

Original Research Article

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Effect of Foliar Application of Plant Growth Regulators on Seasonal Variation in Physiological Behavior in Mango cv. Alphonso

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ABSTRACT

The experiment was conducted during the cropping season of 2015-16 and 2016-17 at Department of Horticulture, College of Agriculture, Dapoli, Maharashtra on 35 years old uniform mango (cv. Alphonso) trees with an objective study the effect of plant growth regulators on suppression of post monsoon vegetative flush in mango. In the investigation the physiological behavior of the mango trees were assessed in relation to influence of plant growth regulator sprays. After 24 hours of treatment, the rate of photosynthesis was significantly varied due to foliar application of plant growth regulators. The rate was lowered down than control. Among the treatments, PBZ 2000 ppm treatment showed lowest rate of photosynthesis ($6.40 \mu\text{mol CO}_2 \text{ m}^{-2} \text{ Sec}^{-1}$) and on par with CCC 1500 ppm and 3500 ppm treatments. The control had highest rate of photosynthesis ($6.65 \mu\text{mol CO}_2 \text{ m}^{-2} \text{ Sec}^{-1}$). After two weeks of treatment, the rate of photosynthesis was significantly influenced due to treatments of different CCC and PBZ concentration. It was reduced compared to previous readings. The significantly lowest rate ($5.30 \mu\text{mol CO}_2 \text{ m}^{-2} \text{ Sec}^{-1}$) was recorded in CCC 3500 ppm and highest ($7.62 \mu\text{mol CO}_2 \text{ m}^{-2} \text{ Sec}^{-1}$) was in control. The respiration rate after 24 hours of treatment, did not differed significantly during first year but differed significantly in second year and it was significantly highest ($2.37 \mu\text{mol CO}_2 \text{ m}^{-2} \text{ Sec}^{-1}$) in PPP 2000 ppm treatment. The lowest rate ($2.18 \mu\text{mol CO}_2 \text{ m}^{-2} \text{ Sec}^{-1}$) was in PPP 500 ppm) and T₇ (Control) treatments. The pooled data showed non significant effect of plant growth regulators on respiration rate at 24 hours after treatment. At two weeks after treatment, PBZ 2000 ppm treatment had highest respiration rate ($2.53 \mu\text{mol CO}_2 \text{ m}^{-2} \text{ Sec}^{-1}$) and the lowest rate ($2.21 \mu\text{mol CO}_2 \text{ m}^{-2} \text{ Sec}^{-1}$) was in control. The treatments of CCC were on par among themselves. No significant differences were observed in leaf transpiration rate after 24 hours of treatment. Whereas, it was significantly differed at two weeks after treatment only in the first year. The significantly highest transpiration rate ($4.358 \mu\text{mol H}_2\text{O m}^{-2} \text{ Sec}^{-1}$) was recorded in PBZ 2000 ppm treatment and lowest rate ($4.358 \mu\text{mol H}_2\text{O m}^{-2} \text{ Sec}^{-1}$) was in control. The stomatal conductance did not differ significantly as reading taken after 24 hours of treatment. At two weeks after treatment, the rate was significantly differed and highest stomatal conductance ($0.220 \mu\text{mol H}_2\text{O m}^{-2} \text{ Sec}^{-1}$) was in control and lowest ($0.156 \mu\text{mol H}_2\text{O m}^{-2} \text{ Sec}^{-1}$) in CCC 2500 ppm treatment.

Keywords

Mango, Alphonso, Plant growth regulators, Gas exchange

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Introduction

The mango (*Mangifera indica* L.) is the premier, most celebrated tropical fruit and known as 'King of the fruits' due to its delicious taste, admirable flavour, appealing aroma and attractive colour and other several desirable characters. It is the oldest fruit cultivated in world for over 4000 years. Mango has intimate association with religious, cultural, aesthetic and economical values since from long time and therefore it the national fruit of India. It is the most popular tropical fruit from Anacardiaceae family originated from South East Asia, the Indo-Burma region.

India has the richest wealth of mango germplasm consisting of more than thousands of varieties growing all over the country. Among the popular cultivars, 'Alphonso' ranks tops and acclaimed as the best Indian mango variety. This cultivar is commercially grown in west coast of India comprising Maharashtra, Goa, Karnataka and Gujarat states.

Lack of environmental signals for mango flowering being a limiting factor for obtaining consistent production especially in Alphonso cultivar. In mango crop, the phenomenon of flowering and fruiting is complex. Davenport and Nunez-Elisea (1997) has described the conceptual model of mango flowering to simplify the interaction of external and internal factors responsible for regulating vegetative and reproductive shoot initiation and induction in mango trees in the tropical and subtropical environments. The flowering in mango is largely influenced by the biochemical constituents present in the floral stimuli at bud break stage. Further, the maturity of terminal shoots and the carbohydrate accumulation in leaves as well as shoot apex are also certainly associated with the synthesis of the floral stimulus in

mango trees. The productivity improvement in current farming system is extensively depends on manipulation of the physiological processes of the crop by chemical means. In commercial mango plantations, it is advantageous to control the vegetative growth to attain regular, early and uniform flowering. Plant growth retardants like paclobutrazol, cycocel, etc. are synthetic compounds normally used to retard the shoot growth in a desired way without altering the developmental patterns of plants. These plant growth regulator alter the physiological processes in plants and gas exchange study can help to assess the response of crop in relation to physiological changes. The present investigation was therefore proposed to study the trend in physiological behavior (Gas exchange) of mango cv. Alphonso as influenced by sprays of plant growth regulators.

Materials and Methods

The experiment was conducted during the cropping season of 2015-16 and 2016-17 at Department of Horticulture, College of Agriculture, Dapoli, Maharashtra on 35 years old uniform mango (cv. Alphonso) trees with an objective study the effect of plant growth regulators on suppression of post monsoon vegetative flush in mango. The experiment was laid out in randomized block design with three replications and seven treatments viz., T₁ . CCC- 1500 ppm , T₂ . CCC- 2500 ppm, T₃ . CCC-3500 ppm, T₄ . PBZ -500 ppm, T₅ . PBZ -1000 ppm, T₆ . PBZ- 2000 ppm, T₇ . Control (No foliar application of PGR). Foliar application of plant growth regulators and nutrients was made at two stages. In the first experiment, the foliar application of PGRs was done in month of September, first spray- 1st fortnight of September and second spray- 2nd fortnight of September as given in treatment details. In the second experiment, two sprays were taken in each treatment, 1st

spray immediately after emergences of new vegetative flush and second 15 days after first spray. The data on gas exchange parameters viz, rate of photosynthesis and respiration, rate of transpiration and stomatal conductance were recorded at three stages i.e. before foliar spraying of plant growth regulators, after 24 hours of treatments and at two weeks after treatments. All these physiological parameters were measured by using artificial light source between 10:00 to 12:00 by portable photosynthesis system (LICOR 6400xt, Loc. Inc. USA) in photon flux density (PFD) value $500 \mu\text{mol}\cdot\text{mol}^{-2} \text{ s}^{-1}$ and using the healthy third or fourth leaf of the mango cv. Alphonso. The experimental data were analyzed according the procedure described by Panse and Sukhatme (1985).

Results and Discussion

The data pertaining to various gas exchange parameters viz, rate of photosynthesis and respiration, rate of transpiration and stomatal conductance was recorded at three stages i.e. before foliar spraying of plant growth regulators, after 24 hours of treatments and at two weeks after treatments are presented in Table 1 to 4.

Rate of leaf photosynthesis

Photosynthesis is fundamental process and photosynthesis rate can be regulated by plant growth regulators by activating secondary messengers that play a crucial role in increasing the enzymatic activity of the plant.

The data on rate of leaf photosynthesis are presented in Table 1 and depicted with Fig. 6. Before imposing the plant growth regulators treatments, the rate of leaf photosynthesis did not differ significantly during both the years. In the present study, it was noticed that no significant variations among the photosynthesis and respiration rate were

noticed before the treatments of CCC and PBZ. The photosynthesis rate was remarkably reduced down in plant growth regulators treatments than the control. The rate of photosynthesis was lowered down from prior to imposing of treatments to 24 hours after treatments and two weeks after treatments. The inverse trend was observed in case of respiration rate.

After 24 hours of treatment, the rate of photosynthesis was significantly varied due to foliar application of plant growth regulators and it was lowered down than control. An overall reduction in rate of photosynthesis was observed after 24 hours of treatments exposure as compared to rate of photosynthesis before exposure of the treatments except control. In the first year, the lowest rate of photosynthesis ($6.29 \mu\text{mol CO}_2 \text{ m}^{-2} \text{ Sec}^{-1}$) was observed in T₃ (CCC 3500 ppm). The highest rate ($6.29 \mu\text{mol CO}_2 \text{ m}^{-2} \text{ Sec}^{-1}$) was in control (T₇) followed by T₄ ($6.47 \mu\text{mol CO}_2 \text{ m}^{-2} \text{ Sec}^{-1}$). The rest of the treatments were on par with each other. In second year, the rate was lowest ($6.46 \mu\text{mol CO}_2 \text{ m}^{-2} \text{ Sec}^{-1}$) in T₆ (PBZ 2000 ppm) which was on par with T₁ ($6.52 \mu\text{mol CO}_2 \text{ m}^{-2} \text{ Sec}^{-1}$). The rest of growth regulator treatments were on par with each other. The highest rate of leaf photosynthesis ($6.75 \mu\text{mol CO}_2 \text{ m}^{-2} \text{ Sec}^{-1}$) was in control. The pooled data indicated that treatment PBZ 2000 ppm (T₆) showed lowest rate of photosynthesis ($6.40 \mu\text{mol CO}_2 \text{ m}^{-2} \text{ Sec}^{-1}$) which was on par with CCC 1500 ppm and 3500 ppm treatments. The control had highest rate of photosynthesis ($6.65 \mu\text{mol CO}_2 \text{ m}^{-2} \text{ Sec}^{-1}$).

After two weeks of treatment, the rate of leaf photosynthesis was reduced compared to previous readings except in control where it was found increased. The data presented in Table 1 revealed that the rate of photosynthesis was significantly influenced due to treatments of different CCC and PBZ

concentration. The lowest rates ($5.21 \mu\text{mol CO}_2 \text{ m}^{-2} \text{ Sec}^{-1}$ and $5.31 \mu\text{mol CO}_2 \text{ m}^{-2} \text{ Sec}^{-1}$) were recorded by PBZ 2000 ppm (T_6) during first year and by CCC 3500 ppm (T_3) in second year. The pooled analysis showed that CCC 3500 ppm (T_3) had lowest rates ($5.30 \mu\text{mol CO}_2 \text{ m}^{-2} \text{ Sec}^{-1}$) and the rest of treatments were on par with each other. The highest rate ($7.62 \mu\text{mol CO}_2 \text{ m}^{-2} \text{ Sec}^{-1}$) was in control.

Neluheni (2004) suggested that the rate of photosynthesis is apparently associated with favourable environmental condition such as optimum sunshine, humidity, temperature with lower transpo-evaporative demand. Urban *et al.*, (2004) studied CO_2 assimilation rate which supports the present findings. Rakshe (2011) has attempted to study the photosynthesis rate of mango during flowering season.

Rate of respiration

The rate of respiration before the plant growth regulator treatments did not vary significantly during both the years. After 24 hours of treatment, there was no significant difference in the respiration rate during first year. But in second year, the respiration rate was significantly highest ($2.37 \mu\text{mol CO}_2 \text{ m}^{-2} \text{ Sec}^{-1}$) in PPP 2000 ppm (T_6) treatment. The lowest rate ($2.18 \mu\text{mol CO}_2 \text{ m}^{-2} \text{ Sec}^{-1}$) was in T_4 (PPP 500 ppm) and T_7 (Control) treatments. The pooled data showed the non significant effect of plant growth regulators on respiration rate at 24 hours after treatment (Table 2).

At two weeks after treatment, the rate of respiration showed the significant variation. During the first year, the highest rate of respiration ($2.37 \mu\text{mol CO}_2 \text{ m}^{-2} \text{ Sec}^{-1}$) was in PPP 2000 ppm (T_6) treatment and it was closely followed by T_2 and T_5 . The lowest respiration rate ($2.20 \mu\text{mol CO}_2 \text{ m}^{-2} \text{ Sec}^{-1}$) was recorded in control (T_7). In the second

year, PPP 2000 ppm (T_6) treatment again registered the highest respiration rate ($2.62 \mu\text{mol CO}_2 \text{ m}^{-2} \text{ Sec}^{-1}$) followed by T_3 , T_5 and T_1 . The lowest rate ($2.21 \mu\text{mol CO}_2 \text{ m}^{-2} \text{ Sec}^{-1}$) was in control followed by T_4 (PBZ 500 ppm). The pooled analysis exhibited almost parallel results and PPP 2000 ppm (T_6) treatment again registered the highest respiration rate ($2.53 \mu\text{mol CO}_2 \text{ m}^{-2} \text{ Sec}^{-1}$) followed by T_5 . The treatments of CCC were on par with each other and the lowest rate ($2.21 \mu\text{mol CO}_2 \text{ m}^{-2} \text{ Sec}^{-1}$) was in control.

Urban *et al.*, (2004) opined that the increase in mitochondrial respiration or decrease in partial pressure of carbon dioxide in intercellular space has direct negative influence on photosynthesis rate.

Rate of transpiration

The data pertaining to the leaf transpiration rate are presented in Table 3, further revealed that no significant differences were observed before the treatment and after 24 hours of treatment during both the years of investigation.

However, the rate was significantly differed at two weeks after treatment only during first year. The significantly highest transpiration rate ($4.358 \mu\text{mol H}_2\text{O m}^{-2} \text{ Sec}^{-1}$) was recorded in PPP 2000 ppm (T_6) treatment and lowest rate ($4.358 \mu\text{mol H}_2\text{O m}^{-2} \text{ Sec}^{-1}$) was in control which was at par with T_4 . The treatments of CCC were on par with each other.

Stomatal conductance

The data regarding stomatal conductance recorded at three different stages are presented in Table 4. The stomatal conductance did not differ significantly at reading taken before the treatment and after 24 hours of treatment.

Table.1 Effect of foliar application of plant growth regulators on rate of photosynthesis in mango cv. Alphonso

Treatments		Rate of photosynthesis ($\mu\text{mol CO}_2 \text{ m}^{-2} \text{ Sec}^{-1}$)								
		Before the treatment			After 24 hours of treatment			After 2 weeks of treatment		
		2015	2016	Pooled mean	2015	2016	Pooled mean	2015	2016	Pooled mean
T ₁	CCC- 1500 ppm	6.55	6.67	6.61	6.34	6.52	6.43	5.24	5.39	5.32
T ₂	CCC- 2500 ppm	6.48	6.72	6.60	6.35	6.54	6.45	5.44	5.41	5.43
T ₃	CCC-3500 ppm	6.57	6.80	6.69	6.29	6.57	6.43	5.29	5.31	5.30
T ₄	PBZ -500 ppm	6.54	6.73	6.64	6.47	6.66	6.56	6.19	6.14	6.16
T ₅	PBZ -1000 ppm	6.46	6.82	6.64	6.38	6.68	6.53	5.32	5.59	5.46
T ₆	PBZ- 2000 ppm	6.52	6.63	6.57	6.33	6.46	6.40	5.21	5.45	5.33
T ₇	Control (No foliar application of PGR)	6.53	6.71	6.62	6.55	6.75	6.65	7.65	7.59	7.62
Mean		6.52	6.73	6.62	6.39	6.60	6.49	5.76	5.84	5.80
S. E.m ±		0.030	0.061	0.042	0.024	0.053	0.029	0.069	0.099	0.060
C.D. at 5%		NS	NS	NS	0.074	0.162	0.084	0.212	0.300	0.176

Table.2 Effect of foliar application of plant growth regulators on rate of respiration in mango cv. Alphonso

Treatments		Rate of respiration ($\mu\text{mol CO}_2 \text{ m}^{-2} \text{ Sec}^{-1}$)								
		Before the treatment			After 24 hours of treatment			After 2 weeks of treatment		
		2015	2016	Pooled mean	2015	2016	Pooled mean	2015	2016	Pooled mean
T ₁	CCC- 1500 ppm	2.15	2.24	2.19	2.20	2.28	2.24	2.31	2.52	2.42
T ₂	CCC- 2500 ppm	2.21	2.18	2.19	2.24	2.23	2.24	2.44	2.38	2.41
T ₃	CCC-3500 ppm	2.13	2.23	2.18	2.19	2.31	2.25	2.32	2.56	2.44
T ₄	PBZ -500 ppm	2.18	2.15	2.17	2.20	2.18	2.19	2.27	2.26	2.26
T ₅	PBZ -1000 ppm	2.27	2.24	2.26	2.32	2.28	2.30	2.43	2.50	2.46
T ₆	PBZ- 2000 ppm	2.13	2.28	2.20	2.17	2.37	2.27	2.45	2.62	2.53
T ₇	Control (No foliar application of PGR)	2.21	2.18	2.20	2.19	2.18	2.19	2.20	2.21	2.21
Mean		2.18	2.21	2.20	2.22	2.26	2.24	2.35	2.44	2.39
S. E.m ±		0.041	0.049	0.032	0.041	0.047	0.031	0.049	0.048	0.034
C.D. at 5%		NS	NS	NS	NS	0.145	NS	0.152	0.149	0.098

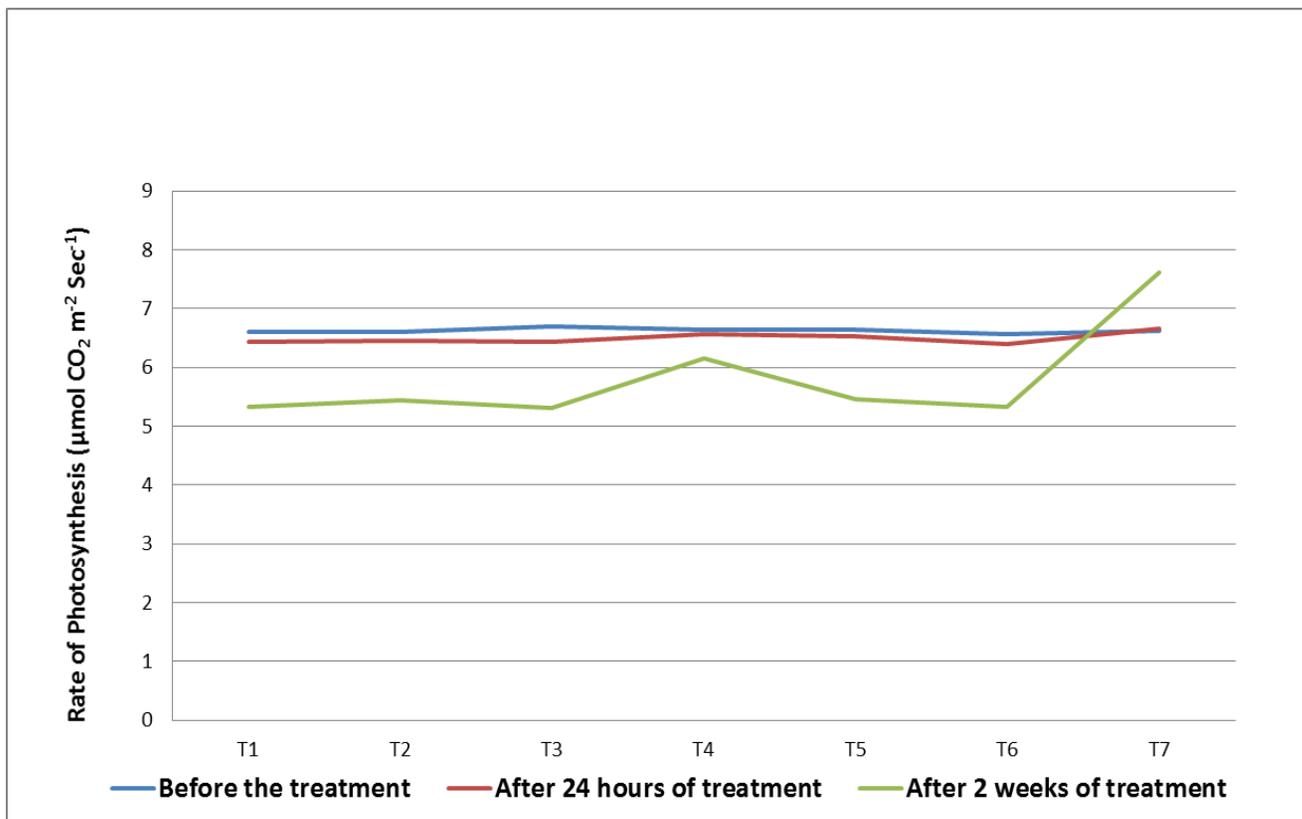
Table.3 Effect of foliar application of plant growth regulators on rate of transpiration in mango cv. Alphonso

Treatments		Rate of transpiration ($\mu\text{mol H}_2\text{O m}^{-2} \text{Sec}^{-1}$)								
		Before the treatment			After 24 hours of treatment			After 2 weeks of treatment		
		2015	2016	Pooled mean	2015	2016	Pooled mean	2015	2016	Pooled mean
T₁	CCC- 1500 ppm	3.669	3.611	3.640	3.690	3.653	3.672	4.189	4.207	4.198
T₂	CCC- 2500 ppm	3.529	3.562	3.546	3.573	3.613	3.593	4.268	3.988	4.128
T₃	CCC-3500 ppm	3.701	3.641	3.671	3.733	3.693	3.713	4.276	4.259	4.267
T₄	PBZ -500 ppm	3.776	3.610	3.693	3.800	3.611	3.706	4.014	3.710	3.862
T₅	PBZ -1000 ppm	3.625	3.752	3.688	3.680	3.713	3.696	4.136	3.999	4.067
T₆	PBZ- 2000 ppm	3.805	3.465	3.635	3.918	3.486	3.702	4.358	3.936	4.147
T₇	Control (No foliar application of PGR)	3.643	3.839	3.741	3.613	3.800	3.707	3.995	3.908	3.952
Mean		3.678	3.640	3.659	3.715	3.653	3.684	4.177	4.001	4.089
S. E.m \pm		0.150	0.158	0.108	0.135	0.157	0.104	0.091	0.182	0.102
C.D. at 5%		NS	NS	NS	NS	NS	NS	0.280	NS	NS

Table.4 Effect of foliar application of plant growth regulators on stomatal conductance in mango cv. Alphonso

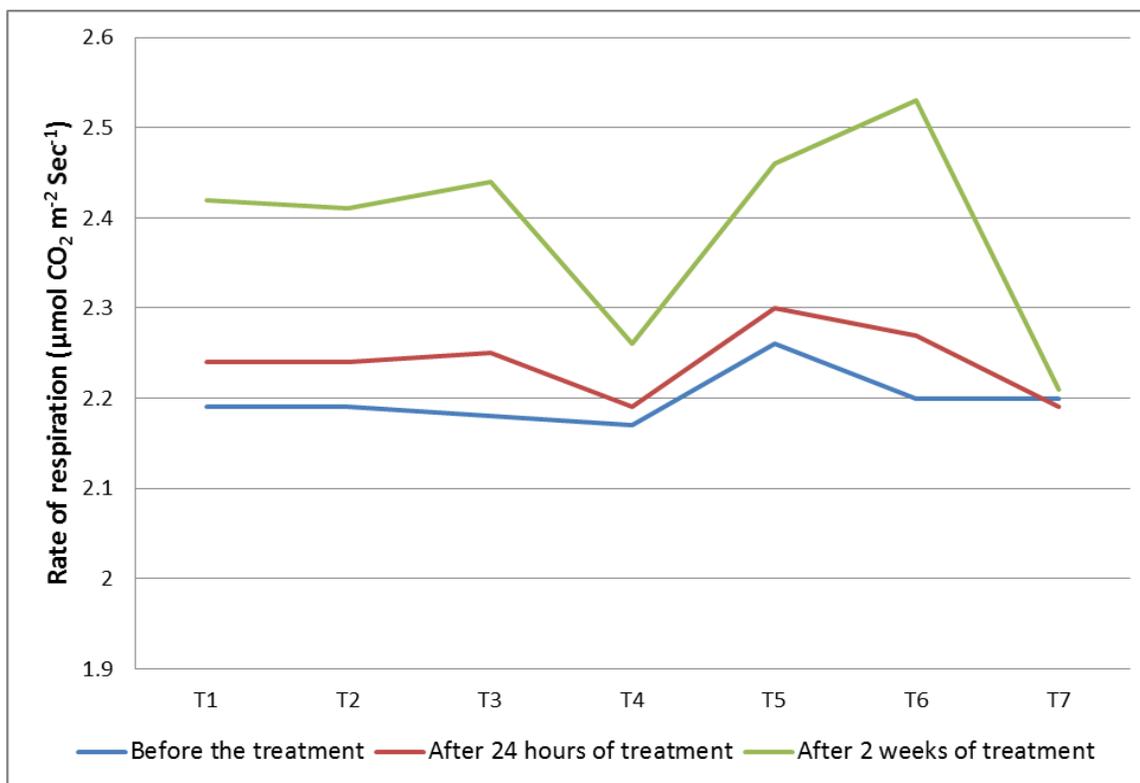
Treatments		Stomatal conductance ($\mu\text{mol H}_2\text{O m}^{-2} \text{Sec}^{-1}$)								
		Before the treatment			After 24 hours of treatment			After 2 weeks of treatment		
		2015	2016	Pooled mean	2015	2016	Pooled mean	2015	2016	Pooled mean
T ₁	CCC- 1500 ppm	0.251	0.225	0.238	0.247	0.223	0.235	0.171	0.141	0.156
T ₂	CCC- 2500 ppm	0.271	0.211	0.241	0.268	0.208	0.238	0.180	0.140	0.160
T ₃	CCC-3500 ppm	0.249	0.242	0.246	0.242	0.237	0.240	0.181	0.175	0.178
T ₄	PBZ -500 ppm	0.247	0.232	0.240	0.248	0.232	0.240	0.193	0.197	0.195
T ₅	PBZ -1000 ppm	0.251	0.239	0.245	0.244	0.234	0.239	0.182	0.151	0.167
T ₆	PBZ- 2000 ppm	0.253	0.251	0.252	0.245	0.271	0.258	0.161	0.169	0.165
T ₇	Control (No foliar application of PGR)	0.262	0.248	0.255	0.261	0.249	0.255	0.228	0.208	0.220
Mean		0.255	0.235	0.245	0.251	0.236	0.244	0.185	0.169	0.177
S. E.m ±		0.014	0.012	0.090	0.013	0.015	0.010	0.008	0.011	0.007
C.D. at 5%		NS	NS	NS	NS	NS	NS	0.024	0.035	0.020

Fig.1 Effect of foliar application of plant growth regulators on rate of photosynthesis in mango cv. Alphonso



Legend: T₁ . CCC- 1500 ppm , T₂ . CCC- 2500 ppm, T₃ . CCC-3500 ppm, T₄ . PBZ -500 ppm, T₅ . PBZ -1000 ppm, T₆ . PBZ- 2000 ppm , T₇ . Control (No foliar application of PGR)

Fig.2 Effect of foliar application of plant growth regulators on rate of respiration in mango cv. Alphonso



Legend: T₁ . CCC- 1500 ppm , T₂ . CCC- 2500 ppm, T₃ . CCC-3500 ppm, T₄ . PBZ -500 ppm, T₅ . PBZ -1000 ppm, T₆ . PBZ- 2000 ppm, T₇ . Control (No foliar application of PGR)

Fig.3 Effect of foliar application of plant growth regulators on rate of transpiration in mango cv. Alphonso

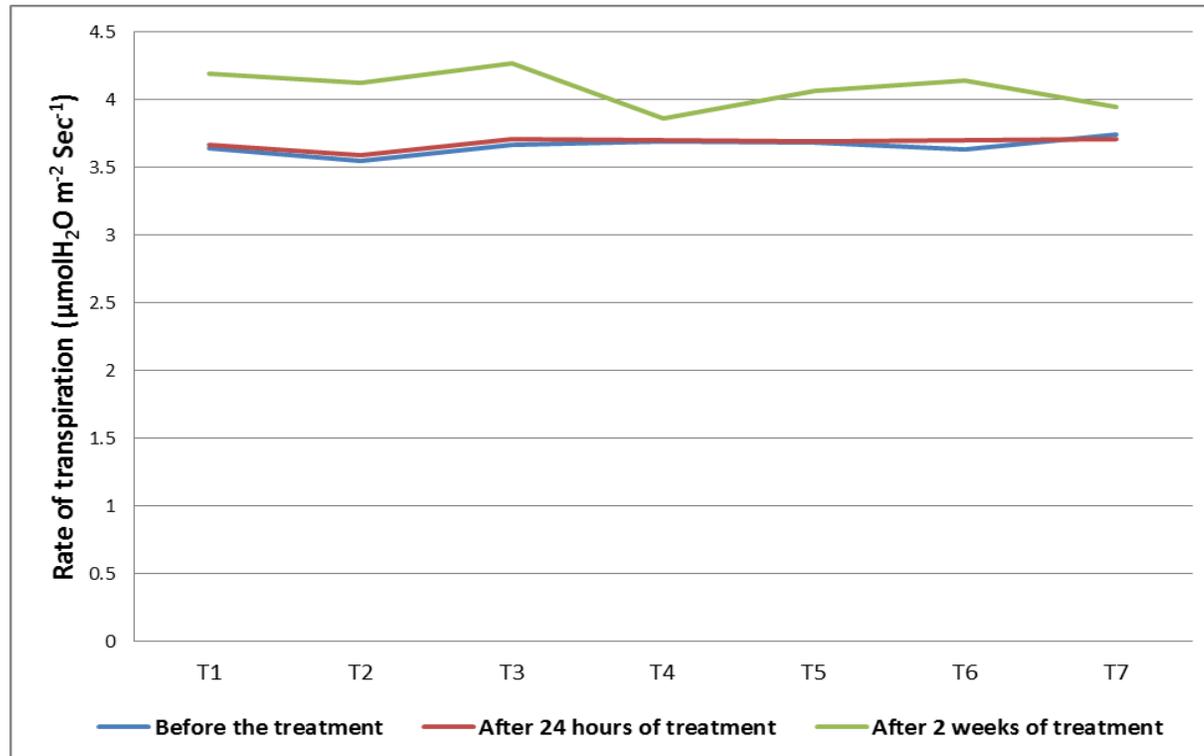
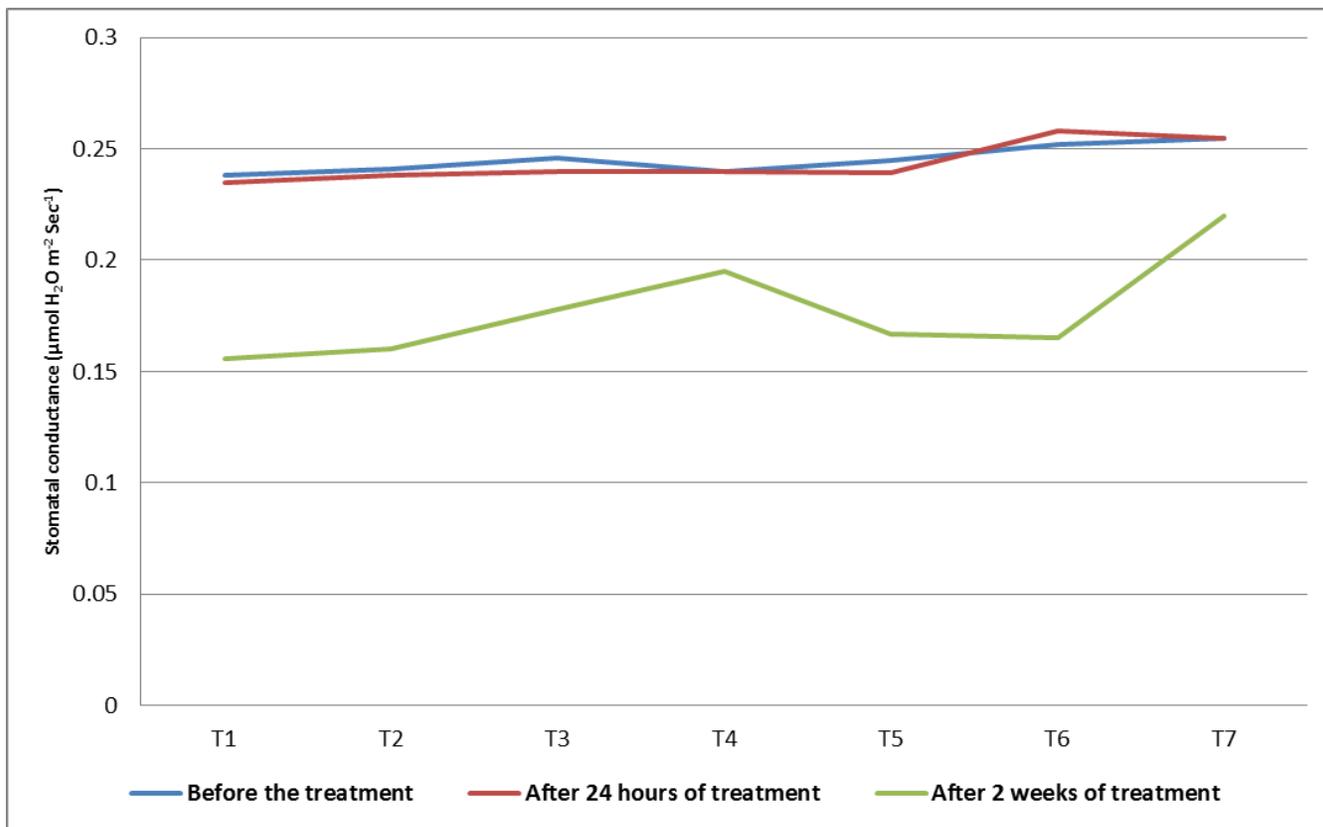


Fig.4 Effect of foliar application of plant growth regulators on stomatal conductance in mango cv. Alphonso



Legend: T₁. CCC- 1500 ppm , T₂. CCC- 2500 ppm, T₃. CCC-3500 ppm, T₄. PBZ -500 ppm, T₅. PBZ -1000 ppm, T₆. PBZ- 2000 ppm, T₇. Control (No foliar application of PGR)

At two weeks after treatment, the rate was significantly differed and during both the years, the stomatal conductance was highest (0.228 and 0.208 $\mu\text{mol H}_2\text{O m}^{-2} \text{Sec}^{-1}$, respectively) in control (T_7) and lowest (0.161 and 0.208 $\mu\text{mol H}_2\text{O m}^{-2} \text{Sec}^{-1}$) in PPP 2000 ppm treatment (First year) and (0.140 $\mu\text{mol H}_2\text{O m}^{-2} \text{Sec}^{-1}$) in CCC 2500 ppm treatment (Second year). The pooled data indicates highest value (0.220 $\mu\text{mol H}_2\text{O m}^{-2} \text{Sec}^{-1}$) in control (T_7) and lowest (0.156 $\mu\text{mol H}_2\text{O m}^{-2} \text{Sec}^{-1}$) in CCC 2500 ppm (T_1) treatment.

The transpiration and stomatal conductance in any plant cell are the important physiological measures to assess the plant water relationship (Terry *et al.*, 1989). The stomatal conductance is linked with high leaf temperature and consequently increased transpiration per stomatal conductance unit (Condon *et al.*, 2002).

As per the earlier reports, plant growth retardants in general and paclobutrazol in particular, which is thousand times more powerful than cycocel and has ability to maintain high water potential of treated plants than that of untreated plants (Wieland and Wample, 1985 and Burondkar, 2005). The lower values to some extent was obtained for transpiration and stomatal conductance could be attributed to the rainy season when relative humidity is always very high (above 85%) in Konkan region. Rakshe (2011) and Burondkar *et al.*, (2012) studied the transpiration rate and stomatal conductance in mango. Bhalerao (2013) also assessed the stomatal conductance of mango which supported the present findings.

The findings of present experiment only indicated the fact and same experiment need to be continued to validate the relationship of phtranspiration and stomatal conductance in mango with vegetative flush and flowering as in photosynthesis and respiration.

References

- Bhalerao, R. R. 2013, Flowering and fruiting behavior with respect of nutrients and carbohydrate status in mango cv. Alphonso and Kesar. Thesis submitted to Navsari Agril. University, Navsari, Gujrat.
- Burondkar, M. M., Pujari, K. H., Shinde, K. A. and Bhavé, S. G. 2012. Seasonal variation in physiological behaviour of Alphonso mango, under konkan conditions. *J. Agril. Res. Tech.* 37(1): 51-54.
- Burondkar, M. M. 2005. Influence of plant growth regulators, polyamine and nutrients on post flowering physiological behaviour in relation to yield and quality in Alphonso mango (*Mangifera indica* L.). Ph. D. Thesis. University of Agricultural Sciences, Dharwad, Karnataka.
- Condon, A. G., Richards, R. A., Rebetzke, G. J., and Farquhar, G. D. 2002. Improving intrinsic water use efficiency and crop yield. *Crop Science* 42: 122-131.
- Davenport, T. L, Nunez -Elisea R. 1997, Reproductive physiology. In: Litz, R.E. (ed.) *The Mango: Botany, Production and Uses*. CAB International, Wallingford, Oxon, UK, pp. 69-146.
- Goguy, T., 1993, Study of effect of three flowering inducing substances on Kent and Zill mango. *Acta Hort.* 341: 216-224.
- Neluheni, K. O. 2004, Seasonal pattern of vegetative growth and photosynthesis in mango (*Mangifera indica* L.) trees. Master's Thesis, University of Pretoria, South Africa.
- Panse, V.G. and Sukhatme, P.V., 1985, *Statistical methods for agricultural workers*. Indian Council of Agricultural Research, New Delhi, pp.167-174.
- Rakshe, M. V. 2011, Physiological studies on effect of stem girdling, root pruning and

- chemical treatments on induction of flowering in Alphonso mango (*Mangifera indica* L.). M. Sc. (Agri.) Thesis submitted to Dr. B. S. Konkan Krishi Vidyapeeth, Dapoli, Maharashtra 415712.
- Terryl, R., Roper and Larry, E. Williams, 1989, Net CO₂ assimilation and carbohydrate partitioning of Grapevine leaves in response to trunk girdling and gibberlic acid application. *Plant Physiology*, 89: 1136-1140.
- Urban. L., Lu, P. and Thibaud, R. 2004. Inhibitory effect of flowering and early fruit growth on leaf photosynthesis in mango. *Tree Physiology*. 24: 387-399.
- Wieland, W. F. and Wample, L. R. 1985, Effects of paclobutrazol on growth, photosynthesis and carbohydrates content of delicious apples. *Sci. Hortic.*, 26 : 139-147.

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