EVALUATION OF OKRA LANDRACES FOR YELLOW VEIN MOSAIC VIRUS AND IT'S MANAGEMENT IN WESTERN TERAI OF NEPAL

Ram Bahadur Khadka

Scientist (Plant Pathology), RARS, Khajura, Banke, Nepal

Nepal Agricultural Research Council.

ABSTRACT

Experiment was conducted for evaluation of okra landraces against Yellow Vein Mosaic Virus (YVMV) and its management at Regional Agricultural Research Station (RARS), Khajura,Banke during rainy season of 2014. A total of 31 okra genotypes were collected from National Gene bank, Khumaltar for screening against the disease. Similarly four different method of disease management viz. regular spray of cypermethrin, Virkon-H, net protected cultivation, milk spray were compared with control check. Disease were scored in 0-6 scale at seven days interval beyond 30 days after sowing, final disease severity (FRS), area under the disease progress curve (AUDPC) were calculated to assess the disease. The okra lines showed diversity in their responses ranging from immune to highly susceptibility. The result revealed that genotype Arkaanamica was only found to be immune with the disease. Among the disease management methods the lowest disease scoring was recorded in net protect cultivation followed by cypermethrinand Virkon H sprayed treatments. Significantly the highest yield was recorded in Virkon-H sprayed plot and it was statistically at par with cypermethrin and net protected cultivation. The results in this initial study reveal that the use of integrated approach like use of resistant variety, protected cultivation under net and/ or regular spraying of vector avoiding factors could be successful to manage the yellow vein mosaic virus disease in Okra.

Key words: *Okra, varietal screening, YVMV, Area Under Disease Progressive Curve, protected cultivation*

Introduction

Okra (Abelmoschusesculentus) is an important vegetable crop of the tropical and subtropical regionsin the world(Akinyele and Osekita, 2006; Alam andHossain, 2008; Kumar et al., 2010). Generally it is grown during summer and rainy seasons in Nepal. However, it can be cultivated during winter season inside the protected structures. Okra has been used for several purposes. Its tender fruits are used as boiled vegetable into fried slices for cooking (Lamont, 1999).It is also taken as an important vegetable for it's aphrodisiac properties. Its stem is used for paper making in paper mills. Okra dried seeds, can be used to prepare vegetable curds, or roasted and ground to be used as coffee additive or substitute (Moekchantuk and Kumar, 2004). Okra leaves can be used as fodder. Okra green fruits are good source of carbohydrate, protein, fats, vitamins and minerals (Haytowitz and Matthews, 1984; Balochet al., 1990; Lamont, 1999; Ali et al., 2005a; Arapitsas, 2008; Fajinmi and Fajinmi, 2010). Moreover, okra mucilage is suitable

for medicinal and industrial applications (Akinyele and Temikotan, 2007). It has been used as a medicine to replace plasma and to expand blood volume (Lengsfeldet al., 2004).

It is cultivated in 7,473 ha area and annual production is 59,121 mt. with average productivity of 7.91 mt./ha in Nepal(CBS, 2010). The productivity of okra is quite lower than neighboring countryIndia. The productivity of okra in India which is the largest okra producer country in the world has 11.96 mt/ha (FAOSTAT2014). The productivity of okra in Nepal is far lower than that of Ghana (20 mt/ha) and Egypt (14.00 mt/ha).There are many biotic factors related to the low productivity of okra in Nepal. Among them Okra Yellow Vein Mosaic Virus (YVMV) is one of the most important factor. It is transmitted by white fly (Bemisiatabaci Gen.). Infection of 100% plants in a field is very usual and yield loss ranges from50 to 94% depending on the stage of crop growth at which infection occurs (Sastry and Singh, 1974). If plants are infected within 20 days after germination, their growth is retarded; few leaves and fruits are formed and loss may be reach up to 94% (Sastry and Singh, 1974).The disease incidence has been seen more serious during rainy season as compared to summer season cultivation in Nepal. Onset and spatial development of the disease varied depending on time of planting.Incidence was lower in the May planting than June and August planting(Dahalet.al.,1992). No proper management system has been recommended till now. But regular spray of insecticide for controlling the white fly population, rouging of infected plants and weed free cultivation has been recommended by some workers in past. There may be possible to produce disease free crops under protected by proper netting, which may help to reduce white fly infestation and resulted not incidence of the disease. So present study was conducted to find the integrated solution for managing the YVMVin okra cultivation in mid -western terai of Nepal.

Materials and Methods

Experimental Site

The experiment was conducted at RARS, Khajura during June to October 2014. RARS, Khajura is located at at 810 37"E longitudes and 280 06"N latitude and an altitude of 181 meters above mean sea level. Average annual rainfall of the station ranged from 1000-1500 mm. The maximum and minimum temperature at the station is 460C and 5.40C respectively, with relative humidity ranging between 27 to 94 %. The soil of the experimental plot was sandy to silty loam, poor in organic carbon and available nitrogen but medium in available phosphorus and potassium pH is 7.2.The average monthly temperature ranged from 25 to 310 C, relative humidity 29 to 76 % and total monthly rainfall from 87 to 549 mm (Fig:1) of the experimental site during the experimental period.

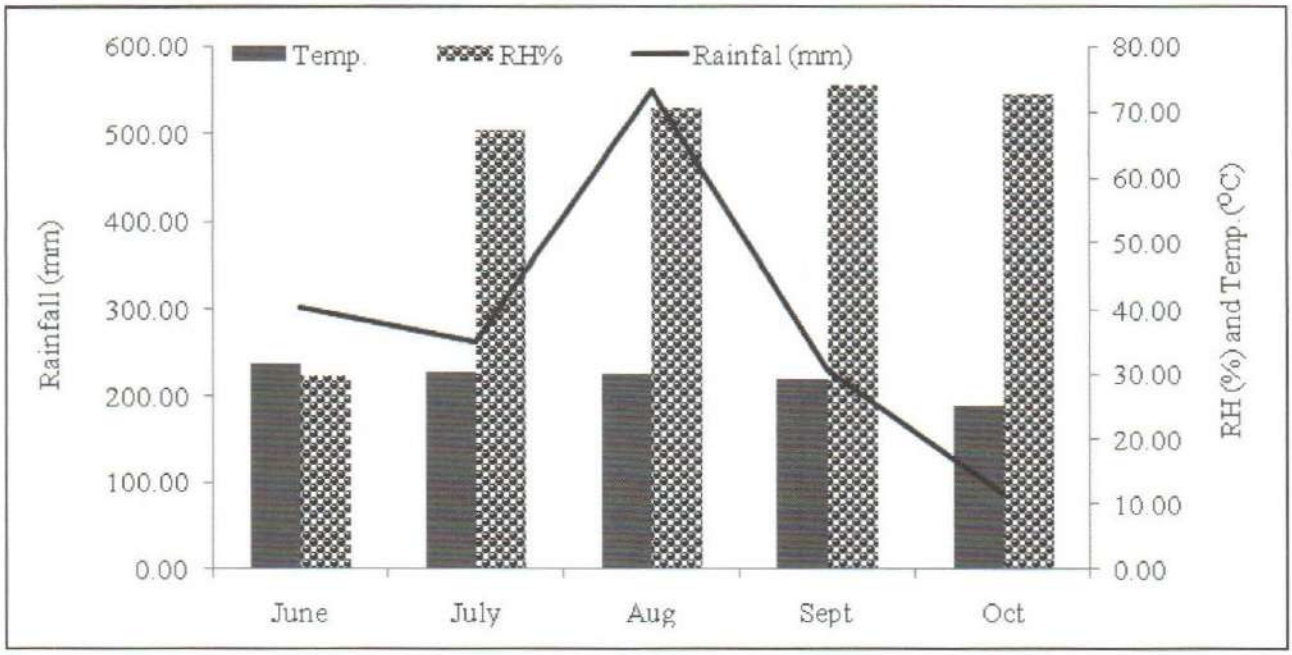

Figure 1. Average temperature, Average Relative Humidity(RH%) and Total Rainfall over the crop period at RARS, Khajura.

Screening of Okra Genotypes against YVMV

Plant material: Thirty one okra genotypes (Arka Anamika(Check),ACC# 626, ACC#7462, ACC# 7579, ACC# 7580, ACC# 7605, ACC# 7656, ACC# 7689, ACC# 8111, ACC# 8392, ACC# 8393, ACC# 8394, ACC# 8395, ACC# 8397, ACC# 8398, ACC# 8403, ACC# 8405, ACC# 8406, ACC# 8407, ACC# 8408, ACC# 8411, ACC# 8412, ACC# 8418, ACC# 8419, ACC#8421, ACC# 8426, ACC#8432, ACC# 8435, ACC#8114, ACC#8396, and ACC#8424) were collected from National Plant Genetic Resource Center, Khumaltar, Lalitpur, Nepal. All genotypes of okra were planted under the field conditions at the RARS, Khajura in June 2014.

In the screening technique, Arka Anamika was taken as a local check and was sown intermittently after every ten test entries so as to monitor the disease pressure. A total of 31 genotypes were tested against YVMV. Sowing of okra genotype was completed on 7th June, 2014 with two replications of row length 2 m and 60 x 25 cm row to row and plant to plant spacing, respectively. Okra seeds were put into 16 shallow holes (2 seeds/hole) in each plot. Seven days after planting, seedlings were thinned keeping one seedling per hole. Fertilization management used urea, diammonium Phosphate(DAP), and muriate of potash (MOP) at the respective rates of N 120 kg/ha, P2O5 80 kg/ha and K2O 60 kg/ha along with 10 mt FYM/ha. Weeding, irrigation, hoeing and other agronomic practices were done as per requirement to keep the crop in good condition.

Evaluation of Different Management Practices

Five different management practices (Control, spraying of cypermethrin 25% EC, Virkon-H, Milk, Net protected cultivation) were applied in RCB design with four replications. Thesuryamethrin (25% cypermethrin(Amit Pesticide, Birgunj Nepal)@2ml per liter water, Virkon-H (Bio-pesticides prepared from Acoroscalamus, Boerhavie diffuse, Bougainvileaspectabils of Hari organic Manure Ltd., Deheradun, India)@2ml per liter water and cow milk @10ml per liter water was applied continuously after seed emergence at one week intervals. The spray volume was 800 liter/ ha. In the net protected treatment the

white nylon nets were used to cover the entire plot from the date of sowing. Intensive care was taken during intercultural operation in the net protected treatment in order to ensure the avoiding of insect entry inside the net house.

Data Collection: The seed emergence was recorded 18 days after sowing. Disease scoring was done at eight weeks after planting in the plot by using the scale used by Ali et al. (2005) as given in Table 1.

Table 1. Disease scoring scale used in the experiment

Response	Rating scale	Severity Range (%)
Immune	0	0
Highly resistant	1	1-10
Moderately resistant	2	11-25
Tolerant	3	26-50
Moderately susceptible	4	51-60
Susceptible	5	61-70
Highly susceptible	6	71-100

Fresh fruits were harvested in each plot at weekly intervals for one month period and number of harvested fruit and total weight of the fruit were recorded. Data collected was subjected to the analysis of variance using R-studio version 0.98.1056. Mean separation were done where there is significant differences by using DuncanMultiple Range Test (DMRT).

Results and Discussion

Evaluation of Different Management Practices

The numbers of harvested plants in the experiment showed significant difference among the treatments (Table 2). The highest plant population was recorded in control treatment (52.25) and it was at par with cypermethrin (51.50) and milk sprayed field (45.25). Significantly, the lowest plant population was recorded in the net protected plot (38.25). The highest fruits per plot were recorded in Virkon –H sprayed plot (88.75) which was at par with control (86.50), milk (77.00) and Cypermethrin (79.75) sprayed plot, where as significantly the lowest numbers of fruit (48.25)were recorded in the net protected plot.

Table 2. Effect of different treatments on yield and yield attributing characters of okra

Treatments	Plant Stand	Number of fruit/ plant	Yield/ plant(gm)	Individual fruit weight(gm)	Yield/ plot (gm)
Cypermethrin 25% EC	51.50a	79.75ab	99.24a	19.66ab	4981.00a
Milk	45.25ab	77.00ab	86.30ab	17.10b	3650.50b
Net protected	38.25b	48.25b	108.35a	23.36a	4136.60ab
Virkon-H	43.00ab	88.75a	112.47a	19.74ab	4625.00a
Control	52.25a	86.50ab	62.13b	16.93b	3271.00c
CV (%)	17.18	33.61	24.78	20.87	14.76
F-test	*	*	*	*	**
LSD	12.19	39.38	35.77	6.22	939.80

The yield per plant was found to be significant among the different treatments. Significantly the highest yield per plant was recorded in the plot treated with Virkon-H(112.47gm) and which was at par with net protected plots(108.34 gm). While significantly the lowest yield per plant was recorded in the control plots (62.13 gm). The fruits weight was also significantly affected by different treatments (Table 2). The highest fruit weight was recorded in the net protected plot (23.36 gm)and it was followed by Virkon-H(19.74gm)and cypermethrin (19.66gm) sprayed plots. Significant the lowest fruit weight was recorded in the control (16.93 gm) plot which was at par with milk sprayed plot (17.10 gm). The total plot yield was also affected by different treatments. The highest ender fruits production were recorded in the cypermethrin sprayed plot (4981 gm) followed by Virkon-H (4625.00gm) sprayed plot which was at par with net protected (4136.5gm) plot. Significantly the lowest green fruit productions were recorded in the control plot (3271gm). Area Under Disease Progress Curve (AUDPC) and relative area under disease progress curve (rAUDPC) were also significantly affected by different treatments (Table 3). Both of these parameters were recorded significantly the highest in control plot (0.0300, 58.625) followed by milk sprayed plot (0.0250,42.875) while the lowest in net protected plots (0,0) respectively.

Varietal Screening

Among the tested genotypes Arkaanamika was found to be immune with local strain of YVMV and no others genotypes were found to be immune category while 8 genotypes were found to be moderately resistant, 12 tolerant, 4 moderately susceptible, 2 susceptible and 3 highly susceptible. The highest numbers of fruit per plant (62.5) were recorded in genotypes ACC# 8405(Table 5)and response of genotypes against YVMV is presented in Table 6. The disease score increased onwards 30 days after planting in control, cypermethrin, milk and vircon-H sprayed treatments while it was constant in net protected treatment (Table 4).

Table 3. AUDPC and rAUDPC over the different treatments

Treatments	AUDPC	rAUDPC
Control	58.625^{a}	0.0300^{a}
Cypermethrin 25% EC	28.875^{b}	0.0150^{b}
Milk	42.875^{ab}	0.0250^{ab}
Net protected	0.000^{c}	0.0000^{c}
Virkon-H	43.250^{ab}	0.0225^{ab}
CV (%)	44.395	41.284
F-test	*	**
LSD	23.751	0.011767

Table 4. Disease progress at differ period in different treatments

Treatments	30 DAP	47DAP	37 DAP
Control	3.25^{a}	3.50^{a}	3.50^{a}
Cypermethrin 25% EC	1.50^{b}	1.75^{ab}	1.75^{b}
Milk	2.25^{b}	2.75^{a}	2.50^{ab}
Net protected	0.00^{c}	0.00^{b}	0.00^{c}
Virkon-H	2.00^{b}	3.00^{a}	2.50^{ab}
CV(%)	32.47	56.43	46.27
F-test	**	**	**
LSD	0.90	1.91	1.46

Table 5. Disease score and crop phonological characters affected by YVMV in screening nursery at RARS, Khajura

Genotypes	Plant stand/Plot	Disease score (0-6 scale)	No. of Fruit/plant
ArkaAnamika	23.75^{ab}	0.25^{e}	37.5^{abcde}
ACC# 6262	9.50^{h}	5.00^{a}	5.0^{fghi}
ACC#7462	14.00^{defgh}	4.00^{abc}	22.5^{cdefghi}
ACC# 7579	20.50^{abcdef}	3.00^{bcd}	40.0^{abcde}
ACC# 7580	20.50^{abcdef}	3.00^{bcd}	46.0^{abcd}
ACC# 7605	14.50^{defgh}	3.50^{abcd}	28.0^{bcdefghi}
ACC# 7656	12.00^{fgh}	3.50^{abcd}	41.0^{abcd}
ACC# 7689	15.00^{cdefgh}	4.00^{abc}	35.5^{abcdefg}
ACC# 8111	13.00^{efgh}	3.50^{abcd}	55.0^{ab}
ACC# 8392	20.50^{abcdef}	2.50^{cd}	41.0^{abcd}
ACC# 8393	20.00^{abcdef}	2.50^{cd}	55.5^{ab}
ACC# 8394	22.00^{abcd}	3.50^{abcd}	2.5^{hi}
ACC# 8395	24.00^{ab}	2.00^{d}	38.5^{abcde}
ACC# 8397	25.00^{a}	3.00^{bcd}	30.5^{abcdefghi}
ACC# 8398	16.00^{bcdefgh}	3.50^{abcd}	8.5^{efghi}
ACC# 8403	24.00^{ab}	2.50^{cd}	22.0^{cdefghi}
ACC# 8405	18.50^{abcdefg}	3.50^{abcd}	62.5^{a}
ACC# 8406	19.50^{abcdef}	2.50^{cd}	2.5^{hi}
ACC# 8407	17.50^{abcdefgh}	2.00^{d}	36.5^{abcdef}
ACC# 8408	18.00^{abcdefgh}	5.00^{a}	0.0 ^{i}
ACC# 8411	21.50^{abcde}	4.00^{abc}	0.0^{i}
ACC# 8412	18.00^{abcdefgh}	4.50^{ab}	1.5^{i}
ACC# 8418	15.00^{cdefgh}	2.50^{cd}	48.5^{abc}
ACC# 8419	20.00^{abcdef}	3.50^{abcd}	34.0^{abcdefgh}
ACC#8421	16.50^{abcdefgh}	4.50^{ab}	28.0^{bcdefghi}
ACC# 8426	10.50^{gh}	2.50^{cd}	4.0^{ghi}
ACC#8432	19.50^{abcdef}	4.00^{abc}	0.0^{i}
ACC# 8435	22.00^{abcd}	3.00^{bcd}	0.0^{i}
ACC#8114	17.00^{abcdefgh}	3.50^{abcd}	16.0^{defghi}
ACC#8396	23.50^{abc}	4.00^{abc}	15.5^{defghi}
ACC#8424	12.00^{fgh}	5.00^{a}	24.5^{bcdefghi}
CV	22.62	29.327	60.029
F-Test	**	**	**

Table 6. Classification of okra genotypes according to their response with yellow vein mosaic virus

Response	Rating scale (0-6 scale)	Number of genotypes	Genotypes
Immune	0	1	ArkaAnamika
Highly resistant	1	0	
Moderately resistant	2	8	ACC# 8392, ACC# 8393, ACC# 8403, ACC# 8406, ACC# 8418, ACC# 8426, ACC# 8395, ACC# 8407
Tolerant	3	12	ACC# 7605, ACC# 7656, ACC# 8111, ACC# 8394, ACC# 8398, ACC# 8405, ACC# 8419, ACC#.8114, ACC# 7579, ACC# 7580, ACC# 8397, ACC# 8435
Moderately susceptible	4	4	ACC# 7462, ACC# 7689, ACC# 8411, ACC# 8432
susceptible	5	2	ACC# 8412, ACC# 8421
Highly susceptible	6	3	ACC.N 6262, ACC# 8408, ACC#.8424

Regarding the yield performance under high disease pressure three genotypes ACC# 8393, ACC# 8111, ACC# 8405 have produced the highest yield(Table 7 and 8). These genotypes produced yield more than 1 kg per plot while 12 genotypes (ACC# 8418, A.rkanamika, ACC# 8392, ACC# 7580, ACC# 8395, ACC# 8407, ACC# 7579, ACC# 7689, ACC# 7656, ACC# 8419, ACC# 7605, ACC# 8397) were found to be medium yielder and 11 genotypes (ACC# 8403, ACC# 8421, ACC# 7462, ACC#.8114, ACC#.8396, ACC#.8424, ACC# 8398, ACC# 8426, ACC# 6262, ACC# 8406, ACC# 8394, ACC# 8412) were found to be low yielder and 4 genotypes(ACC# 8408, ACC# 8411, ACC# 8432 and ACC# 8435) did not gave any yield under high disease pressure at Khajura.

Table 7. Disease score, fruit weight, green fruit yield per plant and total yield of the okra genotypes in yellow vein mosaic varietal screening nursery

Genotypes	Disease score (0-6)	Fruit weight (gm)	Yield/ plant (gm)	Yield/ Plot
A.Anamika	0.375^{d}	23.402^{a}	39.294^{bcdef}	955.25^{abcd}
ACC# 6262	4.500^{ab}	13.500^{abcde}	7.805^{fg}	69.00^{efg}
ACC# 7462	4.000^{abc}	16.905^{abc}	27.015^{cdefg}	$384.00^{abcdefg}$
ACC# 7579	4.000^{abc}	18.385^{abc}	35.580^{bcdefg}	$742.00^{abcdefg}$
ACC# 7580	4.000^{abc}	19.050^{abc}	43.220^{bcdef}	876.00^{abcdef}
ACC# 7605	4.500^{ab}	17.875^{abc}	34.285^{bcdefg}	$532.00^{abcdefg}$
ACC# 7656	3.500^{abc}	17.515^{abc}	61.845^{abc}	$673.00^{abcdefg}$
ACC# 7689	4.500^{ab}	19.965^{ab}	51.135^{bcde}	$717.00^{abcdefg}$
ACC# 8111	3.000^{abc}	19.825^{ab}	89.695^{a}	1097.00^{ab}
ACC# 8392	2.500^{bc}	22.540^{ab}	43.930^{bcdef}	905.00^{abcde}
ACC# 8393	3.000^{abc}	19.885^{ab}	57.300^{abcd}	1146.00^{a}
ACC# 8394	3.500^{abc}	5.400^{ef}	1.350^{g}	27.00^{g}
ACC# 8395	2.000^{cd}	20.165^{ab}	32.175^{bcdefg}	$779.00^{abcdefg}$
ACC# 8397	3.500^{abc}	16.560^{abcd}	20.010^{defg}	$506.00^{abcdefg}$

ACC# 8398	3.500^{abc}	20.335^{ab}	10.605^{fg}	172.00^{defg}
ACC# 8403	2.000^{cd}	23.625^{a}	20.705^{defg}	497.00^{abcdefg}
ACC# 8405	3.500^{abc}	16.805^{abc}	56.885^{abcd}	1073.00^{abc}
ACC# 8406	3.500^{abc}	21.500^{ab}	3.725^{g}	62.00^{fg}
ACC# 8407	2.000^{cd}	20.130^{ab}	42.305^{bcdef}	746.00 ^{abcdefg}
ACC# 8408	5.000^{a}	0.000^{f}	0.000^{g}	0.00^{g}
ACC# 8411	5.000^{a}	0.000^{f}	0.000^{g}	0.00^{g}
ACC# 8412	5.000^{a}	6.335^{def}	0.950^{g}	19.00^{g}
ACC# 8418	3.500^{abc}	20.87^{ab}	66.335^{ab}	995.00^{abcd}
ACC# 8419	4.500^{ab}	17.345^{abc}	34.630^{bcdefg}	592.00^{abcdefg}
ACC# 8421	4.000^{abc}	15.655^{abcde}	24.490^{cdefg}	446.00^{abcdefg}
ACC# 8426	4.000^{abc}	12.500^{bcde}	8.335^{fg}	100.00^{efg}
ACC# 8432	5.000^{a}	0.000^{f}	0.000^{g}	0.00^{g}
ACC# 8435	3.500^{abc}	0	0.000^{g}	0.00^{g}
ACC#8396	4.500^{ab}	15.350^{abcde}	12.105^{fg}	248.00^{cdefg}
ACC#8424	5.000^{a}	9.335^{cdef}	15.335^{efg}	184.00^{defg}
ACC#8114	3.000^{abc}	16.425^{abcd}	15.285^{efg}	264.00^{bcdefg}
CV (%)	35.049	32.528	65.295	79.818
F-test	**	**	**	**

Table 8. Classification of okra genotypes according to their yield under high yellow vein mosaic virus pressure condition

Group	Number of genotypes	Criteria for grouping	Genotypes
High yielder	3	Above 1000gm	ACC# 8393, ACC# 8111, ACC# 8405
Medium yielder	12	500-1000gm	ACC# 8418, A.Anamika, ACC# 8392, ACC# 7580, ACC# 8395, ACC# 8407, ACC# 7579, ACC# 7689, ACC# 7656, ACC# 8419, ACC# 7605, ACC# 8397
Low yielder	11	0-500 gm per plot	ACC# 8403, ACC# 8421, ACC# 7462, ACC#.8114, ACC#.8396, ACC#.8424, ACC# 8398, ACC# 8426, ACC# 6262, ACC# 8406, ACC# 8394, ACC# 8412
No yielder (0)	4		ACC# 8408, ACC# 8411, ACC# 8432 and ACC# 8435

Discussion

Okra Yellow Vein Mosaic is the most serious disease of okra and is transmitted by white fly (Bemisiatabaci Gen.) (Ghanem, 2003). The use of white fly barrier was the major and the most effective method of controlling yellow vein mosaic virus of okra. Different evidence from the past workers have been documented to show the less incidence of disease by using insecticide and protected cultivations. Ali et.al (2005) found four applications of different insecticides like imidacloprid, effective microbes (EM) or neem extract at 15 days interval starting two weeks after germination reduced the spread of YVMV by checking its vector B.tabaci. Similarly Ansar, (2014) found the low disease incidence in insecticidal sprayed plot as compared to control. Similarly different worker from different part of the world

have documented the presence of resistant source for YVMV in okra germplasm. Sarabani, et al.,(2002) has reported tolerant cultivars of okra for YVMV. While Kumar and Reddy, (2015) findings are entirely different then the present study. They found 100% incidence of YVMV in Arkaanamika variety while 0% in other tested hybrids in Hyderabad, India. This showed that the presence of resistant source in prevailed gene pool of okra while the strain of virus may vary according to the location to locations. Similarly Rashid et.al(2002) found two genotypes OK-292 and OK 285 resistant to YVM. These results are in close agreement with the present findings. They also recorded higher yield and lower disease in resistant and tolerance genotypes as compared to susceptible ones.

Conclusion

Yellow vein mosaic virus in okra is one the major yield reducing factor in terai region of Nepal. This disease can be successfully control if integrated disease management is followed seriously by farmers. The present study showed that the disease carrying vector can be control either by cultivating the crops in side the net house or regular spraying of safe insecticide. The study further showed the presence resistant source in local germplasm of okra in Nepal. This source either can be directly released as a resistant variety or can be utilized in okra breeding program for the development of disease resistant variety.

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