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Impact of Nutrients and Organics on Quality, Biochemical Status and Yellow Vein Mosaic Virus Disease Incidence of Okra (*Abelmoschus esculentus* (L.) Moench)

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An experiment was conducted during 2010-11 to study the Impact of nutrients and organics on quality, biochemical status and yellow vein mosaic virus disease incidence of okra. The results pooled over two seasons indicated that the yield and quality parameters *viz*., yield/ plot, total carbohydrates and protein were the highest, while crude fibre was the lowest were observed with application of *Pseudomonas fluorescens.* The enhanced activities of total phenol, peroxidase and polyphenol oxidase (PPO) in healthy and infected leaves due to application of *P.fluorescens* (seed treatment @ 10g kg^{-1} + soil application @ 2.5 kg ha^{-1} with FYM + foliar spray @ 0.2%) in split doses were found to be responsible for the reduction in whitefly population and yellow vein mosaic virus disease incidence.

Key words: Okra, biochemical, nutrients, quality, YVMV disease, *P.fluorescens*

Okra or *bhendi* (*Abelmoschus esculentus* (L.) Moench) is one of the most popular vegetable crops in India grown for its characteristic tender fleshy fruits. It requires heavy manuring for its potential production. It is affected by a number of diseases which cause substantial losses in yield. The most dreaded disease of bhendi is yellow vein mosaic virus disease, which affects the crop at all stages and causes heavy losses by affecting growth, yield and quality (Sastry and Singh, 1974). The virus is transmitted through white fly (*Bemisia tabaci).* Frequent pickings, high operational cost and residue of pesticides entering into food chain are the limiting factors for the chemical control of the disease (Kirankumar, 2007). This viral disease occurs throughout India, wherever it is grown. The disease has been reported to cause upto 94 per cent loss in yield. Seed yield of the crop is also reduced upto 86.13 per cent (Sinha and Chakraborty, 1978). Several approaches have been attempted to manage the bhendi yellow vein mosaic virus through vector control by spray of chemicals in many instances does not bring desired results. In the present study, an attempt was made to manage Yellow vein mosaic virus disease and biochemical status of okra through nutrients and organics**.**

Materials and Methods

An experiment was conducted during 2010-11 at Horticultural College and Research Institute, TNAU, Coimbatore for two seasons in okra hybrid 'COBhH 1'. The first season crop during March to June, 2010 and the second crop from October, 2010 to February, 2011 were raised in randomized block design. The following treatments replicated thrice were given as detailed:

T_1 - Sulphate of potash 1%

T_2 - Micronutrient mixture {Zn (1.68%) + Fe (7.60%) + Mn (1.22%) + Mo (0.14%) + Cu (1.00%) + B (2.48%)} @ 0.25%)

T_3 - Cow urine 10%

T_4 - Fermented buttermilk 10%

T_5 - Humic acid 0.2%

T_6 - Neem oil 0.3%

T_7 - *Pseudomonas fluorescens* as seed treatment 10g/kg + soil application @ 2.5 kg/ ha with FYM on 15 DAS+ foliar spray @ 0.2% on 30,45 and 60 DAS

T_8 - Recommended practice - Soil application of carbofuran 3G 1kg a.i./ha + foliar spray of dimethoate 30 EC 0.03%.

T_9 - Control.

The treatments were applied through foliar spray on 15, 30, 45 and 60 DAS. The field was thoroughly prepared and seeds were sown at 45 X 30 cm spacing in 10m^2 plot size. Okra crop was fertilized with recommended dose of FYM 20t and NPK 40:50:30 kg ha^{-1} (Anonymous, 2004). Quality parameters such as total carbohydrates by anthrone (Hedge and Hofreiter, 1962), protein (Lowry *et al.*,

1951) and crude fibre (Chopra and Kanwar, 1976) were analyzed and expressed in per cent.

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Biochemical analysis for total phenol content using Folin-Ciocalteau reagent (Malick and Singh, 1980) expressed in mg g^{-1}, peroxidase activity (Hammerschmidt *et al*., 1982) expressed in min^{-1} g^{-1} and Polyphenol Oxidase (Sadasivam and Manickam, 1992) expressed in $min^{-1}g^{-1}$ on fresh weight basis were carried out. Regarding YVMV incidence, the number of plants which exhibited yellow vein mosaic disease at fortnightly intervals from the date of sowing was counted in each replication and the percentage of incidence calculated based on the following formula

$$\text{YVMV incidence (\%)} = \frac{\text{No.of infected plants X 100}}{\text{Total number of plants}}$$

The data were analyzed statistically as per Gomez and Gomez (1976).

Results and Discussion

Yield attributes

The present study revealed that the nutrients and organics had significant role in increasing the yield (Table 1.). The highest values of yield /plot (16.13 kg) and marketable fruit yield (15.55 kg/plot) were obtained with treatment T_7 (*Pseudomonas fluorescens* as seed treatment @ 10g kg^{-1} + soil application @ 2.5kg ha^{-1} with FYM on 15 DAS+ foliar spray @ 0.2% on 30,45 and 60 DAS). The increase in yield may also be owing to synthesis of phytohormones like gibberellins, cytokinins and indole acetic acid by plant growth promoting rhizobacteria which are mostly involved in the induction of resistance and promoting plant growth and yield (Van Loon *et al*., 1998; Haas *et al*., 2000; Kloepper, 2003). Among the different secondary metabolites of fluorescent pseudomonads, siderophores and salicylic acid were implicated in the induction of systemic resistance and increased fruit yield (Leeman *et al*., 1996; Maurhofer *et al*., 1998).

Quality parameters

The quality and suitability of a vegetable for consumption in a crop like okra is judged based on the high content of carbohydrate and protein with low crude fibre is considered to be the most desirable character (Table 1.). The quality parameters *viz*., total carbohydrates (6.13 %) and protein (2.11 %) were the highest, while crude fibre was the lowest (14.74 %) in the treatment which received *P.fluorescens.* Increasing the carbohydrate content might be due to the increased IAA activity by *P.fluorescens,* which would have enhanced the sucrose synthetase activity and thereby promoted the carbohydrates content (Khatri and Chenulu, 1974). Similarly, higher protein content could be attributed to the synthesis of coated protein and other associated non structural proteins (Rasmussen *et al.,* 1995). Whereas, Lowest crude fibre content might be due to the enhancement of plant growth promoting system and synthesis of phytohormones resulting in enhanced vegetative growth and high photosynthetic activity (Abusaleha and Shanmugavelu, 1988).

Table 1. Impact of nutrients and organics on yield and quality of okra* (two seasons of 2010-2011)

Treatment	Yield kg/plot	Marketable Yield (kg/plot)	Carbohydrates (%)	Protein (%)	Crude fibre (%)
T_1 - Sulphate of potash 1%	15.05	14.76	5.78 (13.91)	1.77 (7.63)	15.34 (23.05)
T_2 - Micronutrient mixture 0.25%)	14.86	14.51	5.74 (13.85)	1.79 (7.68)	15.17 (22.93)
T_3- Cow urine 10%	15.03	14.61	5.83 (13.96)	1.83 (7.77)	15.22 (22.95)
T_4- Fermented buttermilk 10%	15.26	14.76	5.88 (14.01)	1.87 (23.58)	15.15 (22.89)
T_5 - Humic acid 0.2%	15.95	15.35	6.09 (14.28)	2.01 (8.14)	14.90 (22.70)
T_6 - Neem oil 0.3%	15.76	15.10	5.97 (14.43)	1.93 (7.98)	15.04 (22.81)
T_7- *P. fluorescens* as seed treatment 10g kg^{-1} + soil application 2.5kg ha^{-1} with FYM on 15 DAS+ foliar spray 0.2% on 30,45 and 60 DAS	16.13	15.55	6.13 (14.33)	2.11 (8.35)	14.74 (22.57)
T_8- Recommended practice - Soil application of carbofuran 1kg a.i ha^{-1} + foliar spray of dimethoate 0.03%	14.90	14.60	5.68 (13.76)	1.73 (7.55)	15.48 (23.16)
T_9 - Control	10.96	10.46	4.84 (12.69)	1.11 (6.05)	16.06 (23.62)
SEd	0.24	0.23	0.29	0.13	0.20
CD (0.05)	0.49	0.46	0.63	0.29	0.43

*Pooled data of field experiments. Figures in the parentheses are arc sine transformed value

Biochemical status

Induced systemic resistance (ISR) by fluorescent pseudomonads against pest and disease has been established as a new mechanism by which the plants defend themselves from pest and disease attack (Van Peer *et al*., 1991; Van Loon *et al*., 1998). Prior application of fluorescent pseudomonads as seed treatment and foliar applications would have induced various defense mechanisms (biotic and abiotic stress) in the plants (Chen *et al*., 2000; Kandan *et al.,* 2003).

Table 2. Impact of nutrients and organics on biochemical status of okra* (two seasons of 2010-2011)

Treatment	Total phenol (mg g^{-1})		Peroxidase (ΔOD min^{-1} g^{-1})		Polyphenol oxidase (ΔOD min^{-1} g^{-1})	
	H	I	H	I	H	I
T_1 - Sulphate of potash 1%	14.41	14.93	215.33	15.05	202.00	14.76
T_2 - Micronutrient mixture 0.25%	14.38	14.71	212.50	14.86	201.33	14.51
T_3- Cow urine 10%	14.30	14.86	213.50	15.03	202.50	14.61
T_4- Fermented buttermilk 10%	14.63	15.15	223.00	15.26	214.50	14.76
T_5 - Humic acid 0.2%	15.31	15.66	241.66	15.95	228.66	15.35
T_6 - Neem oil 0.3%	14.95	15.45	232.33	15.76	217.33	15.10
T_7 - *P. fluorescens* as seed treatment 10g kg^{-1} + soil application 2.5kg ha^{-1} with FYM on 15 DAS+ foliar spray 0.2% on 30,45 and 60 DAS	15.71	15.83	249.50	16.13	237.66	15.55
T_8 - Recommended practice - Soil application of carbofuran 1kg a.i ha^{-1} + foliar spray of dimethoate 0.03%	14.40	14.70	211.50	14.90	195.50	14.60
T_9- Control	13.98	13.33	186.33	10.96	159.16	10.46
SEd	0.21	0.29	7.77	0.24	7.81	0.23
CD (0.05)	0.44	0.58	15.62	0.49	15.71	0.46

*Pooled data of field experiments. H – Healthy, I – Infected

The biochemical analysis of leaves revealed that the treatment T_7 with application of *P.fluorescens* significantly influenced the total phenol, peroxidase and polyphenol oxidase in healthy and infected leaves (Table 2.). The increase in phenol content may be attributed to the activation of plant genes in the induction of resistance (Ukey and Sarode, 2003). The accumulation of phenols might be due to excess reduction of hydrogen peroxide by increased respiration (Farkas and Kiraly, 1962). Peroxidase and polyphenol oxidase (PPO) represents another component of an early response in plants to pathogen and pest attack and plays a key role in the biosynthesis of lignin, which limit the extent of disease spread (Bruce and West, 1989; Chen *et al*., 2000). Similar results were reported in TMV infected tomato (Bansal and Kalra, 1986) TLCV infected tomato (Banerjee and Kalloo, 1989).

Table 3. Impact of nutrients and organics on Yellow vein mosaic virus disease incidence of okra* (two seasons of 2010-2011)

Treatment	Days to first incidence of YVMV	YVMV incidence at fortnightly intervals (%)				
		45 DAS	60 DAS	75 DAS	90 DAS	105 DAS
T_1 - Sulphate of potash 1%	48.00	1.81 (4.86)	8.55 (16.85)	13.50 (21.49)	19.10 (25.86)	33.43 (35.27)
T_2 - Micronutrient mixture 0.25%)	46.67	1.13 (3.90)	7.16 (15.51)	14.46 (22.34)	22.73 (28.46)	35.03 (36.26)
T_3- Cow urine 10%	48.33	2.80 (8.00)	7.23 (26.87)	12.80 (20.93)	20.40 (26.75)	31.80 (34.10)
T_4- Fermented buttermilk 10%	48.65	2.10 (5.21)	9.76 (15.49)	14.96 (22.62)	23.06 (28.69)	36.36 (37.02)
T_5 - Humic acid 0.2%	52.33	1.04 (3.75)	6.63 (14.78)	11.80 (19.97)	18.03 (25.06)	28.13 (32.00)
T_6 - Neem oil 0.3%	52.67	2.16 (5.29)	6.36 (14.34)	11.30 (19.61)	17.76 (24.85)	27.56 (31.64)
T_7 - *P. fluorescens* as seed treatment 10g kg^{-1} + soil application 2.5kg ha^{-1} with FYM on 15 DAS+ foliar spray 0.2% on 30,45 and 60 DAS	53.67	1.63 (4.62)	4.16 (11.77)	9.50 (17.89)	15.70 (23.29)	24.23 (29.47)
T_8 - Recommended practice - Soil application of carbofuran 1kg a.i ha^{-1} + foliar spray of dimethoate 0.03%	47.50	2.42 (5.58)	7.53 (15.63)	12.76 (20.9)	21.13 (27.24)	32.86 (34.89)
T_9 – Control	40.67	5.38 (11.15)	17.13 (33.78)	30.93 (29.95)	45.93 (42.65)	65.46 (54.01)
SEd	3.07	4.98	1.93	2.41	1.80	2.97
CD (0.05)	6.52	NS	4.10	5.12	3.83	6.30

*Pooled data of field experiments. Figures in the parentheses are arc sine transformed value. NS- non significant

Yellow vein mosaic virus disease incidence

In the present study, the results generated on the incidence of YVMV in different treatments indicated that the percentage incidence showed increasing trend with the age of the crop from 45 to 105 days in all the treatments (Table 3.). Haas *et al*. (2000) reported that the intensity of YVMV incidence was directly related to the population level of *B.tabaci* and even a single insect is sufficient to transmit the disease. Hence, there would be increased incidence in later stage of the crop, where the sprays would not have any effect against whitefly. However, the lowest percentage incidence was recorded in *P.fluorescens* treated plots. This may be attributed to secondary metabolites production by fluorescent pseudomonads has been implicated in the direct antagonism against several soil borne pathogens, virus infection and also by increase in isozymes, phenol, peroxidase and polyphenol oxidase and their correlation with the induction of systemic resistance (Yet *et al*. 1992; Bakker *et al.,* 2003).

Findings of this study indicate that the application of organics and nutrients to okra has a positive effect on the plant health and on various biochemical traits and quality status. Thus, it could be concluded that increased quality attributes, biochemical traits and management of YVMV disease obtained by using *Pseudomonas fluorescens* was highly effective, economical and eco-friendly.

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