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Evaluation of systemic acquired resistance (SAR) inducing molecules against Panama wilt of banana incited by *Fusarium oxysporum* f. sp. *cubense* TR4 under pot condition

Kewal Chand, SK Singh, Yogita Nain, Kiran Choudhary and Ranjana Meena

Abstract
Banana is one of the important commercial fruit crops grown in the tropical and sub-tropical regions not only in India but also in the world. Production and productivity per unit area in India is very low. Low production and productivity may be due to many factors, among them diseases are playing a major role. Many micro-organisms caused diseases like viruses, bacteria, fungi and nematodes. The most important and economically destructive disease is "Panama wilt", it is also called as *Fusarium* wilt incited by *Fusarium oxysporum* f. sp. *cubense*. The Panama wilt disease is most destructive due to the emergence of new pathogenic race i.e. Tropical race (TR4). In the present time, this disease caused severe damage and farmer face huge problems due to this disease. For management of this disease, six different SAR molecules were evaluated against *Fusarium oxysporum* f. sp. *cubense* TR4 under pot condition. Among the six different SAR inducing molecules maximum 90 days were taken in the first appearance of the wilt symptom in BABA at 0.04 g/l concentration followed by salicylic acid 78 days at 1.0 g/l, Isonicotinic Acid 74 days and Acibenzolar-S-methyl 72 days at 0.20 g/l while in Benzoic Acid 72 days at 1.0 g/l and minimum in Probenazole 68 days after transplanting at 0.20 g/l concentration. BABA (0.04 g/l) was found highly effective in which only 14% wilt index was found followed by Isonicotinic Acid (0.20 g/l) with 28% wilt index, Salicylic acid (1.0 g/l) with 32% wilt index, Acibenzolar-S-methyl (0.20 g/l) with 35% wilt index, Benzoic Acid (1.0 g/l) with 34% wilt index while in Probenazole (0.20 g/l) 38% wilt index was recorded. In control 95% wilt index was recorded.

Keywords: *Fusarium oxysporum* f. sp. *cubense* TR4, Systemic Acquired Resistance (SAR)**,** Panama wilt

Introduction

Banana (*Musa paradisiacal* Linn.) is important perennial monocotyledonous fruit crop. Which was belongs to family Musaceae. The plant is also known as Kalpatharu, which means herb with all imaginable uses. It has been believed that originated hot tropical regions of South East Asia from cultivar *Musa accuminata* and *Musa bulbisiana*. The banana is the oldest cultivated fruits crop known to mankind and it's botanically known as a *Musa paradisiaca*. Banana is the world's most valuable fruit crop. Banana pulp per 100 gm has a calorific value ranging from 67 to 137 calories. The nutritive value of banana is similar to that of potato, but compare to potato, banana pulp contains higher energy in calories per 100 gm. Banana provides a more balanced diet compare to other fruits and has a more therapeutic value with low salt, fat content, and cholesterol. The starch present in banana pseudostem is used to preparation of glue and its sap used as a good dye. The fiber content of harvested stalks of banana and plantain is used extensively for the manufacture of certain papers with high strength, ropes, thread, and numerous handicrafts. There is also the great importance of banana plants for cultural and traditional rituals in many countries.

In 2011, the total gross production value of US$44 billion, and global banana production was nearly 145 Million tons (FAOSTAT 2013) [1]. Important diseases of banana are Panama wilt, bunchy top, bacterial wilt, Sigatoka and fruit rot. Among these, Panama wilt disease is considered to be very serious in banana-growing areas (Singh, 2005) [2]. In India First-time Tropical race 4 of *Fusarium oxysporium* f. sp. *cubense* (TR4) was noticed in cv. *Grand naine* (AAA) in Uttar Pradesh (Damodaran *et al.*, 2019) [3].

Recently, a highly virulent strain *Fusarium oxysporium* f. sp. *cubense* i.e. Tropical race 4 strain B2 has been identified which was affecting the Cavendish group of banana cv *Grand naine* (AAA) in the Koshi belt of Bihar (Shukla and Singh, 2019) [4].

Material and Method

Healthy tissue culture banana plants were having cultivar Grand naine (G-9) collected from the ICAR-AICRP on Fruits field at Pusa, Bihar. Young plants were transplanted in plastic pots at the poly house of the Department of Plant Pathology, RPCAU, Pusa. For irrigation application of sterile distilled water in a pot for two weeks. After hardening pots were treated with pathogens to prepare spore suspension, fungal mycelia were transferred into 250 ml flasks contain *Fusarium oxysporum* f. sp. *cubense* TR4 medium, formation by the followed method of Booth (1977). The flasks with fungal inoculums were put on a rotary shaker at 170 rpm and 25°C for five days. Later, spore suspensions were passed through cheesecloth for separation of fungal mycelia from spores. The remaining spore suspensions in liquid medium was used in a hemocytometer and make final conc. of $5x10^6$ spores/ml by added with sterilized distilled water. The banana plantlets in plastic pots were treated with a 5ml spore suspension of having concentration $5x10^6$spores/ml. The list of SAR chemical activators molecules was shown in Table-1. The chemicals Acibenzolar-S-methyl, Probenazole, salicylic acid, Isonicotinic acid, Benzoic acid and β,Amino-butyric acid (BABA) were used in the evaluation of SAR inducing molecules against Panama wilt in banana. Aqueous solutions of the chemicals were prepared in distilled water of different concentrations in gm per liter (g/l). It was applied in plastic pots by soil drenching. Each treatment was done three replications along with the control. The percent disease incidence was calculated by using the formula total number of transplanted plants showing Panama wilt disease symptom by the total plant transplanted then multiplied by a hundred. The inhibition percent over control also recorded in each replication treatment and data was recorded up to 90 days after transplanting. The data statics has been analyzed by CRD design.

Table 1: Different chemicals used in evaluation of SAR inducing molecules against Panama wilt under pot conditions

Chemicals	Concentrations (g/l)			
Acibenzolar-*S*-methyl	0.05	0.10	0.15	0.20
Probenazole	0.05	0.10	0.15	0.20
BABA	0.01	0.02	0.03	0.04
Isonicotinic Acid	0.05	0.10	0.15	0.20
Salicylic Acid	0.40	0.60	0.80	1.00
Benzoic Acid	0.40	0.60	0.80	1.00

Results and Discussion

Mass culture of *Fusarium oxysporum* f. sp. *cubense* TR4 was multiplied on sand corn medium and rhizome of susceptible cultivar Malbhog (AAB) added in steam-sterilized soil (15 psi for 30 minutes) in pots @ 5% (w/w). Soil mixture with inoculums was served as a control. Each pot was planted with one-month-old tissue culture cv Grand naine banana plant. After 15 days transplanting posts were treated with different SAR inducing molecules having different concentrations. Aqueous solutions were prepared according to the material and methods of the desired concentration. Every pot was drenched with different concentrations of SAR. While control remained as untreated. Data were recorded as the first appearance of disease (DAT), external symptoms and internal symptoms. Among the six different SAR inducing molecules maximum 90 days time was taken in first appearance of the wilt symptom in BABA at 0.04 g/l concentration followed by salicylic acid 78 days at 1.0 g/l, Isonicotinic Acid 74 days and Acibenzolar-S-methyl 72 days at 0.20 g/l while in Benzoic Acid 72 days at 1.0 g/l and minimum in Probenazole 68 days after transplanting at 0.20 g/l concentration.

BABA (0.04 g/l) was found highly effective in which only 14% wilt index was found followed by Isonicotinic Acid (0.20 g/l) with 28% wilt index, Salicylic acid (1.0 g/l) with 32% wilt index, Acibenzolar-S-methyl (0.20 g/l) with 35% wilt index, Benzoic Acid (1.0 g/l) with 34%wilt index while in Probenazole (0.20 g/l) 38% wilt index was recorded. In control 95% wilt index were recorded Table-2 & Table-3

Table 2: Effect of different SAR (Systemic Acquired Resistance) inducing molecules against *Fusarium oxysporum* f. sp. *cubense* TR4 causing Panama wilt of banana under pot condition

SAR inducing molecules	Concentrations (g/L)	First appearance of disease (DAT)	External symptoms (PWI 1-5 IMTP rating scale)	Internal symptoms (PVWI 1-6 IMTP rating scale)
Acibenzolar-*S*-methyl	0.05	60	44	42
	0.10	66	42	40
	0.15	70	38	36
	0.20	72	35	32
Probenazole	0.05	55	48	46
	0.10	60	44	42
	0.15	65	40	38
	0.20	68	38	36
Isonicotinic Acid	0.05	68	36	32
	0.10	70	34	30
	0.15	72	30	28
	0.20	74	28	26
Control		24	95	86
CD at 5%		2.60	2.40	2.48
S.Em. (±)		0.89	0.82	0.85
C.V. (%)		2.44	3.35	3.71

*Mean of three replications

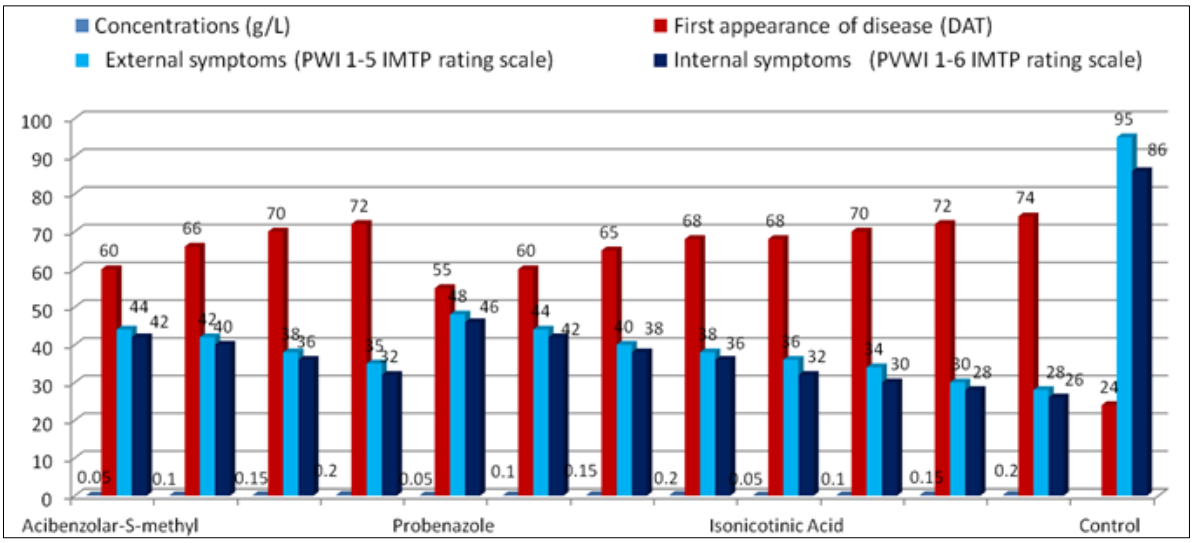

Fig 1: Effect of SAR (Systemic Acquired Resistance) inducing molecules against FOC TR4 causing Panama wilt of banana under pot condition

Table 3: Effect of SAR (Systemic Acquired Resistance) inducing molecules against *Fusarium oxysporum* f. sp. *cubense* TR4 causing Panama wilt of banana under pot condition

SAR inducing molecules	Concentrations (g/L)	First appearance of disease (DAT)	External symptoms (PWI 1-5 IMTP rating scale)	Internal symptoms (PVWI 1-6 IMTP rating scale)
Salicylic Acid	0.40	60	40	36
	0.60	68	38	32
	0.80	74	34	30
	1.00	78	32	28
Benzoic Acid	0.40	60	44	40
	0.60	65	40	36
	0.80	70	36	32
	1.00	72	34	32
BABA	0.01	80	20	18
	0.02	84	18	14
	0.03	88	16	14
	0.04	90	14	12
Control		24	95	86
CD at 5%		2.73	2.54	2.61
S.Em. (±)		0.93	0.87	0.89
C.V. (%)		2.30	4.23	4.89

*Mean of three replications

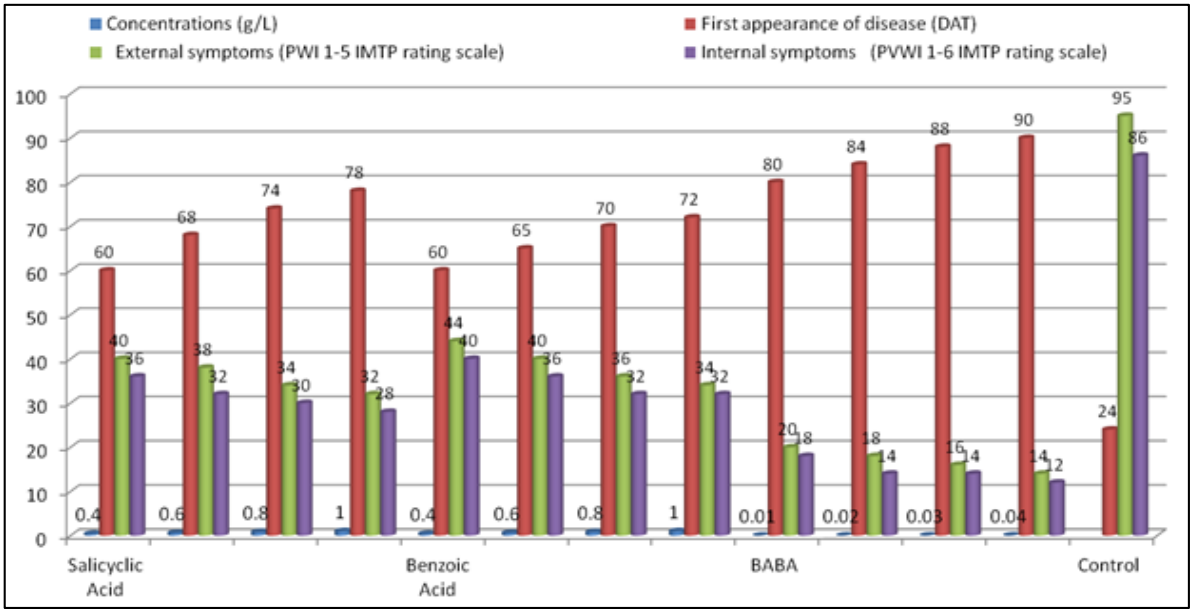

Fig 2: Effect of SAR (Systemic Acquired Resistance) inducing molecules against *Fusarium oxysporum* f. sp. *cubense* TR4 causing Panama wilt of banana under pot condition

Plate 1: Effect of SAR (Systemic Acquired Resistance) inducing molecules against *Fusarium oxysporum* f. sp. *cubense* TR4 causing Panama wilt of banana under pot condition

Six different SAR molecules were evaluated against *Fusarium oxysporum* f. sp. *cubense* TR4 under pot condition. Among the six different SAR inducing molecules maximum 90 days were taken in the first appearance of the wilt symptom in BABA at 0.04 g/l concentration followed by salicylic acid 78 days at 1.0 g/l, Isonicotinic Acid 74 days and Acibenzolar-S-methyl 72 days at 0.20 g/l while in Benzoic Acid 72 days at 1.0 g/l and minimum in Probenazole 68 days after transplanting at 0.20 g/l concentration.

BABA (0.04 g/l) was found highly effective in which only 14% wilt index was found followed by Isonicotinic Acid (0.20 g/l) with 28% wilt index, Salicylic acid (1.0 g/l) with 32% wilt index, Acibenzolar-S-methyl (0.20 g/l) with 35% wilt index, Benzoic Acid (1.0 g/l) with 34% wilt index while in Probenazole (0.20 g/l) 38% wilt index was recorded. In control 95% wilt index was recorded. Systemic acquired resistance (SAR) having a large-scale resistance show after infection by the necrotic pathogens (Hunt and Ryals, 1996, Neuenschwander *et al.*, 1996, Ryals *et al.*, 1996) [5]. Salicylic acid (SA) was major signalling inducing molecule for Systemic acquired resistance (SAR) reaction, it observed the other systemic signals can also be contributed in the production of Systemic acquired resistance(SAR)(Metraux, 2001) [6]. The chemical inducer which, is the non-pretentious nature D, L-(3-aminobutyric acid (BABA), it also reported to induced disease resistance pathways in different crops diseases like downy mildews disease (Cohen, 1994a, Tosi *et al.*, 1998, Siegrist *et al.*, 2000, Silue *et al.*, 2002) [7]. The signalling producing compounds were active by the external application of the chemical substance. However, it has been

found that infection caused in plants with avirulent or virulent pathogens may be induced by the increased production of signalling compounds in the plant (Reymond *et al.*, 2000; Schenk *et al.*, 2000) [8]. In banana plants, resistance response due to different activities like deposit lignin, production of phenolic compounds, and high enzyme concentration used in strength the plant cell wall (Beckman, 1990; De Ascensao and Dubery, 2000) [9]. The activation of plant defence mechanisms was due to chemical activators, thus offering a major approach for controlling *Fusarium* wilt or Panama wilt. This cannot be obtained by traditional methods. The study's objective was to identify a variety of chemical plant activators for reducing *Fusarium* wilt in dwarf Cavendish bananas susceptible and tolerant cultivar. BABA has been studied to have an effect against soil-borne and saprophyte fungal pathogens (Cohen, 1994b; Oka *et al.*, 1999) [10]. Different signalling producing compounds have been reported for the maintenance in resistance response in plants. These are plant hormones like ethylene (ET), salicylic acid (SA) and jasmonic acid (JA) several proteins like substances harpin, nitric oxide (NO) and reactive oxygen intermediates (ROIs) (Wasternach and Parthier, 1997; Delledonne *et al.*, 1998; McDowell and Woffenden, 2003) [11]. Shukla and Dwivedi (2013) [12] also conducted a laboratory study to evaluate the effect of salicylic acid, phenol, and benzoic acid against *Fusarium oxysporum* f. sp. *ciceri* and *Fusarium* udum. Salicyclic acid @ 0.1% and phenol @0.15% concentration completely inhibited the fungal growth of *Fusarium udum* while benzoic acid @ 0.15% concentration reduced the growth upto 98.52% respectively. In the case of *Fusarium oxysporum* f. sp. *ciceri*@ 0.15% concentration of salicylic acid, phenol, and benzoic acid has been found a reduction in growth up to 98.70, 98.52 and 95%. Imazaki and Kadota (2019) [13]observed that control of *Fusarium* wilt of melon incited by *Fusarium oxysporum* f. sp. *melonis* the effects of treatment combinations with *Fusarium oxysporum* Strain (SL0037), probenazole (96mg a.i./l), and soil-alkalizing agents were tested in the field. That was amended with *Fusarium oxysporum* f. sp. *melonis* the melon wilt pathogen. In 3 years of the study, with different combinations. Results were found that a combination of *Fusarium oxysporum* Strain (SL0037), probenazole (96mg a.i./l), and soil-alkalizing agents significantly reduced *Fusarium* wilt of melon and improve the growth of melon plants.

References

1. FAOSTAT. http://faostat.fao.org/.2013.
2. Singh SK. Annual Report of AICRP. Tropical fruits, RAU, Pusa Centre. 2005, 63.
3. Damodaran T, Mishra VK, Jha SK, Gopal R, Rajan S, Ahmed I. First Report of *Fusarium* wilt in banana caused by *Fusarium oxysporum* f. sp. *cubense* Tropical Race 4 in India. Plant Disease "First Look" paper. 2019.
4. Shukla DN, Singh SK. First ever report of Tropical Race 4 of *Fusarium oxysporum* f.sp. *cubense* in dwarf cavendish group of bananas in Bihar state of India. National symposium on Recent challenges and opportunity in sustainable plant health management. February26-28.2019. organized by Indian Phyto pathological Society, New Delhi at Institute of Agricultural Sciences, BHU, Varanasi, UP.
5. Hunt M, Ryals J. Systemic acquired resistance signal transduction. Crit. Rev. Plant Sci. 1996;15:583-606.
6. Metraux JP. Systemic acquired resistance and salicylic acid: current state of knowledge. European Journal of Plant Pathology. 2001;107:13-18.
7. Cohen Y. 3-Aminobutyric acid induces systemic resistance against *Peronospora tabacina*. Physiology and Molecular Plant Pathology.1994a;44:273-288.
8. Reymond P, Weber H, Damond M, Farmer EE. Differential gene expression in response to mechanical wounding and insect feeding in *Arabidopsis*. 2000.
9. Beckman CH. Host responses to the pathogen. In: Ploetz, R.C. (Ed.), *Fusarium* wilt of banana. APS Press, St Paul, Minnesota, USA.1990, 93-105.
10. Cohen Y. Local and systemic control of *Phytophthora infestans* in tomato plants by DL-3-Amino-n-Butanoic acids. Phytopathology.1994b;84:55-59.
11. Wastemach C, Parthier B. Jasmonate-signalled plant gene expression. Trends in Plant Science. 1997;2:302-307.
12. Shukla A, Dwivedi SK. Antifungal approach of phenolic compounds against *Fusarium udum* and *Fusarium oxysporum* f. sp. *ciceri*. African Journal of Agricultural Research. 2013;8(7):596-600.
13. Imazaki I, Kadota I. Control of *Fusarium* wilt of melon by combined treatment with biocontrol, plant-activating, and soil-alkalizing agents. Journal of General Plant Pathology. 2019;85:128-141.