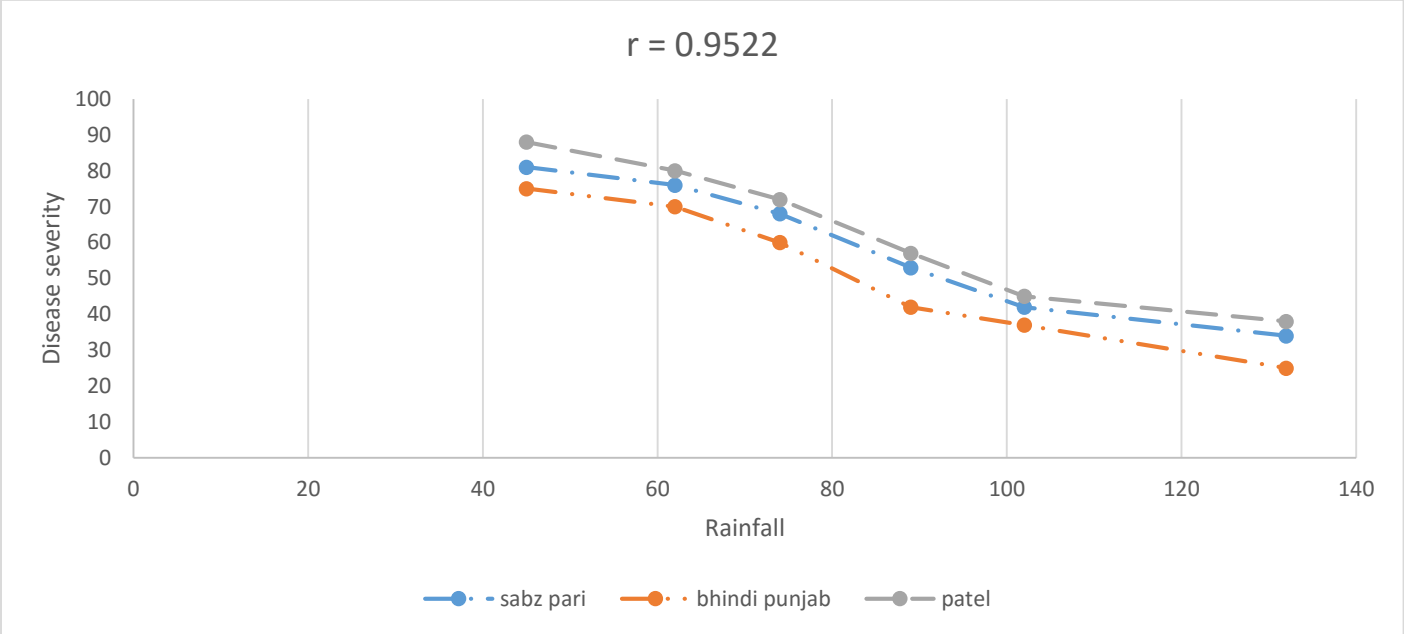

Figure 9: Effect of rainfall in disease severity

Effect of maximum temperature in disease severity:

The value of r indicates that there is strong relationship exists between maximum temperature and disease severity. As temperature increased, the disease severity was increased.

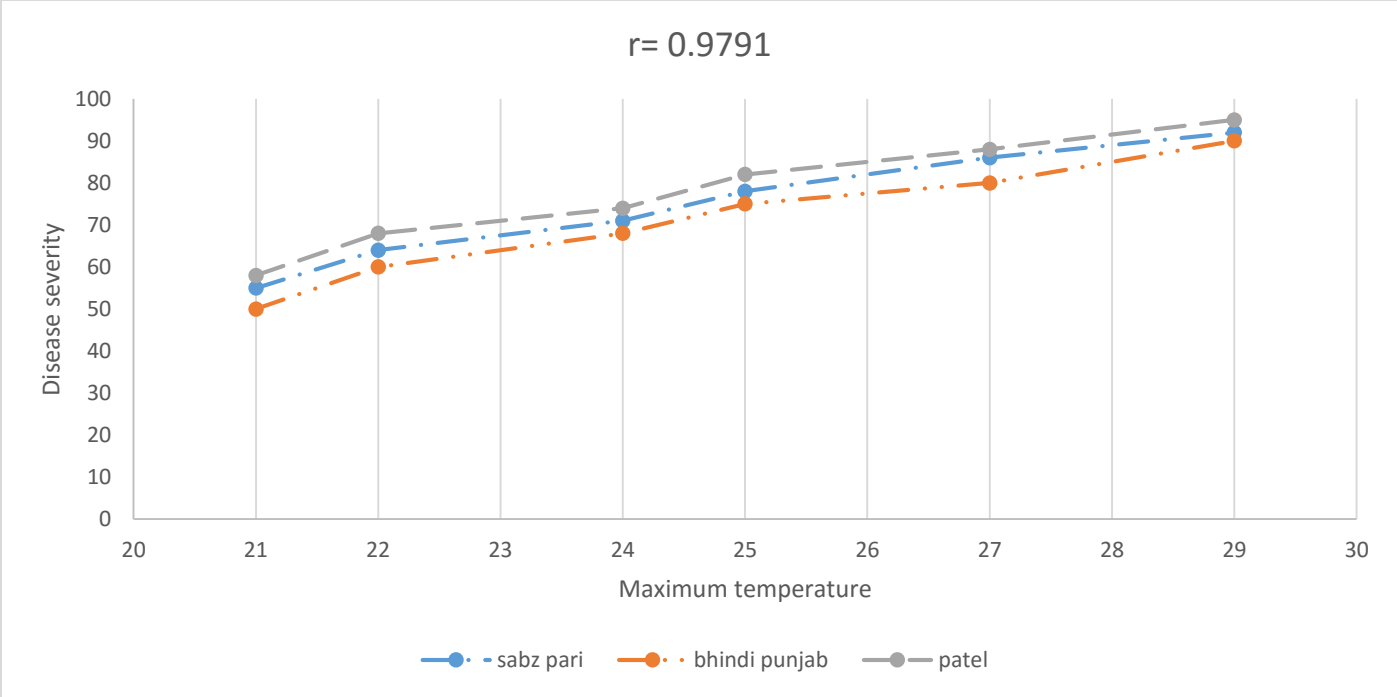

Figure 10: Effect of maximum temperature in disease severity

Effect of minimum temperature on disease severity:

The value of r indicates that minimum temperature has strong relationships with disease severity. As temperature decreased, the disease severity was decreased.

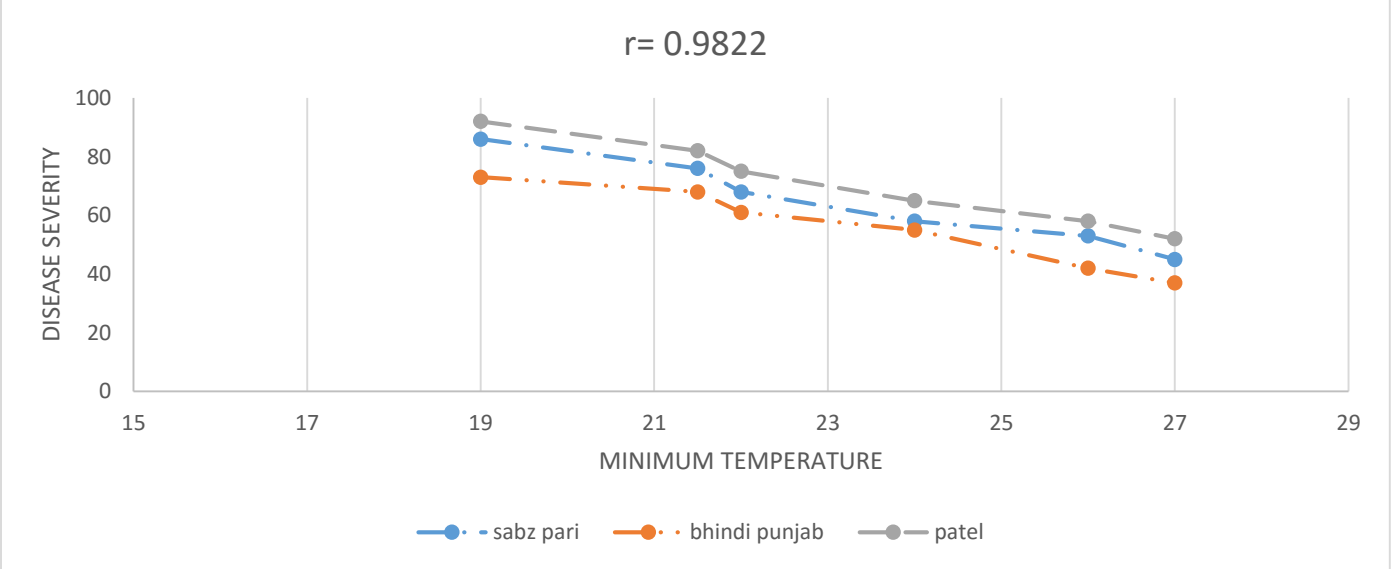

Figure 11: Effect of minimum temperature in disease severity

Table 3: Analysis of variance for treatments x varieties

Source	DF	SS	MS	F	P
Rep	2	0.04104	0.02		
Tr	3	15158.0	5052.68	67.47	0.0348
Error	42	3145.22	74.89		
Total	47	18303.3			

Grand Mean 52.416 CV 16.51

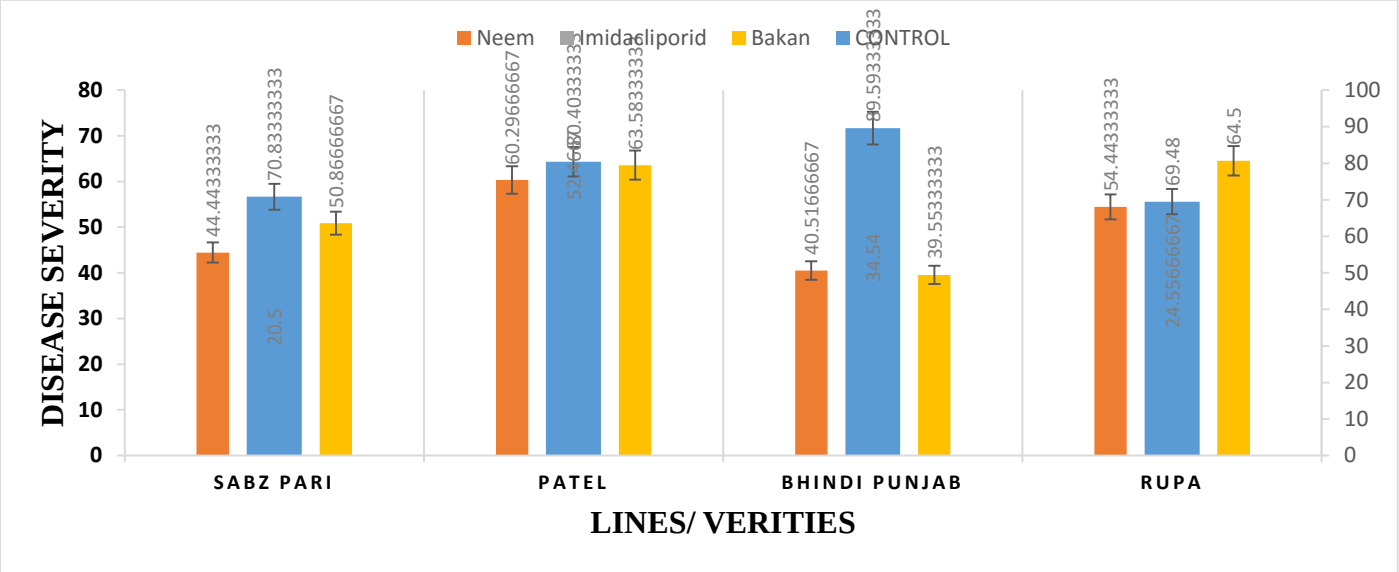

Figure 12: Effects of different treatments on disease severity

Effects of different treatment against on disease:

Results showed that imidcloporid was most effective among all, followed by neem. Bakan was found least effective in controlling OYVMV disease severity in Sabz pari under filed condition.

Table. 4: Analysis of variance of different treatments on Sabz Pari

Source	DF	SS	MS	F	P
Rep	2	1.02	0.51		
Tr	3	3873.92	1291.31	3135.78	0.0754
Error	6	2.47	0.41		
Total	11	3877.41			

Grand Mean 46.661 CV 1.38

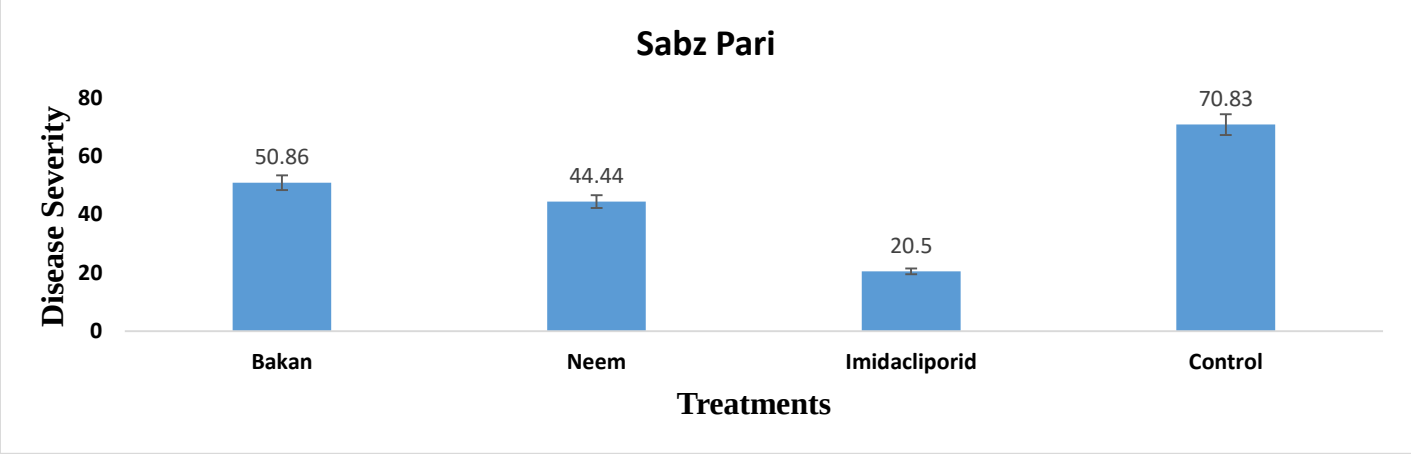

Figure 13: Effect of different treatments on Sabz pari

Effects of different treatments against OYVMV on Patel:

Results showed that imidacloporid was most efficient for the management of disease severity followed by neem extract. Bakain was found least effective against disease management.

Table. 5: Analysis of Variance of treatments and Patel

Source	DF	SS	MS	F	P
rep	2	0.62	0.31		

tr	3	3869.56	1289.85	10478.3	0.00358
Error	6	0.74	0.12		
Total	11	3870.92			

Grand Mean 58.708 CV 0.60

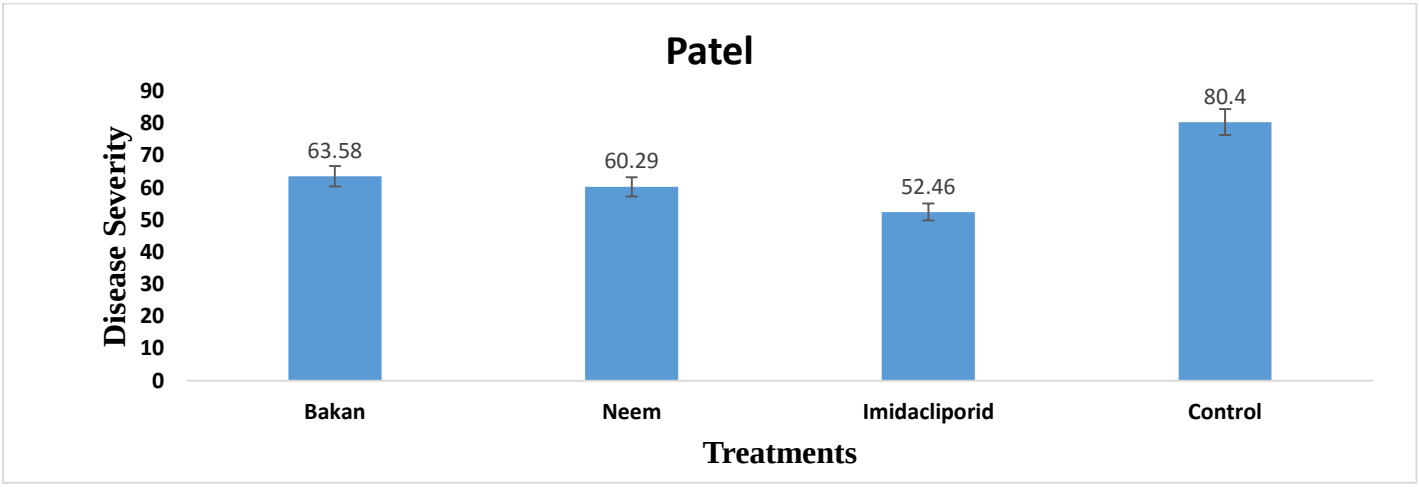

Figure 14: Effect of different treatments on Patel

Effect of different treatments against OYVMV on Bhindi Punjab:

Results showed that imidacloporid was most effective for the reduction of OYVMV disease severity n Bhindi Punjab, followed by Bakan extract. Neem extract was least effective against disease among all.

Table. 6: Analysis of variance of different treatments and Bhindi Punjab

Source	DF	SS	MS	F	P
rep	2	0.27	0.14		
trt	3	6003.88	2001.29	8137.08	0.0128
Error	6	1.48	0.25		
Total	11	6005.63			

Grand Mean 51.051 CV 0.97

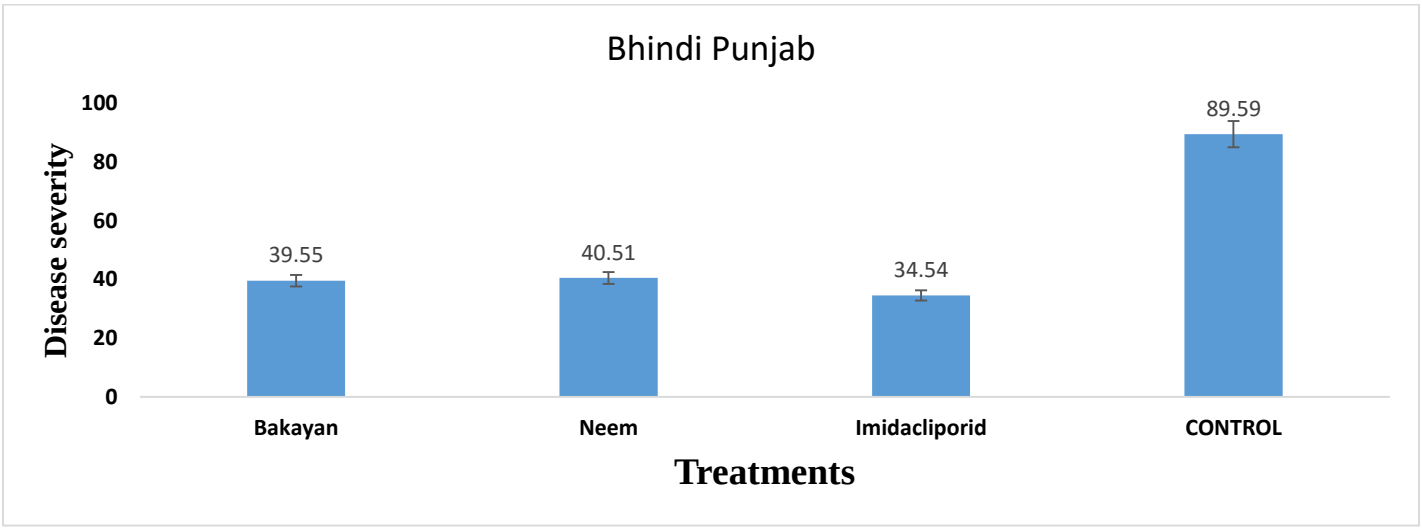

Figure. 15: Effect of different treatments on Bhindi Punjab

Effect of different treatments on Rupa:

Results showed that imidacloporid was best for the management of disease followed by neem. Bakain was found least effective among all**.**

Table. 7: Analysis of variance of different treatments on Rupa

Source	DF	SS	MS	F	P
rep	2	1.73	0.87		
trt	3	3644.12	1214.71	23819.1	0.0785
Error	6	0.31	0.05		
Total	11	3646.16			

Grand Mean 53.245 CV 0.42

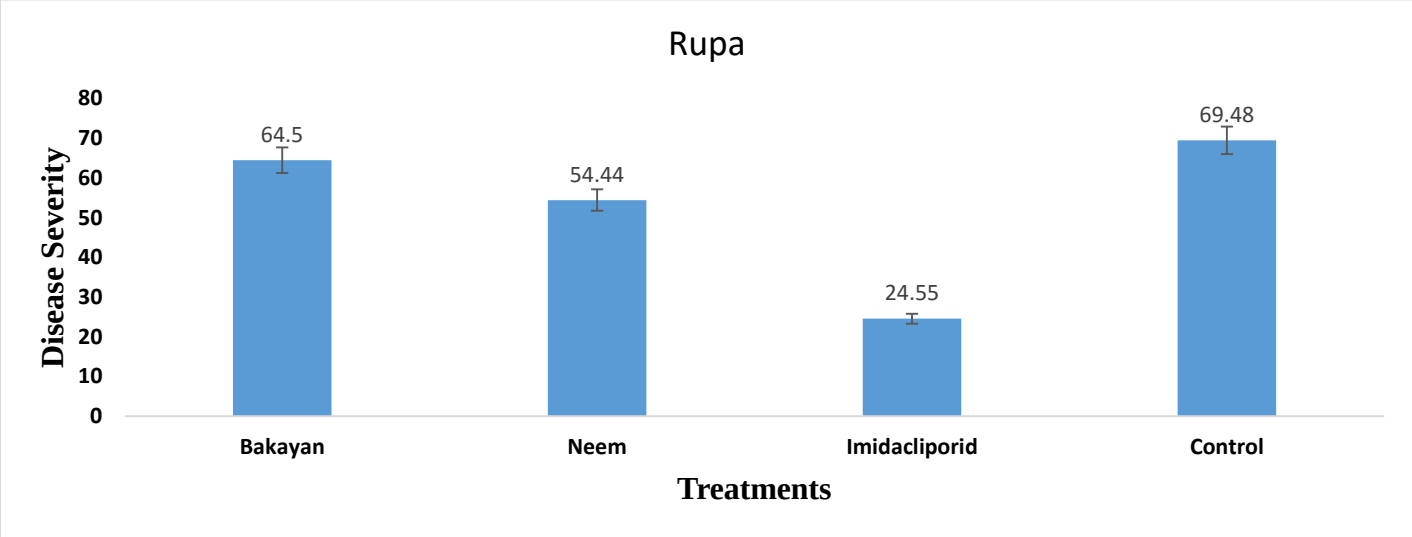

Figure. 16: Effects of different treatments against disease on Rupa

CONCLUSION

Imadicloprid showed best results to manage OYVMV followed by neem and bakain extracts. While neem extract also showed good results to manage the disease.

AUTHOR CONTRIBUTIONS

Mirza Waqas Safder did the main research work and other authors helped in data compiling, statistical analysis and paper writing equally in this research work.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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