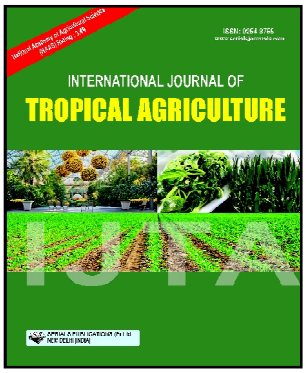

INTERNATIONAL JOURNAL OF TROPICAL AGRICULTURE

ISSN : 0254-8755

available at http: www.serialsjournals.com

Volume 36 • Number 2 • 2018

Air Pollution Tolerance Index of Mango (*Mangifera indica*) Varieties

Aswini A. and Jyothi Bhaskar[1]

PhD Scholar, Department of Pomology and Floriculture, College of Agriculture, Vellayani
[1]Professor, Department of Fruit Science, College of Horticulture, Kerala Agricultural University, Vellanikkara, Thrissur – 680 656, India, E-mail: aswini.ajith@gmail.com

Abstract: In order to evaluate the susceptibility level of plants to air pollutants, four parameters, namely ascorbic acid, chlorophyll, relative water content, and leaf-extract pH, were determined and computed together in a formulation signifying the air pollution tolerance index (APTI) of plants. APTI values of 24 mango varieties under normal planting system and six varieties under high density planting system were studied. Plants with a high index value were tolerant to air pollutants and vice-versa. On the basis of their indices, different plant groups were categorized into sensitive, slightly tolerant, moderately tolerant and highly tolerant. The APTI determination provides a reliable method for screening sensitive/tolerant plants under field conditions.

Keywords: APTI, *Mangifera indica*, Chlorophyll

INTRODUCTION

Air pollution is a menace throughout the world. Rapid industrialization lead to the deterioration of air quality. All combustion releases gases and particles into the air. These can include sulphur and nitrogen oxides, carbon monoxide and soot particles, as well as smaller quantities of toxic metals, organic molecules and radioactive isotopes. Various strategies exist for controlling atmospheric pollution, but vegetation provides one of the best natural way of cleaning the atmosphere by providing an enormous leaf area for impingement, absorption and accumulation of air pollutants level in the environment to a various extent (Das, 2010). Trees act as air pollution sinks but the better performance comes from the pollution tolerant species (Mahecha *et al.,* 2013). By monitoring plants tolerance toward air pollution, they can be screened and can be employed as biological indicators or monitors of air pollution. Air pollution tolerance index which is

based on four parameters, has been used for identifying tolerance levels of plants species.

Air pollution tolerance index is used by landscapers to select plant species tolerant to air pollution. Air pollution tolerance index has also been used to rank plant species in their order of tolerance to air pollution (Singh and Rao, 1983). The aim of this study is therefore to determine the APTI values of different mango varieties under normal and high-density planting.

MATERIALS AND METHODS

The present experiments were conducted for the period from March 2015 to June 2018, at College of Horticulture, Kerala Agricultural University (KAU) Vellanikkara. Twenty-four varieties from normal planting and six varieties from high density planting system maintained in the mango orchard of Dept. of Fruit Science, College of Horticulture, Vellanikkara where utilized for the studies.

The College of Horticulture, Vellanikkara where the experiment was conducted lies at a latitude of 10° 31' N and longitude of 76° 3' E. The area lies 22.25 m above MSL and enjoys the typical warm humid tropical climate of Kerala. The materials used and methodology adopted for the studies are described below.

Ascorbic acid (mg 100g^{-1})

Ascorbic acid (mg/100g) were determined by the method of Sadasivam and Manickam (1996) using oxalic acid, 2,6-dichloro phenol indophenol dye and standard sock solution and titrating against the dye.

$$Ascorbic\ acid = \left(\frac{0.5\,mg \times V_2 \times 100\,ml}{V_1 \times 5\,ml \times weight\ of\ the\ sample} \right) \times 100$$

Relative water content (%)

Relative water content was estimated by taking leaf bits and weighing them (fresh weight (FW)). Then the turgid weight (TW) was measured after floating them in water for five hours. After recoding the turgid weight the samples were dried in hot air oven to a constant weight and recorded as dry weight (DW).

Relative water content (%) = FW – DW / TW – DW x 100

pH of the leaf

Fresh leaf 0.5 g sample was homogenised using 50 ml distilled water and the supernatant was fed into digital pH meter for the detection of pH.

Chlorophyll content (mg g^{-1})

Chlorophyll content (mg g^{-1}) were determined by using dimethyl sulphoxide method of Shoaf and Lium (1976).

Atmospheric pollution tolerance index (APTI)

Atmospheric pollution tolerance index was calculated after determining the four parameters viz., ascorbic acid, total chlorophyll, relative water content and leaf extract pH. The plants were categorized into sensitive (40-50), slightly tolerant (50-60), moderately tolerant (60-70) and highly tolerant (70-80) based on APTI values. Atmospheric pollution tolerance index was computed and plants were categorized by the method suggested by Singh *et al.* (1991) using the equation:

APTI = [A(T+P)+R]/10

Where, A= Ascorbic acid content (mg/g)

T= Total chlorophyll (mg/g)

P=pH of leaf extract

R=Relative water content of the leaf (%)

RESULTS AND DISCUSSION

Ascorbic acid- Ascorbic acid is a strong reductant and it activates many physiological and defence mechanism in the plants. Its reducing power is directly proportional to its concentration. However it's reducing activity is pH dependent, being more at

higher pH levels because high pH may increase the efficiency of conversion of hexose sugar to ascorbic acid and is related to tolerance to pollution (Chouhan et al 2012). The result of the study revealed that Chandrakaran has highest ascorbic acid content and Prior has the lowest (Table 1) under high density planting.

Under normal planting system the range of ascorbic acid content varied from 70.19 to 110.57 mg $100g^{-1}$, H 151 recorded the last value and Amrapali has the highest value (Table 2).

Total Chlorophyll- Chlorophyll is an index of productivity of plant. Chlorophyll content of plants varies from species to species, age of leaf and also with the pollution level as well as with other biotic and abiotic condition (Katiyar and Dubey 2001). It is revealed from the study that Ratna has the least total chlorophyll due to air pollution (Table 1).

Chlorophyll content varied from 0.72 mg $100g^{-1}$ (Prior) to 1.36 mg $100g^{-1}$ (Bennet Alphonso) under normal planting system (Table 2).

Relative Water Content (RWC) - Water is a crucial pre requisite for plant life. RWC (Relative Water Content) of a leaf is the water present in it relative to its full turgidity. In the present study Mallika has maximum relative water content and Moovandan has the least value (Table 1.). High water content within a plant body will help to maintain its physiological balance under stress condition such as exposure to air pollution when the transpiration rates are usually high.

Under normal planting system the range of RWC varied from 12.54 % (Sindhu) to 69.05 % (Bennet Alphonso) (Table 2).

Leaf extract pH- Plants with lower pH are more susceptible while those with pH around 7 are tolerant (Kumar and Nandini 2013). The change in leaf extract pH might influence the stomatal sensitivity due to air pollution. The pH ranges between 5.86 to 6.07. The pH of leaf extract was slightly acidic. Chandrakaran recorded the lowest pH and Ratna has the highest pH (Table 1).

Under normal planting system under normal planting system pH content varied from 5.31 (Amrapali) to 6.58 (Pkm 2) (Table 2).

Table 1
APTI values of mango trees in high density planting

		Ascorbic acid (mg/g)	*Chlorophyll (mg/g)*	*RWC*	*pH*	*APTI*
HDP(3x3m)	Moovandan	93.21	1.27	23.08	5.87	68.83
	Moovandan	95.50	1.04	18.18	5.83	67.38
	Moovandan	97.45	0.94	14.29	6.05	69.56
	Moovandan	90.75	1.23	28.57	6.32	71.35
	Moovandan	94.34	1.10	21.43	5.88	67.96
		94.25	**1.11**	**21.11**	**5.99**	**69.02**
	Vellaikolumban	67.92	1.21	33.33	6.35	54.71
	Vellaikolumban	33.96	1.00	26.67	6.00	26.42
	Vellaikolumban	86.79	1.16	23.53	5.80	62.76
	Vellaikolumban	132.08	1.32	14.29	5.91	96.93
	Vellaikolumban	41.51	0.93	38.46	5.99	32.59
		72.45	**1.12**	**27.26**	**6.01**	**54.68**

contd. table 1

		Ascorbic acid (mg/g)	*Chlorophyll (mg/g)*	*RWC*	*pH*	*APTI*
	Chandrakaran	98.11	1.36	14.29	6.11	74.70
	Chandrakaran	124.53	1.03	37.50	5.71	87.67
	Chandrakaran	113.21	0.96	38.46	5.88	81.32
	Chandrakaran	86.79	1.73	22.22	5.84	67.88
	Chandrakaran	94.34	1.37	28.57	5.74	69.95
		103.40	**1.29**	**28.21**	**5.86**	**76.30**
	Mallika	97.94	1.34	36.36	5.99	75.46
	Mallika	94.34	1.11	35.71	6.08	71.43
	Mallika	90.94	1.35	42.86	5.54	66.95
	Mallika	94.34	1.19	46.15	6.00	72.46
	Mallika	92.53	1.37	33.33	6.22	73.53
		94.02	**1.27**	**38.88**	**5.97**	**71.97**
	Ratna	113.21	0.89	30.77	6.30	84.47
	Ratna	124.53	0.97	37.50	6.08	91.57
	Ratna	90.26	1.11	50.00	5.97	68.94
	Ratna	113.21	0.66	27.27	5.90	77.04
	Ratna	37.74	1.05	6.25	6.11	27.63
		95.79	**0.94**	**30.36**	**6.07**	**69.93**
	Prior	97.36	1.12	11.11	6.85	78.70
	Prior	90.94	1.27	30.00	5.90	68.19
	Prior	26.42	1.16	30.77	5.57	20.86
	Prior	41.51	1.56	28.57	5.57	32.43
	Prior	79.25	1.29	38.46	5.86	60.50
		67.09	**1.28**	**27.78**	**5.95**	**52.14**

Table 2
APTI values of mango trees under normal planting system

		Ascorbic acid (mg/g)	*Chlorophyll (mg/g)*	*RWC*	*pH*	*APTI*
Normal planting (9x9m)	Alphonso	96.42	1.49	22.73	5.93	73.80
	Alphonso	97.55	1.16	16.67	5.33	64.99
	Alphonso	92.45	0.66	17.65	5.87	62.10
		95.47	**1.10**	**19.01**	**5.71**	**66.96**
	Banganapalli	92.64	1.20	18.75	6.10	69.46
	Banganapalli	93.77	1.07	25.00	6.20	70.68
	Banganapalli	90.00	1.10	60.00	5.99	69.78

contd. table 2

	Ascorbic acid (mg/g)	*Chlorophyll (mg/g)*	*RWC*	*pH*	*APTI*
	92.14	**1.12**	**34.58**	**6.10**	**69.97**
Bennet Alphonso	90.94	1.57	57.14	5.55	70.47
Bennet Alphonso	94.91	1.06	66.67	6.11	74.70
Bennet Alphonso	92.26	1.46	83.33	5.96	76.76
	92.70	**1.36**	**69.05**	**5.87**	**73.98**
Chandrakaran	132.08	0.79	25.00	6.20	94.83
Chandrakaran	93.77	1.19	20.00	5.30	62.89
Chandrakaran	93.34	0.89	19.05	6.50	70.93
	106.40	**0.96**	**21.35**	**6.00**	**76.22**
Dashehari	98.68	1.47	25.00	6.85	84.61
Dashehari	94.04	1.12	24.00	5.90	68.44
Dashehari	96.04	0.87	23.53	6.97	77.60
	96.25	**1.15**	**24.18**	**6.57**	**76.89**
Mallika	93.13	1.41	41.67	5.88	72.01
Mallika	97.36	0.85	60.00	5.40	66.89
Mallika	95.85	1.22	41.67	5.78	71.27
	95.45	**1.16**	**47.78**	**5.69**	**70.06**
Amrapali	139.62	0.87	34.21	5.21	88.30
Amrapali	97.36	0.79	25.00	5.40	62.81
Amrapali	94.72	0.85	21.05	5.31	60.46
	110.57	**0.84**	**26.75**	**5.31**	**70.52**
Ratna	132.08	0.86	24.00	5.11	81.31
Ratna	96.23	1.26	20.00	5.99	71.75
Ratna	97.36	0.89	15.38	5.87	67.37
	108.56	**1.00**	**19.79**	**5.66**	**73.48**
Pkm 1	94.34	0.74	50.00	6.25	70.92
Pkm 1	120.75	0.57	80.00	5.99	87.20
Pkm 1	88.30	1.62	62.50	6.38	76.88
	101.13	**0.97**	**64.17**	**6.21**	**78.33**
Pkm 2	92.08	1.16	28.57	6.88	76.85
Pkm 2	83.58	0.99	53.33	6.74	69.90
Pkm 2	86.98	0.89	50.00	6.12	66.00
	87.55	**1.01**	**43.97**	**6.58**	**70.92**
H 45	81.13	1.42	30.00	6.55	67.65
H 45	88.30	1.32	50.00	6.42	73.37
H 45	88.49	0.90	50.00	6.32	68.87
	85.97	**1.21**	**43.33**	**6.43**	**69.96**

contd. table 2

	Ascorbic acid (mg/g)	*Chlorophyll (mg/g)*	*RWC*	*pH*	*APTI*
H 151	66.04	1.35	21.74	6.20	52.00
H151	73.58	1.00	26.67	6.80	60.08
H 151	70.94	0.71	18.18	6.21	50.91
	70.19	**1.02**	**22.20**	**6.40**	**54.33**
Arka Aruna	90.94	0.99	41.67	5.99	67.61
Arka Aruna	91.13	0.69	83.33	5.85	67.92
Arka Aruna	92.45	1.03	11.54	5.37	60.32
	91.51	**0.90**	**45.51**	**5.74**	**65.29**
Himayuddin	77.36	0.94	33.33	5.63	54.13
Himayuddin	79.62	1.21	71.43	5.21	58.24
Himayuddin	77.17	1.02	37.50	5.47	53.85
	78.05	**1.06**	**47.42**	**5.44**	**55.41**
Kalepady	84.72	1.21	33.33	6.31	67.04
Kalepady	84.91	1.08	45.45	6.00	64.68
Kalepady	89.81	1.09	62.50	6.35	73.08
	86.48	**1.13**	**47.10**	**6.22**	**68.27**
Muvandan	80.94	1.23	20.00	6.22	62.27
Muvandan	87.17	1.18	27.27	6.21	67.14
Muvandan	88.49	1.28	22.22	6.20	68.38
	85.53	**1.23**	**23.16**	**6.21**	**65.93**
Neelum	85.85	1.45	55.56	6.50	73.78
Neelum	82.26	1.06	62.50	5.90	63.52
Neelum	87.17	1.07	42.86	5.21	59.01
	85.09	**1.19**	**53.64**	**5.87**	**65.44**
Prior	93.40	0.54	71.43	5.98	68.08
Prior	97.36	0.91	41.67	5.55	67.03
Prior	98.68	0.71	50.00	5.98	70.99
	96.48	**0.72**	**54.37**	**5.84**	**68.70**
Swarnarekha	57.36	1.47	23.08	6.10	45.75
Swarnarekha	62.26	1.05	19.05	6.00	45.80
Swarnarekha	39.62	1.06	19.35	6.21	30.73
	53.08	**1.19**	**20.49**	**6.10**	**40.76**
Tholikippan	77.36	0.92	25.93	6.00	56.15
Tholikippan	76.98	0.84	17.65	6.20	55.99
Tholikippan	62.26	0.90	25.00	6.33	47.52
	72.20	**0.89**	**22.86**	**6.18**	**53.22**

contd. table 2

	Ascorbic acid (mg/g)	*Chlorophyll (mg/g)*	*RWC*	*pH*	*APTI*
Vellaikolumban	84.91	1.07	33.33	6.10	64.22
Vellaikolumban	86.04	0.00	33.33	6.25	57.11
Vellaikolumban	80.00	1.52	36.36	6.31	66.30
	83.65	**0.86**	**34.34**	**6.22**	**62.54**
Neelgoa	82.26	1.12	32.14	6.30	64.27
Neelgoa	84.91	0.81	23.33	6.45	63.99
Neelgoa	85.09	0.84	30.77	6.21	63.04
	84.09	**0.92**	**28.75**	**6.32**	**63.77**
Sindhu	92.64	1.19	11.11	5.21	60.36
Sindhu	94.91	1.07	15.38	6.01	68.69
Sindhu	93.58	0.77	11.11	6.11	65.52
	93.71	**1.01**	**12.54**	**5.78**	**64.86**
Mulgoa	97.55	0.64	16.67	5.55	62.08
Mulgoa	90.00	0.76	46.15	5.00	56.49
Mulgoa	93.77	1.42	28.57	5.42	66.97
	93.77	**0.94**	**30.46**	**5.32**	**61.85**

It was observed that Pkm 1 variety had the maximum APTI value in the highly tolerant group, Banganappalli, H 45 and Ratna had the maximum APTI value in moderately tolerant group. In slightly tolerant group Himayuddin had the greatest value. Swarnarekha was the most sensitive variety (Table 3).

Table 3
APTI values of mango trees in normal planting

Sensitive	*Slightly tolerant*	*Moderately tolerant*	*Highly tolerant*
40-50	50-60	60-70	70-80
Swarnarekha 40.76	Himayuddin 55.41	Banganappalli 69.97	Pkm 1 78.33
	H 151 54.33	H 45 69.96	Dashehari 76.89
	Tholikippan 53.22	Prior 68.70	Chandrakaran 76.22
		Kalepady 68.27	Bennet Alphonso 73.98
		Alphonso 66.96	Ratna 73.48
		Muvandan 65.93	Pkm 2 70.92
		Neelum 65.44	Amrapali 70.52
		Arka Aruna 65.29	Mallika 70.06
		Sindhu 64.86	
		Neelgoa 63.77	
		Vellaikolumban 62.54	
		Mulgoa 61.84	

In high density planting (HDP) Chandrakaran had the maximum APTI value in the highly tolerant group. Ratna and Moovandan had the maximum APTI value in moderately tolerant group. In slightly tolerant group Vellaikolumban had the greatest value (Table 4).

Table 4
APTI values of mango trees in high density planting

Slightly tolerant	*Moderately tolerant*	*Highly tolerant*
50-60	60-70	70-80
HDP Vellaikolumban 54.68	HDP Ratna 69.93	HDP Chandrkaran 76.30
HDP Prior 52.14	HDP Moovandan 69.02	HDP Mallika 71.97

Different plant species vary considerably in their susceptibility to air pollution. The varietal variation is predominant in mango trees (Joshi and Swami, 2007). The varieties with high APTI and low APTI can serve as tolerant and sensitive one respectively. Thus the present study revels that under normal planting system Pkm 1 serves to be the highly tolerant variety and Swarnarekha is the most sensitive one to air pollution. Whereas in high density planting system Chandrakaran is the most tolerant variety and Prior is the susceptible one to air pollution.

ACKNOWLEDGMENT

The authors gratefully acknowledge Kerala Agricultural University, Thrissur, Kerala, 680656, India for providing funds and facilities for carrying out the research works.

REFERENCE

Chuhan, A., Iqbal, S., Maheshwari, R. S., and Bafna, A., (2011). "Study of air pollution tolerance index of plants growing Pithampur Industrial area sector 1,2 and 3", *Res. J. Recent Sci.,* vol.1, pp.172-177.

Das, S., and Prasad, P., (2010). "Seasonal variation in air pollution tolerance indices and selection of plant species for industrial areas of Rourkela", *Indian J. Environ. Protection*, vol.30, pp.978-988.

Joshi, P. C. and Swami, A. (2007). "Physiological responses of some tree species under roadside automobile pollution stress around city of Haridwar, India" *The Environmentalist*, vol. 27, pp. 365- 368.

Katiyar V., and Dubey P. S., (2001). "Sulphur dioxide sensitivity on two stage of leaf development in a few tropical tree species", *Indian J. Environ. Toxicology*, vol. 11, pp. 78-81.

Kumar, M., and Nandini, N., (2013). "Identification and Evaluation of Air Pollution Tolerance Index of Selected Avenue Tree Species of Urban Bangalore, India", *Internat. J. Emerging Technol. Computational Applied Sci.,* vol.13, pp.388-390.

Mahecha, G.S., Bamniya, B.R., Nair, N., and Saini, D. (2013). "Air Pollution Tolerance Index of Certain Plant Species-A Study of Madri Industrial Area, Udaipur (Raj.), India" *Inter. J. Innovative Res Sci.,* Engineering and Technology. vol. 2:12, pp 7927-7929.

Sadasivam, S. and *Manickam,* A. *1996*. *Biochemical methods*. 2nd edition, New Age International (p) Ltd. Publisher, New Delhi, pp 179–186.

Shoaf, T.W. and Lium, B.W. (1976). Improved extraction of chlorophyll a and b from algae using dimethyl sulphoxide. Limnol. Oceanogr. 21: 926-928.

Singh, S.K. and Rao, D.N. (1983). Evaluation of the plants for their tolerance to air pollution Proc. Symp on Air Pollution control held at IIT, Delhi 218-224.