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EFFICACY OF *ALOE VERA* GEL, NEEM LEAF EXTRACT AND BIO-CONTROL AGENT ON INCIDENCE OF ANTHRACNOSE AND STEM END ROT OF MANGO

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ABSTRACT

A laboratory experiment was performed at, Banaras Hindu University, Varanasi during 2015 to assess the efficacy of bio-control agent Psueudomonas fluorescens and extracts obtained from plants (Aloe vera, neem) on the extension of post harvest life, suppression of anthracnose and stem end rot disease of mango fruits cv. Langra stored at ambient condition. Physiologically mature mango fruits were treated with Pseudomonas fluorescens (10^7 cfu/ml), Aloe vera gel (1: 1(v/v diluted with water) and neem leaves extract 1:1(w/v diluted with water) by dipping them for 5 min. After treatment application, fruits were air-dried and stored at ambient condition (30º ± 2ºC) for 12 days. Among the treatments, Pseudomonas fluorescens (10^7 cfu/ml) showed significant reduction (8.23%) in disease incidence compared to control (34.69%). Loss of firmness and PLW (Physiological loss in weight) was also found minimum in P. fluorescens treated fruits. While, fruits treated with Aloe vera gel delayed to increase in total soluble solids, total sugars and colour development compared to other treatments. Thus, P. fluorescens (10^7 cfu/ml) treatment may be used as a bio control agent in reducing anthracnose and stem-end rot and maintained desirable fruit quality of mango.

Keywords: Mango, anthracnose, stem-end rot, biocontrol agent, *Aloe vera* gel, neem leaf extract, quality parameters

INTRODUCTION

Mango (*Mangifera indica* L.) is an important fruit crop in the world. The world market continues to become more prices competitive in spite of post harvest challenges for example, losses caused by diseases (HCDA, 2011). Mango fruit suffers from many post harvest problems like diseases and disorders, which reduce the value of fruits during storage. In India, major post harvest diseases of mango are anthracnose (*Colletotrichum gloeosporioides*), stem end rot and soft rot (*Botryodiplodia theobromae*) (Jeffries *et al.* 1990) which is caused by fungus. Due to fungicide residual effects and awareness by consumers, now-a-days organically bio-control measure of anthracnose, stem end rot and soft rot are becoming very popular in national and international markets. After harvesting of fruit, coating is becoming very popular to prevent the deterioration of fruit quality (Gill *et al.* 2005). The popularity of plant products are increasing day by day because of their biodegradability, least persistence, least toxic effect, economic and easy availability. Among the natural products, one of the most promising natural compounds is *Azardirachtin* which is extracted from *Azadirachta indica* A. Juss (neem) tree and *Aloe Vera* gel extracted from *aloe vera* plant which has antiviral, antifungal, antibacterial and insecticidal properties. Hence, the present study was conducted to evaluate and compare the bio-control efficacy of *Pseudomonas fluorescens, Aloe vera* gel and neem leaf extract against anthracnose and stem-end rot and also their impact on physico-chemical properties of fruit quality.

MATERIALS AND METHODS

The experiments were conducted at the laboratory of Department of Horticulture, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi during 2015. For the experiment fresh, physiologically mature (green skin and light cream pulp) and uniform mango fruits of cv. Langra were harvested along with 5-6 cm stalk. Treatments were performed by dipping the fruits in *Pseudomonas fluorescens* bio-control agent (10^7 cfu/ml), *Aloe vera* gel (1:1 v/v diluted with distilled water) and neem leaf extract (1:1 w/v) solutions for 5 minutes but in case of control, fruits were treated with distilled water. After treating, the fruits were air-dried and stored at ambient condition ($30^0 \pm 2^0$C) for 12 days. The experiment was laid out in completely randomized block design with four treatments and four replications. Observations were recorded on physiological loss in weight,

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fruit firmness (by numerical rating scale), peel colour numerical rating scale), peel thickness, ascorbic acid content, total soluble solids, titratable acidity, total sugars content and disease incidence at 3, 6, 9 and 12th day after treatment. Fruit firmness and peel colour were determined by numerical rating scale 1-5 (Maqbool, 2006), whereas the peel thickness was determined by using screw gauge. Disease incidence calculated by number of fruits showing disease symptoms divided by total number of fruits and then converted into percent value.

RESULTS AND DISCUSSION

Significantly minimum physiological loss in weight (4.10, 9.37, 14.25 and 17.18%) at 3, 6, 9 and 12 days, respectively was recorded in *Pseudomonas fluorescens* (10^7 cfu ml^{-1}) treated fruits followed by *Aloe vera* gel (4.30, 9.96, 16.4 and 20.40%) and neem leaf extract (4.74, 10.57, 16.9 and 20.36%). It was higher in control (untreated fruits) at 3, 6, 9 and 12 days, but at 3rd days it was higher in neem leaf extract. The untreated fruits might be attributed to higher amount of water loss and higher metabolic activity in respect of respiration and it showed highest disease incidence of 0.33, 6.76, 14.20 and 34.69% at all the stages. The lower loss in weight was observed for *Pseudomonas fluorescens* (10^7 cfu ml^{-1}) treated fruits which may be due to lower incidence of diseases and lower metabolic activity. Moreover, *Aloe vera* gel and neem leaf extract reduced the extent of loss in weight of fruit by providing a barrier for diffusion of water vapour and controlling respiratory exchange. These results corroborated with the findings of Gupta *et al.* (2014) and Shinde *et al.* (2009) in mango cv. Dashehri and cv. Keshar, respectively. The fruits treated with *Pseudomonas fluorescens* (10^7 cfu ml^{-1}) showed significantly highest fruit firmness score (4.66, 3.52, 1.98 and 1.06 at at 3, 6, 9 and 12 days) as compared to other treatments at all the stages except 3rd days and minimum (0.40) score was recorded in control at 3, 6, 9 and 12 days (Table 1). The ripening process was delayed in bio-control agent, *Aloe vera* gel and neem leaf extract treated fruits due to slower respiration rate, which leads to reduced softening of fruit. These findings are in agreement with the results obtained by Marpudi *et al.* (2011) in papaya and Gupta *et al.* (2014) and Shinde *et al.* (2009) in mango. The minimum (4.28) score for peel colour were found for the fruits treated with *Pseudomonas fluorescens* (10^7 cfu ml^{-1}) and *Aloe vera* gel at 12 days followed by neem leaf extract (4.91 at 12 days) and maximum (1.21, 3.35, 3.55 and 4.97 at all the stages) in control but neem leaf extract showed minimum at 3rd and 6th days after treatment as compared to *Aloe vera* gel and *Pseudomonas fluorescens* (10^7 cfu ml^{-1}) and it is also observed that *Aloe vera* gel minimum as compared to neem leaf extract and *Pseudomonas fluorescens* (10^7 cfu ml^{-1}) at 9th days after traement. It may be due to lower percentage of water loss from the fruit skin. These findings are in accordance with Ergun and Satici (2012) in apple. The maximum (0.61, 0.50, 0.38 and 0.32 mm at 3, 6, 9 and 12 days) peel thickness was recorded in *Pseudomonas fluorescens* (10^7 cfu ml^{-1}) treated fruit followed by *Aloe vera* gel (0.22 mm at 12 days) and neem leaf extract (0.20 mm) and minimum (0.19 mm at 12 days) in control. *Pseudomonas fluorescens* (10^7 cfu ml^{-1}) is significantly higher to *Aloe vera* gel and neem leaf extract at 3, 6, 9 and 12 days. The higher peel thickness is mainly due to lower loss of moisture from the fruit. Generally, *Aloe vera* gel comprised of polysaccharides, which prevented the loss of moisture from the fruit by formation of a barrier to water diffusion between fruit and environment, thus avoiding its external transference (Ni *et al*., 2004).

The TSS increase during the storage might be due to hydrolysis of insoluble polysaccharides into simple sugars (Wills *et al*., 1980). The highest values of TSS (15.26, 20.06, 26.25 and 26.59 ^{0}Brix at 3, 6, 9 and 12 days) were recorded in *Pseudomonas fluorescens* (10^7 cfu ml^{-1}) treated fruits followed by control (26.48), while lowest (14.09, 18.44, 23.03 and 24.83 ^{0}Brix at all the stages) in *Aloe vera* gel. *Pseudomonas fluorescens* (10^7 cfu ml^{-1}) and control treatments were statistically at par in respect of TSS (Table 2). The maximum (0.2%) titratable acidity was recorded in neem leaf extract treated fruits while lowest (0.08%) in control and *Pseudomonas fluorescens* (10^7 cfu ml^{-1}) treated fruits (0.12%). Higher retention of titratable acidity was by neem leaf extract followed by *Aloe vera* gel treated fruits might be attributed to delay in ripening process. These results are supported by finding of Marpudi *et al.* (2011) and Chouhan *et al.* (2012) in apple. This was due to faster ripening of control fruits; the change in starch into

Table 1: Effect of different treatments on physiological loss in weight, fruit firmness, peel colour and peel thickness in mango fruits

Treatments	Physiological loss in weight (%)				Fruit firmness (%)				Peel colour				Peel thickness (mm)			
	Days after storage				Days after storage				Days after storage				Days after storage			
	3	6	9	12	3	6	9	12	3	6	9	12	3	6	9	12
Aloe vera gel (1:1 v/v)	4.30	9.96	16.40	20.04	4.33	2.48	1.80	0.97	1.10	1.44	3.53	4.28	0.58	0.40	0.28	0.22
Neem leaf extract (1:1 w/v)	4.74	10.57	16.90	20.36	4.36	2.62	1.49	0.79	1.10	1.32	3.67	4.91	0.57	0.38	0.26	0.20
P. fluorescens (10^7cfu ml^{-1})	4.10	9.38	14.25	17.18	4.66	3.52	1.98	1.06	1.15	1.63	3.69	4.28	0.61	0.50	0.38	0.32
Control (distilled water)	4.69	10.74	17.18	20.70	4.43	1.98	1.08	0.40	1.21	3.35	3.55	4.97	0.54	0.32	0.19	0.19
C.D. (P = 0.05)	0.019	0.019	0.021	0.019	0.014	0.019	0.014	0.019	0.021	0.019	0.105	0.019	0.019	0.017	0.019	0.019

Table: 2: Effect of different treatments on total soluble solids, titratable acidity, total sugar and ascorbic acid content in mango fruits

Treatments	Total soluble solids (^{0}Brix)				Titratable acidity (%)				Total sugar (%)				Ascorbic acid content (mg/100g)			
	Days after Storage				Days after Storage				Days after Storage				Days after Storage			
	3	6	9	12	3	6	9	12	3	6	9	12	3	6	9	12
Aloe vera gel (1:1 v/v)	14.09	18.44	23.03	24.83	0.49	0.37	0.22	0.16	13.57	17.72	22.36	23.33	62.57	60.55	57.90	2.81
Neem leaf extract (1:1 w/v)	14.43	18.55	23.31	25.03	0.47	0.23	0.27	0.20	14.00	16.05	22.55	23.58	61.12	59.50	55.31	51.93
P. fluorescens (10^7cfu ml^{-1})	15.26	21.06	26.25	26.59	0.43	0.30	0.19	0.12	14.85	20.05	24.96	25.09	61.41	59.44	5.22	1.86
Control (distilled water)	14.98	22.62	27.06	26.48	0.41	0.29	0.14	0.83	14.12	21.86	25.26	25.06	59.49	54.27	48.49	3.49
C.D. P = 0.05)	0.43	0.27	0.161	0.107	0.027	0.034	0.017	0.019	0.027	0.038	0.032	0.050	0.103	0.086	0.093	0.086

sugar is faster. Total sugars content increased progressively up to end of the storage. *Pseudomonas fluorescens* (10^7 cfu ml^{-1}) treated fruit significantly reduced respiration as well as disease incidence percentage, which lead to higher (14.85, 20.05, 24.96 and 25.09% at 3, 6, 9 and 12 days) content of total sugars but in case of control it was 25.06% and they are statistically at par between themselves. *Aloe vera* gel treated fruits showed that the sugar content was 13.57, 17.72, 22.36 and 23.38% at 3, 6, 9 and 12 days, respectively. Lower sugars content may be due to delay in the ripening process which has also been confirmed by Chauhan *et al.* (2012). The ascorbic acid content of the fruit was highly affected by bio-control agent and organic treatments. The ascorbic acid content was reduced with the advancement of storage period because it is highly sensitive to oxidation. The maximum (52.81 mg/100g at 12 days after traetment) ascorbic acid was found with *Aloe vera* gel treatment followed by neem leaf extract (91.93 mg/100g) because these were slower ripening process may be ascribed to vulnerability of ascorbic acid to oxidative destruction due to the slower respiration rate as well as oxidation in the fruits (Othman *et al.*, 2009).

Table: 3: Effect of different treatments on disease incidence and sensory evaluation at 12 days after storage in mango fruits

Treatments	Disease incidence (%) Days after Storage				Sensory evaluation at 12 days after storage						
	3	6	9	12	Col-our	Aro-ma	Appea-rance	Tex-ture	Taste	Accep-tability	Remark
Aloe vera gel (1:1 v/v)	0.21	3.38	10.42	16.46	6.50	5.70	5.63	5.62	5.97	30.32	Like slightly
Neem leaf extract (1:1w/v)	0.23	3.10	9.56	15.90	5.90	4.95	5.05	4.88	5.32	27.85	Neither like nor dislike
P. fluorescens (10^7cfu ml^{-1})	0.08	0.92	4.39	8.23	7.10	6.75	7.04	6.72	6.89	34.41	Like moderately
Control (distilled water)	0.33	6.76	14.2	34.69	4.90	3.90	4.42	4.46	4.76	23.17	Dislike slightly
C.D. (P = 0.05)	0.019	0.019	0.02	0.018	1.398	1.078	1.384	1.135	1.257	1.592	

Incidence of anthracnose and stem-end rot was found significantly higher in control, while it was highly inhibited both *Pseudomonas fluorescens* (10^7 cfu ml^{-1}) and *Aloe vera* gel treatments. The maximum control was obtained by *Pseudomonas fluorescens* (10^7 cfu ml^{-1}) treatment (Table 3). It has been reported that *Pseudomonas fluorescens* (10^7 cfu ml^{-1}) produce antimicrobial compounds like 2, 4-diacetylphloroglucinol (DAPG), phenazines and hydrogen cyanide (Haas and Défago, 2005).

The present investigation revealed that, post harvest application of *pseudomonas fluorescens* (10^7 cfu ml^{-1}) was highly effective in inhibiting the anthracnose and stem-end rot in mango. It also significantly reduces the loss in weight, fruit softening, peel colour, peel thickness and maintained higher TSS, total sugars, ascorbic acid content and incidence control.

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