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Efficacy of plant growth regulator and food preservative against *Penicillium* rots of Kinnow (*Citrus deliciosa* Ten.) fruits

R. N. Sharma, R. P. Maharshi* and R. B. Gaur

Deptt. of Plant Pathology, Agricultural Research Station (Rajasthan Agricultural University), Sriganganagar-335 001,

** Deptt. of Plant Pathology, S.K.N. College of Agriculture (Rajasthan Agricultural University), Jobner-303 329,*

Abstract

Kinnow (*Citrus deliciosa*) fruits are prone to attack with various post-harvest fungal rots. Among these, *Penicillium* rots viz., green mould rot (*P. digitatum*) and blue mould rot (*P. italicum*) are most destructive, sharing around 40 to 50 per cent of the total post-harvest fruit decay occurred in Sriganganagar belt of Rajasthan. Studies were conducted to evaluate the efficacy of Naphthalene acetic acid (NAA) and potassium metabisulfite (KMS) against these two post-harvest rots during 2004-05 and 2005-06. The results revealed that the dipping treatment of KMS solution proved significantly superior to NAA in respect of retarding the incidence of these rots. The reduction of 57.53 and 60.58 per cent incidence was recorded in green mould rot and blue mould rot respectively in pre-inoculation treatment of KMS while 50.70 and 54.53 per cent reduction in incidence of these rots was noted in post-inoculation treatment of the same chemical in comparison to control. The disease incidence was found to increase with increasing period of incubation.

Key words: Kinnow, post-harvest, *Penicillium*, rots, PGR, food preservative.

Introduction

Kinnow (*Citrus deliciosa* Ten.) is a hybrid variety of mandarin group of citrus. It is exceedingly popular due to its adaptability to varied agro-climatic conditions, heavy bearing and excellent juice quality. It is mostly grown in Northern states of India, covering area of 45101 ha and producing 324208 million tonnes with productivity of 7.18 million tonnes ha^{-1} (Singh and Thakur, 2006). Rajasthan occupies a pivotal role in Kinnow cultivation with 10382 ha area and annual production of 85700 million tonnes with productivity of 250-300 qtl ha^{-1} (Anonymous, 2008). Kinnow fruits are prone to attack with various post-harvest fungal rots during storage. Among these, green mould rot and blue mould rot caused by *Penicillium digitatum* and *P. italicum* respectively are most destructive causes around 40 to 50 per cent of the total post-harvest fruit loss in Sriganganagar belt of Rajasthan (Sharma, 2007). It is not essential to kill a pathogen present in a injury in order to prevent disease development but rather only to maintain a fungistatic concentration of the chemical at the injury site for as long as the injury is receptive to infection. Fruits that have an active metabolism show considerable resistance to microbial infection and decay, whereas stressed or senescent fruits are prone to disease. Plant growth regulators control physiological processes at extremely low concentrations, are known to delay the senescence and onset of fruit rotting (Sommer, 1982). Present investigation was therefore undertaken to find out efficacy of plant growth regulator (PGR) viz., naphthalene acetic acid (NAA) and food preservative viz., potassium metabisulfite (KMS) against two major post-harvest *Penicillium* rots in Kinnow fruits.

Material and methods

Healthy and mature fruits of uniform size were harvested, surface sterilized and pricked through 'pin-prick method' (Tomkins and Trout, 1931) upto the depth of 2 mm, making 5 wounds/fruit. These fruits were separately inoculated by dipping them in spore suspension (10^6 spores ml^{-1}) of each pathogen i.e. *P. digitatum* and *P. italicum* separately for 2 minutes. The plant growth regulator (NAA) and food preservative (KMS) were dissolved separately in sterile distilled water so as to get 100 and 600 ppm concentration of these chemicals respectively and used for pre- and post-inoculation dip treatments (Thompson, 1996. In case of pre-inoculation treatment, the fruits were first dipped in the test chemical for 5 minutes, air dried for 15 minutes and then inoculated with the respective pathogen. While in the post-inoculation treatment, the fruits were first inoculated and then treated with chemicals. Parallel controls with fruits dipped in

sterile distilled water were run simultaneously. The interval between inoculation and treatment with chemicals or vice-versa was of 12 hr. Each treatment was replicated thrice, having seven fruits in each replication. The experimental design was a factorial completely randomized design.

The inoculated fruits were enclosed separately in pre-sterilized perforated polythene bags partially sealed with paper pins and incubated at 25 ± 1°C temperature and 90-100 per cent relative humidity. The number of wounds showing rotting were recorded on 3rd and 6th day of inoculation and analysed statistically after angular transformation. The rot reduction index (RRI) was calculated on the basis of aggregate mean of rotting (Gutter, 1969) is given below:

$$RRI = \frac{\text{\% rot in control} - \text{\% rot in treatment}}{\text{\% rot in control}} \times 100$$

Results and discussion

In general, fruits treated with plant growth regulator (NAA) and food preservative (KMS) exhibited significantly less incidence of rotting in both pre- and post-inoculation treatments as compared to untreated control fruits. Between these chemicals, KMS given significantly better results to NAA in reducing the incidence of rots. The rot incidence was found to increase with increasing period of incubation. At 6th day of inoculation the rot incidence was significantly higher to the incidence of rot

Table 1. Efficacy of plant growth regulator and food preservative against green mould rot incidence in post-harvest treated Kinnow fruits

Treatments	Conc. (ppm)	% Rot incidence in pre-inoculation treatment at (days)				% Rot incidence in post-inoculation treatment at (days)			
		3	6	Mean	RRI	3	6	Mean	RRI
Naphthalene acetic acid	100	30.4 (33.4)	46.1 (42.8)	38.2 (38.1)	48.1	38.6 (38.4)	53.9 (47.3)	46.3 (42.8)	39.2
Potassium metabisulfite	600	25.0 (30.0)	37.5 (37.8)	31.3 (33.9)	57.5	30.7 (33.7)	44.3 (41.7)	37.5 (37.7)	50.7
Control	-	60.0 (50.8)	87.1 (69.6)	73.6 (60.2)	0.0	62.2 (52.0)	90.0 (72.1)	76.1 (62.1)	0.0
Mean		38.5 (38.1)	56.9 (50.0)			43.8 (41.4)	62.7 (53.7)		
CD (*P=0.05*)									
Treatments			2.3					2.1	
Days			1.9					1.7	
Treatments x Days			3.3					2.9	
CV (%)			5.0					4.1	

Figures in parentheses are arc sine transformed values

Table 2: Efficacy of plant growth regulator and food preservative against blue mould rot incidence in post-harvest treated Kinnow fruits

Treatments	Conc. (ppm)	% Rot incidence in pre-inoculation treatment at (days)				% Rot incidence in post-inoculation treatment at (days)			
		3	6	Mean	RRI	3	6	Mean	RRI
Naphthalene acetic acid	100	28.6 (32.3)	41.8 (40.3)	35.2 (36.3)	52.6	35.4 (36.5)	50.0 (45.0)	42.7 (40.7)	44.5
Potassium metabisulfite	600	24.3 (29.5)	34.3 (35.8)	29.3 (32.7)	60.6	28.9 (32.5)	41.1 (39.9)	35.0 (36.2)	54.5
Control	-	60.0 (50.8)	88.6 (70.8)	74.3 (60.8)	0.00	61.8 (51.8)	92.2 (74.2)	77.0 (63.0)	0.0
Mean		37.6 (37.5)	54.9 (49.0)			42.0 (40.3)	61.1 (53.0)		
CD (*P=0.05*)									
Treatments		2.4						1.5	
Days		1,9						1.2	
Treatments x Days		3.4						2.1	
CV (%)		5.2						3.0	

Figures in parentheses are arc sine transformed values

occurred at 3rd day of inoculation in both pre- as well as post-inoculation treatments.

Green mould rot

Dipping treatment of KMS proved significantly superior in checking the rot where only 31.3 and 37.5 per cent incidence was noted in pre- and post-inoculation treatments respectively (Table 1) as compared to NAA treatment. The rot incidence in untreated control fruits was 73.6 and 76.1 per cent in pre- and post-inoculation treatments respectively. The rot incidence of 38.5 and 56.9 per cent recorded at 3rd and 6th day of inoculation in pre-inoculation treatment while these were 43.8 and 62.7 per cent rot respectively in post-inoculation treatment.

Blue mould rot

In KMS treatment, the blue mould rot was 29.3 and 35.0 per cent rot in pre- and post-inoculation treatments respectively while, these were 35.2 and 42.7 per cent in NAA treatment as compared to 74.3 and 77.0 per cent in untreated control fruits (Table 2). At 3rd and 6th day of inoculation, the rot incidence of 37.6 and 54.9 per cent recorded in pre-inoculation treatment while 42.0 and 61.1 per cent rot incidence was observed in post-inoculation treatment at same days of inoculation respectively.

These findings are corroborated with that of Dhatt *et al.* (1995) who reported that plant growth regulators reduced the incidence of post-harvest diseases and consequently increased shelf life of citrus fruits. The efficacy of plant growth regulators against *Penicillium* rot of sweet orange fruits has also been reported earlier by Godara (1994). Gupta and Pathak (1990) reported that NAA was most effective against post-harvest rotting of fruits when applied at 0.01 per cent concentration. According to Adaskaveg *et al.* (2002) plant growth regulators delayed the senescence of citrus fruits and consequently delay their susceptibility to rotting. Therefore, the incidence of rottings reduced in NAA treated fruits might be due to its antisenescent properties that maintained better fruits, avoiding congenial conditions for attack of pathogenic fungi. Most of these compounds occur naturally and hence their use in post-harvest citrus treatments is expected to receive consumer acceptance (Singh *et al.*, 2004).

Sharma *et al.*, (1994) and Jakhar (2003) have also reported the efficacy of potassium metabisulfite in checking post-harvest spoilage in mango and tomato fruits. Potassium bisulfite checks the post-harvest fruit decay by releasing sulphur dioxide (SO_2) which had inhibitory effect on pathogenic moulds (Luvisi, 1992). In general, fruit rot incidence increased over duration of storage might be due to weakening of the defence system in fruits against the fungal attack because of decrease in pectin substances and multiplication of already existing pathogens during storage (Dennis, 1977).

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