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Research Article

Integrated management of whitefly; the vector of okra yellow vein mosaic virus through diverse germplasm and plant extracts

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Abstract

The present research was conducted to study the population incidence of whitefly (*Bemisia tabaci*) on 15 okra cultivars using four plant extracts with a control for its management under field conditions. The data regarding to population incidence of whitefly was recorded. Minimum whitefly population was recorded on Sabz pari (7.67%) and Sanam (9.22%) followed by Kiran (17%), Green wonder (17.33%), Okra-1548 (19%), Click-5769 (20.33%), A. Selection (20.44%), Laxmy (20.78%), Okra-7100 (21%), Pusa Swani (21.89%), Pk-0k-1 (23.44%), Pmf Beauty (26.11%), Okra-7080 (26.78%), Jk-tetra-6 (28.78%) and Super star (31.11%). Among plant extracts *Azadirachta indica* was 24.4% effective as compared to *Eucalyptus camaldulensis* (25.9%), *Melia azedarach* (27.1%), *Cassia fistula* (28.1%) and control (31.9%) and minimum whitefly was recorded at okra-7100 (26.8%) followed by laxmy (26.8%), okra-7080 (27.5%), jk-tetra-6 (28.2%) and pmf beauty (28.2%). Azadirachta indica and variety okra-7100 performed better among all extracts and varieties.

Keywords: Whitefly, OYVMV, Plant extracts

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Introduction

Okra (*Abelmoschus esculents*) is commonly known as Bhindi tori and belongs to family Malvaceae (Akanbi et al., 2010). It is enriched with proteins, carbohydrates, fats, vitamins and minerals (Gopalan et al., 2007). Okra seeds are good source of oil and protein (Oyelade et al., 2003). Okra is being grown worldwide; the most important okra growing countries include Nigeria, India, Egypt, Ghana and Pakistan etc. (FAO, 2003). In Pakistan, It is one of the cash crops of Sindh (Khoso, 1992). So many insect pests attack okra plants from sowing up to harvesting. The most destructive insect pests are whitefly, thrip, jassid, aphid, spotted bollworm, American bollworm etc. Among the insect pests, whitefly; the vector of yellow vein mosaic virus is the injurious one. Whitefly destroys the okra plant by sucking the sap from the leaves and transmits certain viral diseases (Atwal, 1994). Whitefly was described over 100 years ago and has since become one of the most important pests worldwide in subtropical and tropical agriculture as well as in greenhouse production systems (Oleivera et al., 2001). OYVMV is one of the major factors (Fajinmi and Fajinmi, 2010) and is transmitted by white fly (*Bemisiatabaci* Gen.) (Ghanem, 2003). Growth of infected plants is retarded; few leaves and fruits are formed and losses may be reach up 94% (Ali et al., 2005). Plant resistance to pests is based on the plant genetics and the significant molecular

interactions that occur between host and pest organism (Pedley and Martin, 2003). Selecting a plant variety that has resistance or tolerance to pest makes it possible to avoid or lessen the use of pesticides or other management strategies (Gebhardt and Valkonen, 2001). Effective and efficient control of pest can be achieved by the use of synthetic chemical but there is hazard of pesticide toxicity (Ferrer and Cabral, 1991; Harris et al., 2001; Dukic et al., 2004). There is a need to search for alternative approaches without toxicity problems that are ecofriendly and not capital intensive. Plant metabolites and plant based pesticides appear to be one of the better alternatives as they are known to have minimal environmental impact and danger in contrast to the synthetic pesticides (Varma and Dubey, 1999). Plant extracts of many higher plants have been reported to exhibit insecticidal properties and contribute better in decreasing pest population (Okigbo and Ogbonnaya, 2006; Shariff et al., 2006; Bouamama et al., 2006; Ergene et al., 2006; Kiran and Raveesha, 2006; Mohana and Raveesha, 2006).

Material And Methods

Okra cultivars (Pmf Beauty, Laxmy, Sabz pari, Sanam, Super Star, Green Wonder, Click-5769, Kiran, Pk-ok-1, Advantage Selection, Okra-1548, Pusa Swani, Okra-7100, Okra-7080, and Jk-tetra-6) were collected from Ayub Agriculture Research Institute (AARI) Faisalabad. Nursery was planted at 60 cm RxR and 20 cm PxP distance in clay loam soil at research area of Department of Plant Pathology, University of Agriculture Faisalabad. All the agronomic practices were done to maintain the crop. The plants were selected randomly and the number of Whiteflies was counted by observing upper, lower and middle leaves of each plant. The data was recorded at third, fifth and seventh day.

Four plant extracts neem (*Azadirachta indica*), Eucalyptus, (*Eucalyptus camaldulensis*), Bakain (*Melia azedarach*) and Amaltas (*Cassia fistula*) @ S/20 with one control was evaluated against okra yellow vein mosaic virus on five cultivars i.e., Pmf Beauty, Laxmy, Okra-7100, Okra-7080, and Jk-tetra-6 which were sown in the research area of Department of Plant Pathology, University of Agriculture Faisalabad during 2011. Each variety was sown in three replications with 60 cm (RxR) and 20 cm (PxP) distance under randomized complete block design (RCBD). Standard dose of extracts were prepared by taking 75g plant leaves and 25ml water (Ilyas *et al.*, 1997). Plant leaves were soaked in a 1% solution of sodium hypochlorite for 2-3 minutes rinsed with sterile water and were macerated in 25mL of distilled water to get their extract. Extracts were passed through three folds of Maslin cloth for filtration filter paper. This prepared dose was considered as (S.D) standard dose. S/20 concentrations of all plant extracts were prepared from standard solution and were stored at 4^{o}C to inactivate the activities of microbes. The data was calculated regarding to whitefly population was statically analyzed by LSD at 5% probability level (steel et al., 1997).

T_1= *Azadirachta indica* (S/20)

T_2 = *Eucalyptus camaldulensis* (S/20)

T_3 = *Melia azedarach* (S/20)

T_4 = *Cassia fistula* (S/20)

T_5 = Control

RESULTS

Screening

Minimum whitefly population was recorded at Sabz Pari (7.67%) and Sanam (9.22%) while Kiran, Green wonder and Okra-1548 showed 17%, 17.33% and 19% whitefly population respectively. 20.33%, 20.44% and 20.78% population was observed at Click-5769, A. Selection and Laxmy respectively. Whitefly population recorded at Okra-7100 and Pusa swani was 21% and 21.89% respectively. Pk-0k-1, Pmf beauty and Okra-7080 showed 23.44%, 26.11% and 26.78%

whitefly population respectively. Maximum whitefly population was recorded at Jk-tetra-6 and Super star 28.78% and 31.11% respectively (Table.1).

Management

All Treatments (T), Varieties (V), Days (D) and their interactions (TxV), (TxD), (VxD) and (TxVxD) expressed significant results (Table.2). After first application of plant extracts 28.99% whitefly population was reduced while after second application population of whitefly was recorded 27.94%. Maximum population of whitefly was reduced 25.64% after third application (Table.3. fig.1). Among plant extracts *A. indica* resulted better and was 24.4% effective against whitefly followed by *Eucalyptus camaldulensis* (25.96%), *Melia azedarach* (27.18%), *Cassia fistula* (28.16%) and control (31.93%) as shown in fig.2 and table.4. Among varieties Okra 7100 respond better (26.76%) after the application of plant extracts followed by laxmy (26.80%), okra-7080 (27.53%), Jk-tetra-6 (28.24%) and pmf beauty (28.29%) as shown in fig.3 and table.5.

Interaction between varieties and Days (VxD) resulted that after three applications of plant extracts minimum whitefly was recorded on okra-7100 26.76%. While whitefly recorded on laxmy was 26.80% followed by okra-7080 (27.53%), jk-tetra-6 (28.24%) and pmf beauty (28.29%) as shown in Table.6. After 1st application of plants extract 28.53% whiteflies were calculated on variety okra-7100 followed by laxmy (28.73%), okra-7080 (27.60%), Jk-tetra-6 (29.60%) and pmf beauty (30.47%). While after 2nd application okra-7100 showed 26.73% whitefly poplation followed by laxmy 26.73%, okra 7080 27.73%, jk-tetra-6 29.07% and pmf beauty 29.27 %. After 3rd application minimum whitefly population was recorded at okra-7100 25%, while at laxmy 24.73% population was recorded, on okra-7080 27.27%, on jk-tetra-6 26.07% and on pmf beauty 25.13% whitefly population was recorded (Fig.4).

Interaction among treatment and days (TxD) showed that *Azadirachta indica* was most effective (24.40%) among plant extracts followed by *Eucalyptus camaldulensis* (25.96%), *Melia azedarach* (27.18%), *Cassia fistula* (28.16%) and control (31.93%) as shown in Table.7. After 1st application *Azadirachta indica* resulted 25.07% on whitefly followed by *Eucalyptus camaldulensis* 27.33%, *Melia azedarach* 28.33%, *Cassia fistula* 30.07% as compared to control 34.13%. After 2nd application *Azadirachta indica* resulted 25.53% on whitefly while *Eucalyptus camaldulensis* resulted 26.20%, *Melia azedarach* resulted 27.80%, *Cassia fistula* resulted 28.27% as compared to control 31.93%. Maximum results were calculated after 3rd application of *Azadirachta indica, Eucalyptus camaldulensis, Melia azedarach and Cassia fistula,* 22.60 %, 24.33%, 25.40%, 26.13% and 29.73% respectively (Fig.5).

Interaction among treatment and varieties (TxV) resulted that *Azadirachta indica* was most effective on all varieties. After the application of *Azadirachta indica* the whitefly recorded on okra-7100 was 22.33% while on laxmy it was 23.22%, on okra-7080 25.11% whitefly was recorded, on jk-tetra-6 (25.44%) and on pmf beauty 25.88% whitefly was recorded. *Eucalyptus camaldulensis* effect on okra-7100, laxmy, okra-7080, jk-tetra-6 and pmf beauty was 24.88%, 25.66%, 26.22%, 26.55% and 26.44% respectively. *Melia azedarach* reduced 26.66% whitefly population on okra-7100, 26.55% on laxmy, 26.77% on okra-7080, 27.77% on jk-tetra-6 and 28.11% on pmf beauty. After the application of *Cassia fistula* okra-7100 showed (28%), laxmy (27.77%), okra-7080 (28.55%), jk-tetra-6 (28.77%) and pmf beauty (27.66%) reduction in whitefly population (Fig.6).

Interaction between treatment, varieties and days (TxVxD) resulted that among plant extracts *Azadirachta indica* was most effective on all varieties okra-7100 (22.33%), laxmy (23.22%), okra-7080 (25.11%), jk-tetra-6 (25.11%) and pmf beauty (25.89%) as compared to all other extracts and control. While among varieties Okra showed resitant response (Table.8. Fig. 7).

Table 1: Mean Values of Population Incidence of whitefly on Fifteen Okra Varieties.

Sr. No	Variety	Mean Values
1.	Sabz Pari	7.67 h
2.	Sanam	9.22 h
3.	Kiran	17.00 g
4.	Green Wonder	17.33 g
5.	Okra-1548	19.00 fg
6.	Click-5769	20.33 ef
7.	A. Selection	20.44 ef
8.	Laxmy	20.78 def
9.	Okra-7100	21.00 def
10.	Pusa Swani	21.89 de
11.	Pk-0k-1	23.44 cd
12.	Pmf Beauty	26.11 bc
13.	Okra-7080	26.78 b
14.	Jk-tetra-6	28.78 ab
15.	Super Star	31.11 a
LSD (5%)		1.66

Means sharing similar letters are statistically non-significant (P>0.05).

Table.2. Evaluation of different plant extracts against whitefly (ANOVA).

SOV	DF	SS	MS	F	P≥F
Replication (R)	2	1.77	0.884		
Days (D)	2	440.06	220.031	178.05	0.0000**
Variety (V)	4	99.85	24.962	20.20	0.0000**
Treatments (T)	4	1448.12	362.029	292.95	0.0000**
Days x Variety (DxV)	8	119.40	14.926	12.08	0.0000**
Days x Treatment (DxT)	8	38.07	4.759	3.85	0.0004**
Variety x Treatment(VxT)	16	71.71	4.482	3.63	0.0000**
Days x Variety x Treatment (DxVxT)	32	66.24	2.070	1.68	0.0214*
Error	148	182.90	1.236		
Total	224	2468.12			

* = Significant (P<0.05); ** = Highly significant (P<0.01)

Table.3. Means of whitefly population after 1st, 2nd and 3rd application.

Applications (days)	whitefly population
After 1st application	28.987a
After 2nd application	27.947b
After 3rd application	25.640c

Table.4. Comparative efficacy of different plant extracts on whitefly population.

Sr#	Treatment	Reduction in whitefly population
T_1	*Azadirachta indica* (S/20)	24.400e
T_2	*Eucalyptus camaldulensis* (S/20)	25.956d
T_3	*Melia azedarach* (S/20)	27.178c
T_4	*Cassia fistula* (S/20)	28.156b
T_5	Control	31.933a
	LSD	0.463

*Mean values sharing similar letter do not differ significantly as determined by the LSD test at 5% level of probability.

Table.5. Response of different varieties against whitefly population after spray of different plant extracts

Sr#	Treatment	Reduction in whitefly population
1	Pmf Beauty	28.289a
2	Jk-tetra-6	28.244a
3	Okra-7080	27.533b
4	Laxmy	26.800c
5	Okra 7100	26.756c
	LSD	0.463

*Mean values sharing similar letter do not differ significantly as determined by the LSD test at 5% level of probability.

Table.6. Reduction in whitefly population in interaction of different application (days) and varieties

Variety	Mean
Okra-7100	26.76C
Laxmy	26.80C
Okra-7080	27.53B
Jk-tetra-6	28.24A
Pmf beauty	28.29A

*Mean values sharing similar letter do not differ significantly as determined by the LSD test at 5% level of probability

Table.7. Mean values of whitefly population in interaction of treatments and application (days)

Treatment	Mean
A. indica	24.40E
Eucalyptus	25.96D
M. azedarich	27.18C
C. fistula	28.16B
Control	31.93A

*Mean values sharing similar letter do not differ significantly as determined by the LSD test at 5% level of probability

Table.8. Mean values of whitefly population in interaction of application (days), varieties and treatment

Varieties	**Okra-7100**			**Laxmy**			**Okra-7080**			**Jk-tetra-6**			**Pmf beauty**		
Treatments	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
A. indica	23.7xy	23.7xy	19.7a	25.0tx	23.7xy	21.0za	25.0tx	25.33s-x	25.0tx	25.7rw	27.0ns	23.7xy	26.0qv	28.0kp	23.7xy
Eucalyptus	26.3pu	24.7ux	23.7xy	27.3mr	25.7rw	24.0wxy	26.3pu	26.7ot	25.7rw	28.0kp	27.7lq	24.0wxy	28.7in	26.3pu	24.3vwx
M. azedarich	28.3jo	26.0qv	25.7rw	28.7in	27.0ns	24.0wxy	25.7rw	27.7lq	27.0ns	29.0im	29.0im	25.3sx	30.0fj	29.3hl	25.0t-x
C. fistula	29.7gk	27.7lq	26.7ot	30.0fj	27.3mr	26.0qv	29.0im	28.0kp	28.7in	30.3ei	29.0im	27.0ns	31.3dg	29.3hl	22.3yz
Control	34.7ab	31.7cf	29.3hl	32.7cd	31.0dh	28.7in	32.0cde	31.0dh	30.0fj	35.0ab	32.7cd	30.3ei	36.3a	33.3bc	30.3ei

*Mean values sharing similar letter do not differ significantly as determined by the LSD test at 5% level of probability

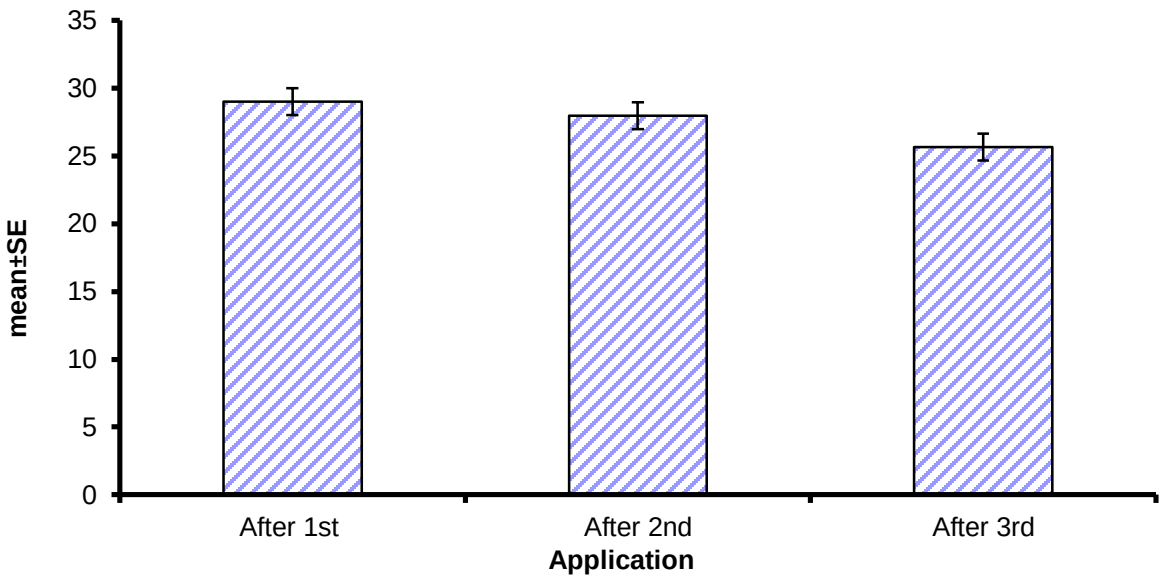

Fig.1. **Whitefly population after spray of different plant extracts.**

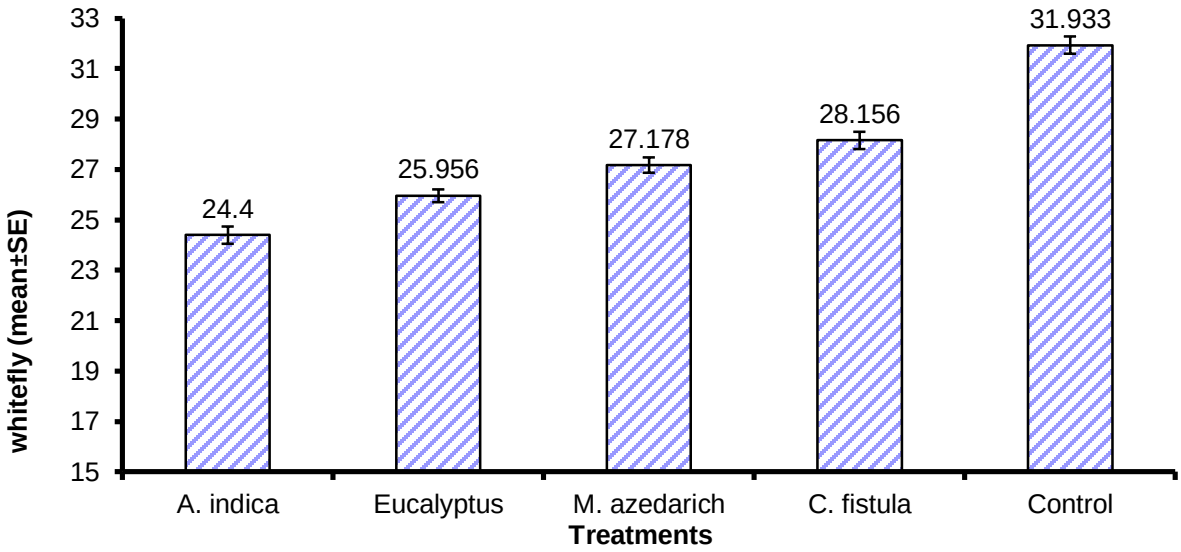

Fig.2. **Effect of plant extracts against whitefly**

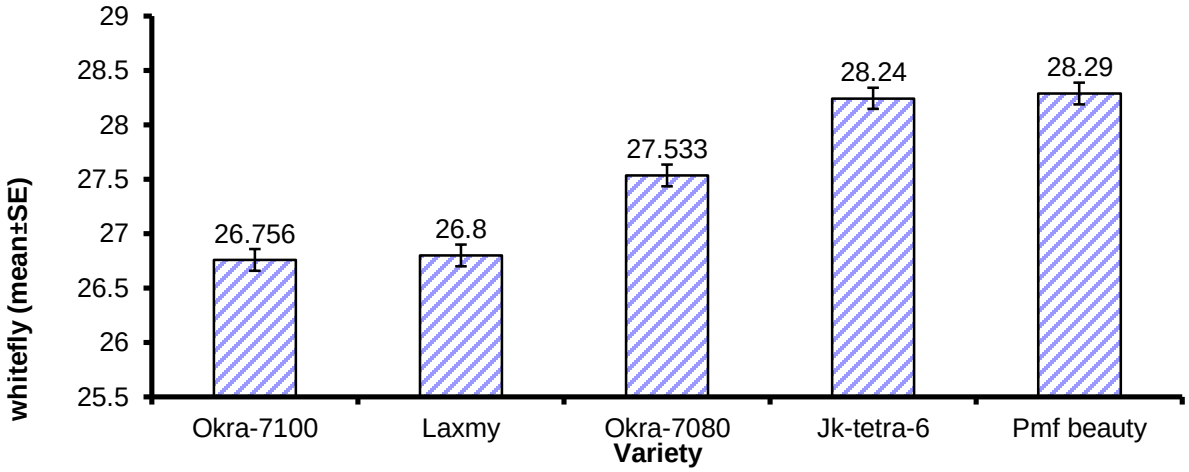

Fig. 3**. Response of different varieties against whitefly after spray of different plant extract**

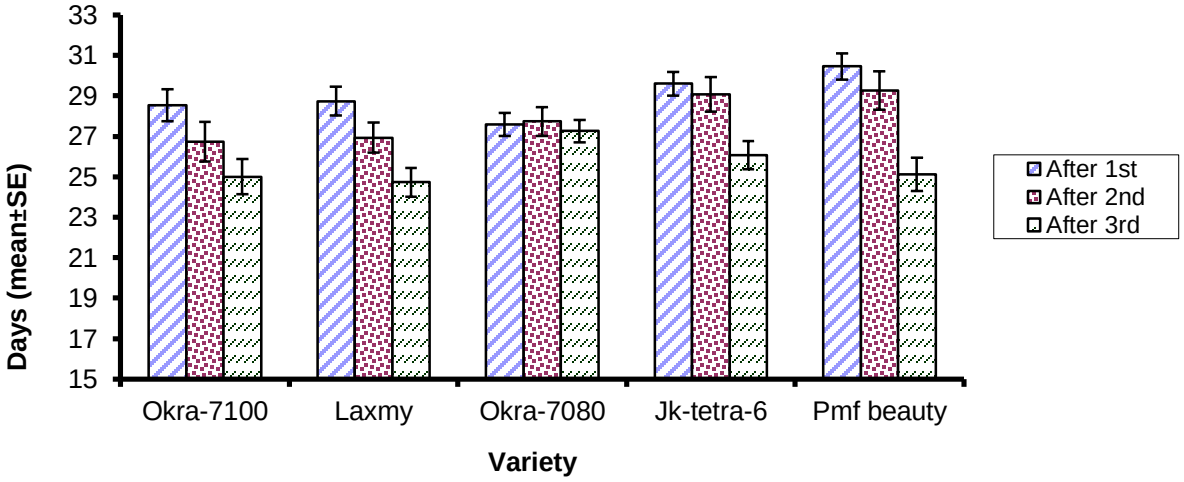

Fig.4. **Whitefly population on varieties after spray.**

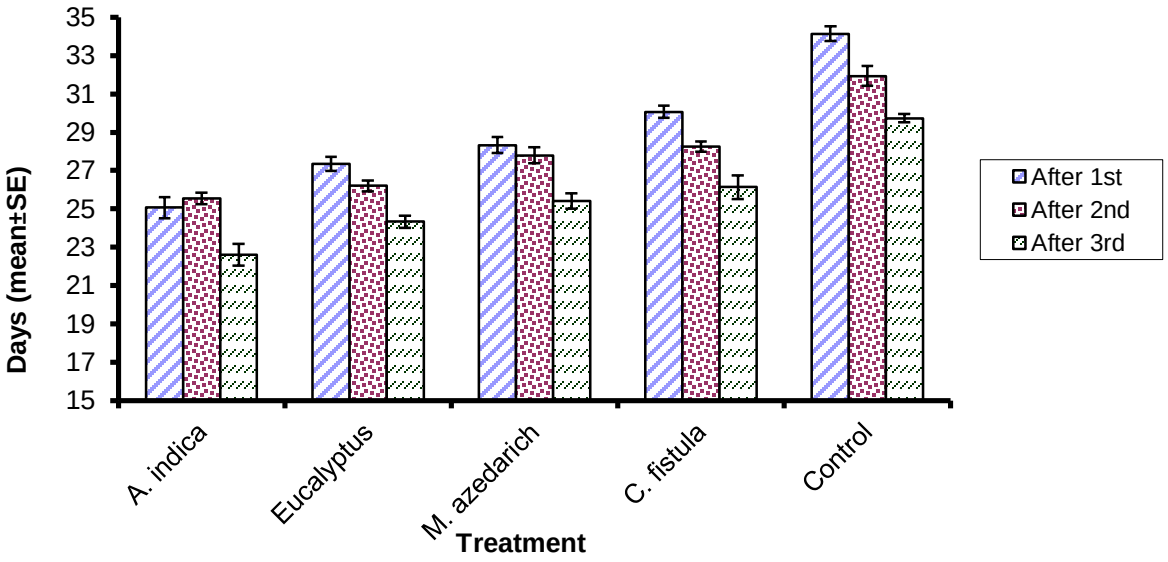

Fig.5. **Effect of plant extracts on whitefly population**

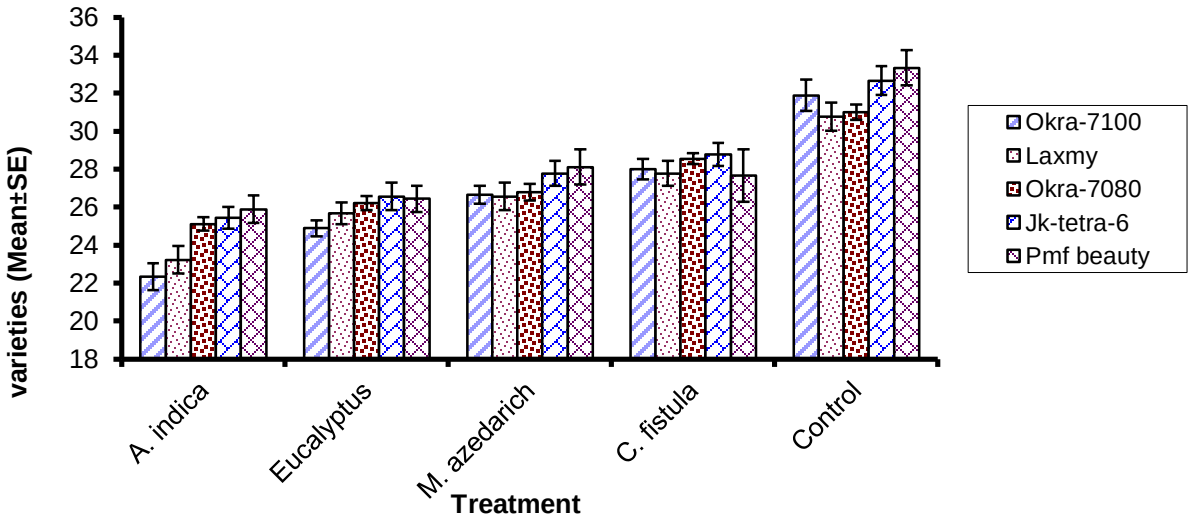

Fig.6. **Effect of plant extracts on varieties**.

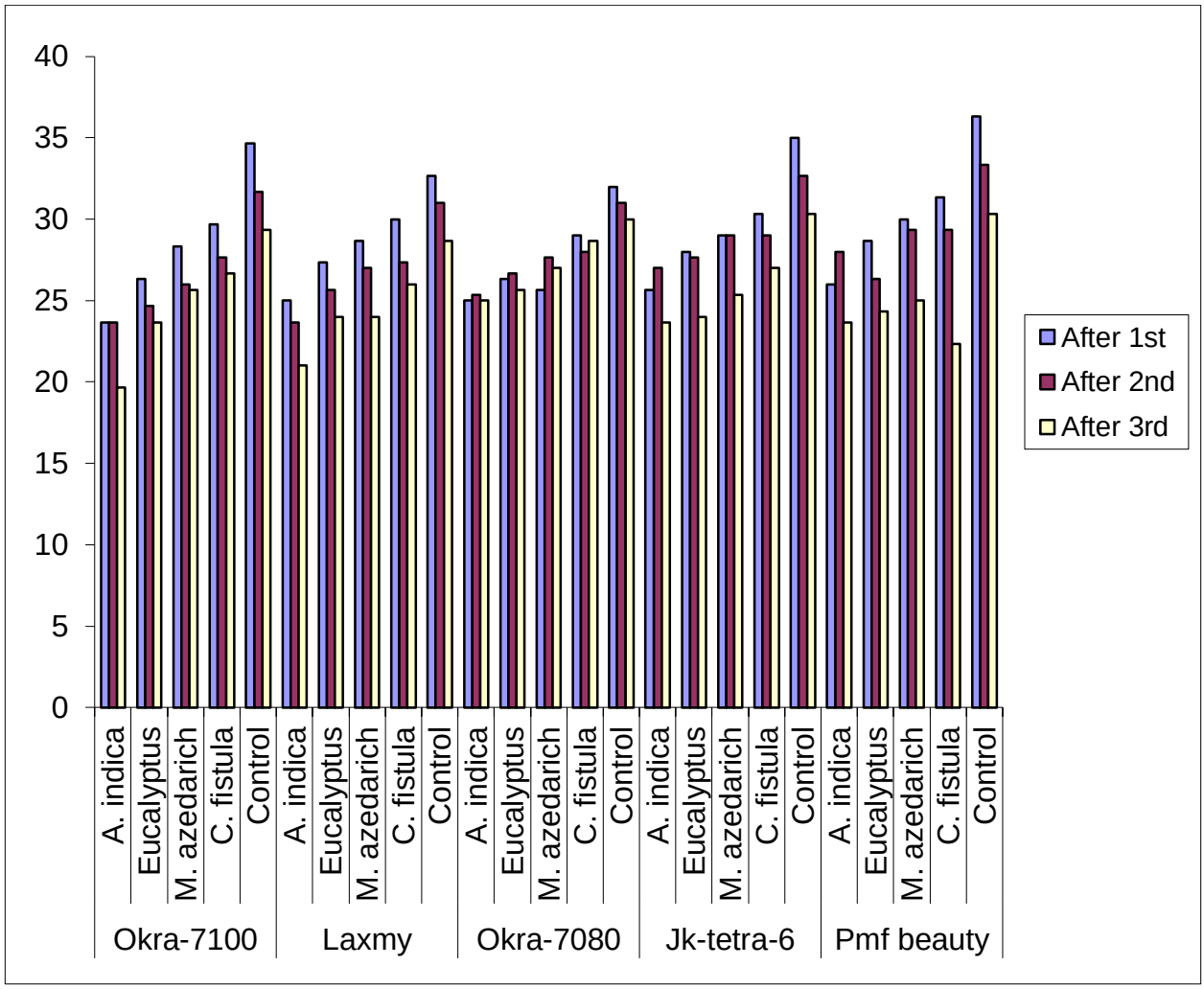

Fig.7. **Mean values of whitefly population in interaction of application (days), varieties and Treatment**

Discussion:

The whitefly population must be reduced for reducing disease incidence to obtain good production, but the pesticides used against whitefly are equally poisonous to all livings and increase environmental pollution, hence be avoided as far as possible and should select such cultivars which are resistant to whitefly population. During last five years Okra Yellow Vein Mosaic Virus has emerged as a major threat for okra crop. The virus is transmitted by whitefly (*Bemisia tabaci*) (Pun et al., 1999). The management of whitefly through plant extracts is good and effective way to control the disease (Choudhary et al., 1995). *Melia azedarach* is used as insect repellent and contain a number of triterpenoids, the meliacarpin that are similar but not identical to the azadirachtin and these to have insect growth regulating bioactivities (Batcher 2000, Kruas 2002). *Aazadirachta* indica contains azadirachtin which is a chemical compound and inhibits feeding and is a good insect repellent (Dr. Mallick F. Rahman M.). *Cassia fistula* leaf extract significantly reduce the egg laying and fecundity and recommended as a pest control agent (Raja et al., 2000). *Eucalyptus camaldulensis* is also used as insect repellent (Inouye et al., 2001). In the present studies four plants extracts (*A. indica, Eucalyptus camaldulensis, Melia azedarach, Cassia*

fistula) were used against vector of okra yellow vein mosaic virus on five varieties. Minimum whitefly population was recorded at Sabz pari (7.67%) and Sanam (9.22%) followed by Kiran (17%), Green wonder (17.33%), Okra-1548 (19%), Click-5769 (20.33%), A. Selection (20.44%), Laxmy (20.78%), Okra-7100 (21%), Pusa Swani (21.89%), Pk-0k-1 (23.44%), Pmf Beauty (26.11%), Okra-7080 (26.78%), Jk-tetra-6 (28.78%) and Super star (31.11%). Response of varieties is based on the plant genetics and the significant molecular interactions that occur between host and pest organism (Pedley and Martin, 2003). Selecting a plant variety that has resistance or tolerance to diseases makes it possible to avoid or lessen the use of pesticides or other management strategies (Gebhardt and Valkonen, 2001). Among plant extracts *Azadirachta indica* was 24.4% effective as compared to *Eucalyptus camaldulensis* (25.9%), *Melia azedarach* (27.1%), *Cassia fistula* (28.1%) and control (31.9%) and minimum whitefly was recorded at okra-7100 (26.8%) followed by laxmy (26.8%), okra-7080 (27.5%), jk-tetra-6 (28.2%) and pmf beauty (28.2%). *Azadirachta indica* and variety okra-7100 performed better among all extracts and varieties.

Nath and Saikia (1993) suggested that the disease incidence of YVMV on okra can be reduced by controlling the vector, whitefly. Whitefly population and disease incidence can also be controlled by changing the date of sowing and growing of resistant varieties (Goswami et al. 1992). Nath et al. (1992) studied the sowing time of okra crop to reduce the incidence of YVMV and white fly population. Early sowing (10 Feb-10 March) gave significant positive results due to low population of *Bemisia tabaci*. Singh (1990) noted that for the development of yellow vein mosaic virus hot weather was favorable with little or no rainfall and also for the multiplication of vector (*Bemisia tabaci*). Cold weather with high relative humidity and rainfall were unfavorable to whitefly multiplication and spread. Mazumder et al., (1995) conducted experiments on the incidence of bhendi yellow vein mosaic bigeminivirus and its vector *Bemisia tabaci* in okra for two consecutive years. Crops sown between February 25 and 20 revealed lower disease incidence and whitefly population compared with sowings dates of March 15 to July 25. Kumar *et al*. (2004) studied that number of insect pest (whitefly, American bollworm, stink bugs, rough bollworm, looper, caterpillars and green vegetable bugs) attack on Okra crop. Kumar (2004) studied that the intensity of insect pest and their damage varies from year to year depending upon the environmental conditions. Approximately 145 species of insect pests attack on cotton crop and almost all of these attack on okra plant. Yet , about 12 of these are of major importance and cause economic losses. 6 being the most important, *Amrasca devastans* (jassid), *Bemisia tabaci* (whitefly), *Thrips tabaci* (thrips), *Helicoverpa armigera* (American bollworm), *Erias* sp. (spotted bollworm) and *Pectinophora gosypiella* (pink bollworm). Present study is also based on the whitefly population losses on the crop and their attack. Rao et al. (1990) suggested that neem oil is good for the control of white fly and in present study results showed that neem was effective against whitefly population.Lindquist and Casey (1990) sprayed oils and neem extracts against leafminer, aphid, thrips and whiteflies and got excellent results. Choudhary et al. (1995) used different plant extracts against disease incidence. Hassan et al., (1996) noted that neem oil was very effective against sucking pest of cotton. Kulat et al. (1997) conducted experiment to check the efficacy of six plant extracts and resulted that the use of plant extract is an effective way to control the whitefly.

Conclusion:

Present study concluded that whitefly *(Bemisia tabaci)* is a vector of Okra Yellow Vein Mosaic Virus and damages the crop by sucking its sap. By recording the whitefly population we can manage spray program and can select the varieties resistant and tolerant to the disease and the use of plant extract can be helpful in controlling the whitefly population.

Conflict Of Interest:

There is no conflict of interest.

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