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PLANT ENVIRONMENTAL VARIABLES STUDIES IN JAMUN CV. GOMA PRIYANKA

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ABSTRACT : A definite increasing trend for carboxylation efficiency of Jamun plants was observed from March to October months followed by a reduction in photosynthetic rates during November and December months. Stomatal conductance and relative humidity percentage of Jamun leaves were low before monsoon months followed by a sharp increase from July to September months. Transpiration rates were found correspondingly high during June to August months and exhibited a positive correlation with leaf temperature. Vapour pressure deficit values of Jamun leaves were found positively correlated with leaf temperature and were at higher end during May, June and July months. From the experiment, it appeared characteristically that the leathery leaves of Jamun had lower transpiration rates during March to June months. Further, during this period the plant manifested maximum water use efficiency. It indicates better survivability of plants under acute water scarcity which is hallmark of arid and semi arid conditions. It can be utilized as potential underutilized fruit which holds promise for the future in view of adding diversity to fruit basket of the country.

Keywords: *Syzigium cuminii, transpiration, stomatal conductance, water use efficiency.*

Syzigium cuminii Skeels. is an evergreen tropical tree in the flowering plant family Myrtaceae and is native to South East Asia region. Jamun is known as Black Plum or Indian Black berry, Kala Jam, Jam and Phalinda in different parts of India. It is one of the most popular minor fruits of indigenous origin. The plant is very hardy and it suits very well to arid and semi arid conditions. It is found growing naturally as scattered trees in the landscapes of Jhalawar district and is an important source of livelihood for tribal people in South Eastern Rajasthan. The ability of Jamun tree to thrive successfully in neglected areas makes it special and comparable over other minor fruits. With an intent to adjudge the potential of Jamun trees under shallow vertisols of Jhalawar district, plants of cultivar 'Goma Priyanka' were procured from Central Horticulture Experimental Station, Godhra and were planted in border row as windbreak at 5 × 5m distance during August 2011. Carbon assimilation efficiency during the day determines growth, development and productivity of the plants. Carboxylation efficiency of a plant is a fundamental indicator to understand the basic physiology of the plant in conjunction with the growth of the plants. Till date, no such type of studies has been reported in Jamun with respect to variation in plant environment variables. Therefore, the present investigations were conducted to study photosynthetic attributes in Jamun cv. Goma Priyanka in response to seasonal variations.

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MATERIALS AND METHODS

The experiment was conducted at Fruit Instructional Farm, College of Horticulture and Forestry, Jhalarapatan, Jhalawar district of Rajasthan state, India. Jamun plants cv. Goma Priyanka of 3 years age were selected for study and they received recommended doses of manures and fertilizers. The border row of windbreak plants of Jamun was raised in black vertisols of clayey texture. Jamun plants were spaced at 5 × 5 m distance in a linear row as windbreak against custard apple block. The data on gas exchange parameters were recorded on 12 plants periodically month wise from March, 2014 to December, 2014 (replicated thrice on physiologically mature leaves of outer parts of tree canopy). The gas exchange measurements were taken during morning hours (8.00 to 10.00 am) with Ciras-2, Portable Photosynthesis System (PP System). The gas flow to leaf chamber was maintained at 300±2 µmols^{-1} and the leaves were allowed to acclimate under a photosynthetic photon flux density of 1000 µmol quanta^{-1} m^{-2}s^{-1}. All the experimental variables pertaining to leaf were taken on fully expanded physiologically mature leaves. The chamber temperature was maintained at 30 ± 0.5°C. CO_2 analyzer calibrated with various CO_2 concentrations were used for the experimentation. CO_2 analyzer was calibrated with various CO_2 concentrations, a series of cylinders containing soda lime and drierite of known concentrations were used for the experimentation. The chamber was placed outside exposed to full sunlight. *Pn* was measured during morning hours (8.00-10.00 am) every first of month commencing from March, 2014 to December, 2014 and are expressed as µmol $m^{-2}s^{-1}$ for studying seasonal variations month wise in Jamun plants. The Jamun tree resumed vegetative growth with the onset of spring and growth continued throughout the year. The data values for each treatment (triplicates) were analyzed statistically using randomized block design adopting Indostat software.

RESULTS AND DISCUSSION

The results presented in Table 1 clearly elucidate that with the onset of spring in the month of March, 2014, the *Pn* value of 5.0 µmol $m^{-2}s^{-1}$ was recorded with a minimum of sub stomatal conductance *ci* value (270). Stomatal conductance *gs* were also found low (4.0) along with low relative humidity percentage (1.28%) in Jamun leaves. Transpiration rate (E) was at its lowest (0.20) during the study period (March 2014 to December 2014). Photosynthetic active radiation (1523) was comparatively good during March month. The leaf temperature (38.10°C) was recorded during the month of March. The suboptimal photosynthesis rate observed during March month might be attributed to the translocation of assimilates in the developing leaves of new flush during spring season as there is initiation of rhizosphere activities with the rise in temperature after winter months. Lower stomatal conductance during March month resulted in greater water use efficiency (125.00) at this time.

The data further revealed that in the month of April 2014, there was a slight increase in photosynthetic rate (5.2) with corresponding increase in sub stomatal conductance concentration (291 ppm). Mesophyll conductance was at low level (4.50) followed by low relative humidity percentage (1.32) in Jamun leaves. Also low transpiration rate E (0.20) was observed in Jamun leaves during April month. Vapour Pressure Deficit did not show any correlation with either *Pn* or *gs* during April month. There was slight increase in leaf temperature (38.60°C) during April month with a Photosynthetic Active Radiation value of 1558. Similar findings have been reported by Kriedemann and Barrs, (3) in citrus plants, where low assimilation rates were found accompanied by low rates of transpiration and extreme sensitivity to moisture deficit at soil level.

The perusal of data (Table 1) for May month highlighted an increase in assimilation rate (5.42) of Jamun leaves followed by slight increase in stomatal conductance *gs* (5.0). Further, Photosynthetic Active Radiation (1642) was observed with an increase of leaf temperature (41.30°C) during June month. However, relative humidity percentage (1.32) of Jamun leaves got increased slightly during May month suggesting better water regulating physiology mechanism of Jamun plants during the summer. Further substomatal CO_2 concentration *ci* (320) increased during May month and rate of transpiration E (0.30) also increased during May month as a protective mechanism to save water loss from leaves. Vapour Pressure Deficit (58.8) during May month showed a positive correlation with relative humidity percentage of leaves. The data in Table 1 for June indicated increasing carboxylation efficiency (5.84) of plants with the progressive increase of Photosynthetic Active Radiation (1784) along with slight increase in stomatal conductance *gs* (5.25), relative humidity percentage (1.59) and sub stomatal CO_2 concentration (342).

A perusal of Table 1 for July revealed better photosynthetic rate *Pn* (5.90) as compared to the previous summer months. Stomatal conductance rose significantly (7.85) in comparison to lower values of *Pn* (4.50, 5.00 and 5.25) observed during April, May and June months, respectively. There was a significant increase in relative humidity percentage (4.47) of Jamun leaves along with a significant concurrent increase of substomatal CO_2 concentration during July month. Transpiration rate E was recorded high (0.80) during July month along with high Vapour Pressure Deficit (6.15) during July month. The increase in photosynthetic rate *Pn* and relative humidity percentage during July month might be attributed to better availability of moisture in the soil profile due to monsoon rains (67.20mm) recorded during last week of June month.

The data in Table 1 for August revealed that *Pn* rate rose steeply (6.12) along with rise in stomatal conductance *gs* value of 9.00. Relative humidity percentage (5.10) along with substomatal CO_2 concentration (430.00) was also very high due to better moisture availability (220.00mm rainfall received) in soil profile during July month. Both transpiration rate E (0.70) and Vapour Pressure Deficit (58.8) decreased slightly during August month. The key environmental factor influencing transpiration efficiency is the vapour pressure deficit or relative humidity of the leaves (Condon *et al.,* 1). The more humid the atmosphere, the greater is the transpiration efficiency provided other conditions are not constraint.

The data for September month (Table 1) revealed that carboxylation efficiency reached its peak level (7.00) during the study period. However, maximum stomatal conductance *gs* (9.20) and substomatal

CO_2 concentration (593 ppm) were observed during September month. Both transpiration rate E (0.60) and Vapour Pressure Deficit (56.5) declined during the September month indicating less pressure of evapotranspiration driving forces. Relative humidity percentage of Jamun leaves was at its maximum (5.32) coupled with low leaf temperature (33.40°C) which exhibited a positive correlation with maximum stomatal conductance value of 9.20.

The data for October month (Table 1) indicated that photosynthetic rate decreased slightly (6.40) in consonance with stomatal conductance *gs* (8.50). There was slight increase in leaf temperature (36.80°C) however other parameters such as relative humidity percentage, substomatal CO_2 concentration, transpiration rate, photosynthetic active radiation and vapour pressure deficit got reduced in their values as compared to previous month. Changes in carboxylation efficiency have been associated with vegetative growth and development (Mika, 4).

The data for November (Table 1) indicated the reduction in carboxylation efficiency (4.80) of along with significant reduction in stomatal conductance (5.35), leaf temperature (29.87°C) and relative humidity percentage (30.50) of leaves. Decreases in photosynthetic rate were approximately proportional to stomatal conductance. The result as reported by Downton *et al.* (2) supports the results of present investigations. Substomatal CO_2 concentration (320ppm), transpiration rate E (0.35) and vapour pressure deficit (51.4) were found declined significantly with the onset of winter. Photosynthetic active radiation (1422) also decreased significantly indicating the effect of light on declining *Pn* of Jamun leaves.

The data in Table 1 for December revealed further decline in carboxylation efficiency (3.50) along with low stomatal conductance (4.00) during winter month. All other parameters such as photosynthetic active radiation, leaf temperature, relative humidity percentage of leaves, substomatal CO_2 concentration, transpiration rate and vapour pressure deficit declined significantly during winter months indicating the reduction in rhizosphere activity of Jamun plants.

Results compiled in Table 1 indicated that during peak summer months of April, May, June and July, Jamun plants exhibited maximum water use efficiency values of (125.00, 115.55, 108.40 and 111.23) in contrast to rainy and post rainy months when there is ample of soil moisture availability to sustain the plants.

Table 1: Photosynthetic data of Jamun cv.Goma Priyanka (2014).

Month	Pn	PAR	gs	T_{leaf}	RH (%)	ci	E	VPD	WUE
March	5.0	1523	4.0	38.10	1.28	270	0.20	53.3	125.00
April	5.2	1558	4.5	38.60	1.30	291	0.20	53.8	115.55
May	5.42	1642	5.0	41.30	1.32	320	0.30	58.8	108.40
June	5.84	1785	5.25	45.40	1.59	342	0.55	62.4	111.23
July	5.90	1760	7.85	41.40	4.47	399	0.80	61.5	75.15
August	6.12	1659	9.00	36.40	5.10	430	0.70	68.8	68.00
Sept.	6.40	1648	9.20	33.40	5.32	445	0.46	66.5	69.56
Oct.	7.00	1445	8.50	36.80	4.98	593	0.60	52.4	82.35
Nov.	4.80	1422	5.35	29.87	3.50	320	0.35	51.4	89.71
Dec.	3.50	1315	4.00	23.20	2.56	288	0.18	49.5	87.50
CD (P=0.05)	0.24	6.18	0.26	2.78	0.21	6.63	0.05	4.37	35.29

The mean *Pn* of Jamun leaves was found 5.51 and mean PAR as 1575.70. Estimation of the light response of the curve showed that photosynthetic light saturation occurred near 1575.70 during morning hours. The strength of the relationship is indicated by correlation coefficient r (r = 0.5429). The significance of relationship is expressed in probability levels. Under the present study, the value of p was found 0.1048 which indicates that the smaller the value of p level, the more significant is the relationship between *Pn* and P.A.R (Fig. 1).

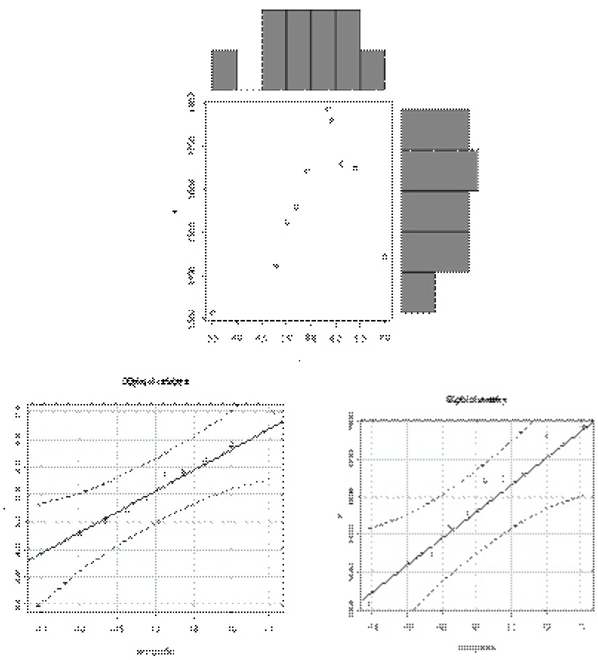

Fig.1: Pearson correlation between *Pn* and P.A.R of Jamun leaves.

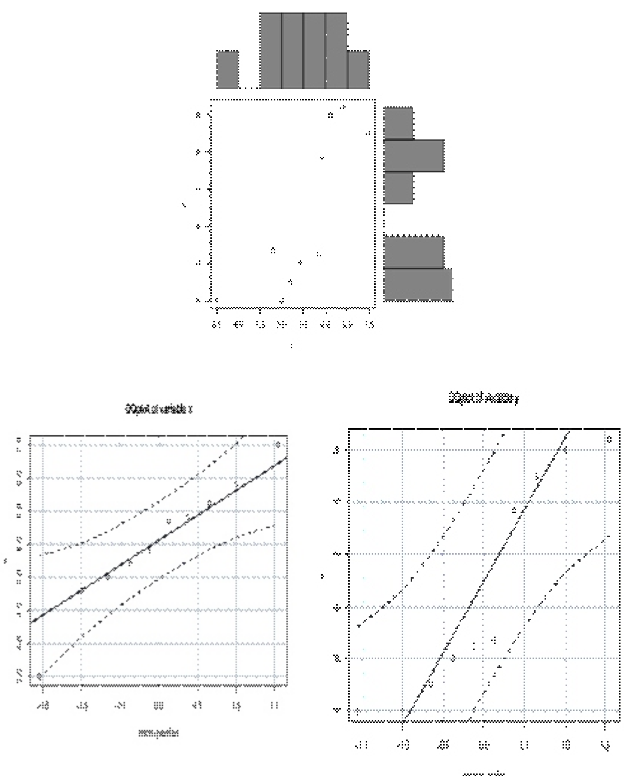

Fig.2: Pearson correlation between *Pn* and *gs* of Jamun leaves.

The mean *Pn* of Jamun leaves was observed 5.51 and mean *gs* as 6.25 (Fig. 2). The changes in assimilation rates were paralled by the rates of stomatal conductance. The strength of the relationship is indicated by correlation coefficient *r* (*r* = 0.8017) and there exists a strong relationship between *Pn* and *gs*. The significance of relationship is expressed in probability levels. Under the present study, the value of *p* was 0.0052 which indicates that the smaller the value of *p* level, the more significant is the relationship between *Pn* and *gs*.

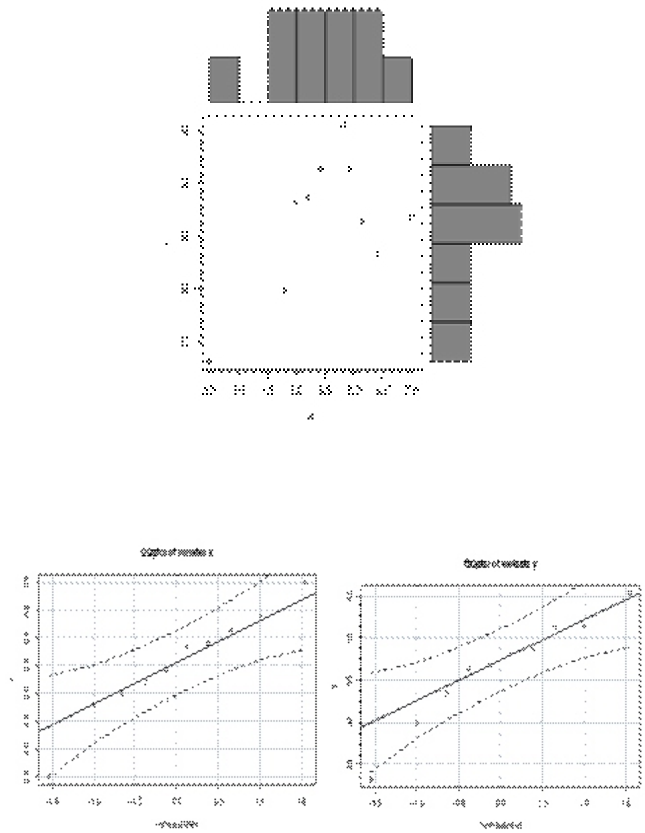

Fig.3: Pearson correlation between *Pn* and T_{leaf} of Jamun leaves.

The mean *Pn* of Jamun leaves was 5.51 and mean T_{leaf} was 36.44 (Fig. 3). Jamun exhibited a typical trend and the assimilation rates increased as the temperature increased. Photosynthetic rates were increased by about 75 per cent at 36.44°C. The strength of the relationship is indicated by correlation coefficient *r* (*r* = 0.5740) and there exists a moderate relationship between *Pn* and T_{leaf}. The significance of relationship is expressed in probability levels. Under the present study, the value of *p* was 0.0826 which indicated that the smaller the value of *p* level, the more significant is the relationship between *Pn* and T_{leaf}.

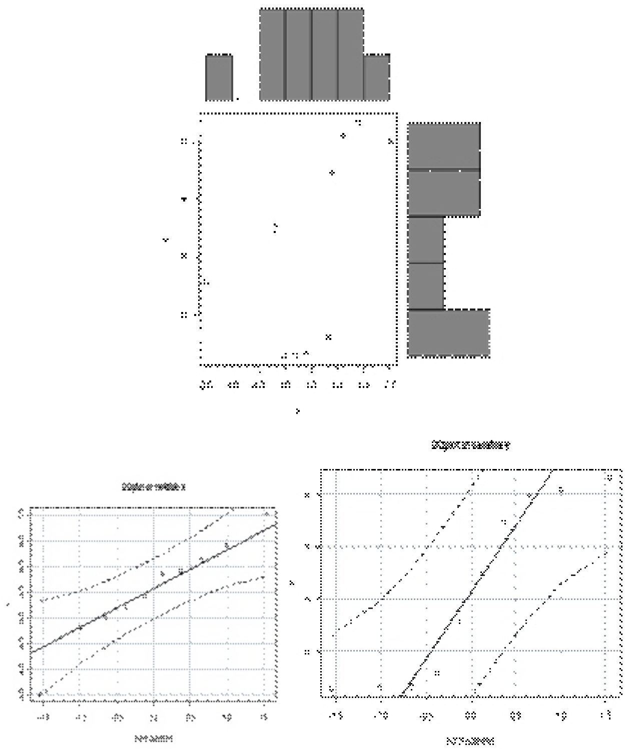

Fig. 4: Pearson Correlation between *Pn* and Relative Humidity % of Jamun leaves.

The mean *Pn* of Jamun leaves was 5.51 and mean Relative Humidity per cent as 3.14 (Fig. 4). The strength of the relationship is indicated by correlation coefficient *r* (*r* = 0.5601) and there exists a moderate relationship between *Pn* and R.H (%) of Jamun leaves. The significance of relationship is expressed in probability levels. Under the present study, the value of *p* was 0.0921 which indicates that the smaller the value of *p* level, the more significant is the relationship between *Pn* and R.H (%).

The mean *Pn* of Jamun leaves was 5.51 and mean ci as 369.8 ppm (Fig. 5). The strength of the relationship is indicated by correlation coefficient *r* (*r* = 0.8250) and there exists a strong relationship between *Pn* and *ci* of Jamun leaves. Sub-stomatal CO_2 concentration increased steeply from June to October months along with the rise in assimilation rates.The significance of relationship are expressed in probability levels. Under the present study, the value of *p* was 0.0032 which indicated that the smaller the value of *p* level, there is very highly significant relationship between *Pn* and *ci* of Jamun leaves.

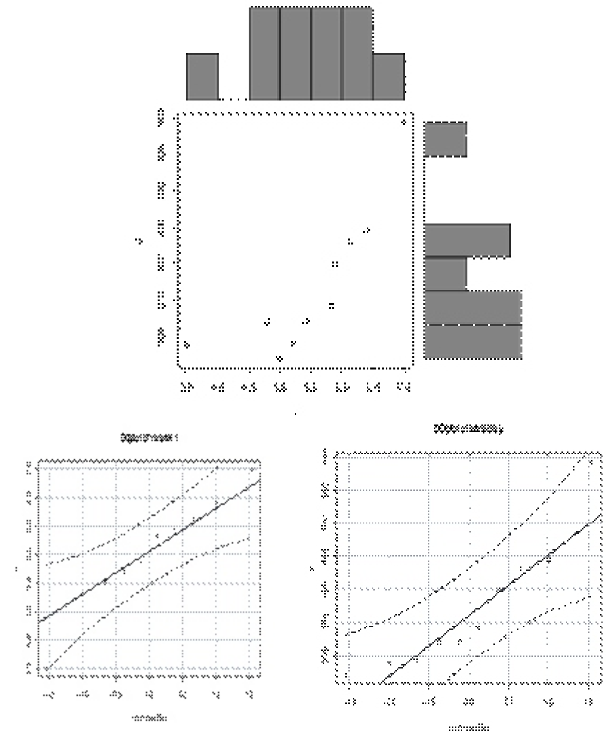

Fig. 5: Pearson Correlation between *Pn* and Substomatal CO_2 concentration (*ci*) of Jamun Leaves.

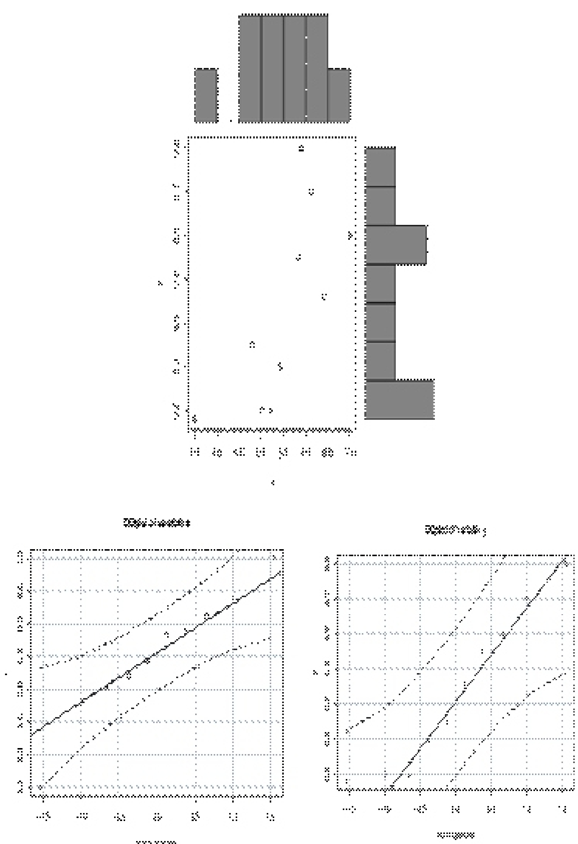

Fig. 6: Pearson Correlation between *Pn* and transpiration rate (E) of Jamun leaves.

The mean *Pn* of Jamun leaves was 5.51 and mean E of Jamun leaves was 0.43 (Fig. 6). The strength of the relationship is indicated by correlation coefficient *r* (*r* = 0.7110) and there exists a strong relationship between *Pn* and E of Jamun leaves. The significance of relationship is expressed in probability levels. Under the present study, the value of *p* was 0.0211 which indicates that the smaller the value of *p* level, there is very highly significant relationship between *Pn* and E of Jamun leaves.

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