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Identification of photosynthetic efficient elite mulberry genotypes physio-biochemical study under irrigated condition of West Bengal

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ABSTRACT

A physio-biochemical study was conducted at CSR& TI, Berhampore, West Bengal. for identification of photosynthetic efficient mulberry genotypes, maintained in the Germplasm Bank under irrigated, Gangetic alluvial soil conditions The data of 6 crops in two consecutive years (2006 and 2007) revealed that among the tetraploids studied (twenty), the genotype T-30 was found to be superior in respect to photosynthesis (14.18 μ mol $m^{-2}s^{-1}$), total chlorophyll (1.91 mg g^{-1} fresh weight), total soluble sugar (47.7 mg g^{-1} fresh weight.), leaf moisture content (81.06%) and Leaf area (103.4 cm^2). while genotype T-36 was found superior in respect to total soluble protein (33.9 mg g^{-1} fresh weight) content in leaf only. The efficient mulberry genotypes thus selected through photosynthesis and other important physio-biochemical parameters could be exploited for future breeding programme for improvement of mulberry productivity and quality.

Key words: Leaf moisture, mulberry genotypes, photosynthesis, protein and stomatal conductance

Leaves of mulberry are the sole food of silkworms for quality silk production. Mulberry plants grow under different agro-climatic conditions. Therefore, production of quality leaves is an important mandate towards the development of sericulture industry. Improvement in quality and quantity of mulberry as well as silk worm for breeding programme has a great impact on the development of silk industry as a whole (Chaitanya *et al.*, 2002). Breeding for superior mulberry genotypes with photosynthetic efficiency and desirable quality characters contributing towards yield, should be the strategy for a successful breeding programme. Among the various factors for mulberry breeding, selection of promising genotypes with desirable economic traits is very important. For selection of promising genotypes, efforts should be given on the desirable physiological attributes and quality characters of the genotypes. Photosynthesis and its related physio-biochemical parameters have long been considered for determining the leaf yield of a crop (Menon and Srivastava, 1984 and Ghosh *et al.*, 2006).

It is well evident that polyploid genotypes of mulberry are superior in quality than the diploids (Seki and Oshikane, 1959). It is pertinent to mention here that higher the leaf quality, lower is the requirement of leaf for silkworm. The high yield potential of triploids has been studied through morpho-anatomical basis (Vijayan *et al.*, 1998). Recommendation of a genotype by selection, based on photosynthetic efficiency in mulberry for future breeding programme is an important criterion. In this direction, an attempt was made to evaluate and shortlist some elite genotypes (tetraploids) with respect to net photosynthetic rate and its related parameters. Physiological parameters greatly assist the plant breeding process for selection of a genotype from a large segregating population (Sarkar *et al.*, 1991). Hence a study was undertaken to characterize the genotypic variations in different *in-situ* gas exchange parameters and its related quality characters among 20 tetraploids. The current investigation, therefore, was preliminary screening of the efficient elite genotypes (tetraploids) with high photosynthetic rate and leaf quality as confirmed through physio-biochemical study.

MATERIALS AND METHODS

The study was conducted with twenty (20) tetraploids, maintained in the mulberry germplasm bank of CSR&TI, Berhampore, West Bengal. Ten plants of each genotype were planted at 90 cm × 90 cm spacing and were maintained at 1.6 m height. Cultural operations and application of inputs were followed as per the recommended package of practices for irrigated condition. Physio-biochemical data were recorded after 70 days of pruning. Fifth leaf from the top was collected for estimation of total chlorophyll by the method of Arnon *et al.* (1949), total soluble protein and sugar by the method of Lowry *et al.*(1951) and Morris *et al.* (1948) respectively. Photosynthesis, stomatal conductance, stomatal resistance and water use efficiency were recorded in the 5^{th}-6^{th} leaf from top by Licor-6200 portable photosynthetic meter at 9-11hrs in the field. Leaf water status was measured by the method of Ritchie and Holladay (1990). Pooled data of 3 crops (Feb.- Sept.) for 2 years were statistically analyzed by the method followed by Panse and Sukhatme (1967).

RESULTS AND DISCUSSION

In the present study, significant genotypic variations were found in respect to photosynthetic rate, total chlorophyll content in leaf and leaf area.

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Average of two years data revealed that genotypes T-30 and T-36 were found to be superior in photosynthesis and its related physio-biochemical parameters. Maximum photosynthesis, water-use efficiency and stomatal conductance were recorded in T-30 (14.18μ mol $m^{-2}s^{-1}$, 0.854 and 7.01 cm s^{-1}, respectively). The genotypes possessing highest photosynthesis secure relatively high activity of the carboxylating system. Photosynthesis is largely dependent on stomatal regulation and plant productivity/ yield is directly related to the photosynthetic efficiency (Hsiao, 1973).

Table1: Performance of mulberry genotypes

Genotypes	Photosynthetic rate (μ mol m^{-2} S^{-1})	Water use efficiency (pWUE)	Stomatal conductance cm S^{-1}	Stomatal resistance S cm^{-1}	Leaf area (cm^{-2})
T-1	9.17	0.538	3.05	0.526	99.28
T-2	10.97	0.647	3.43	0.471	96.86
T-7	9.66	0.661	2.72	0.646	97.28
T-11	10.10	0.771	2.45	0.786	67.81
T-12	10.77	0.651	1.87	0.554	77.28
T-13	9.55	0.595	2.48	0.645	81.06
T-15	11.30	0.584	2.76	0.616	90.33
T-17	7.51	0.471	1.32	0.800	93.87
T-20	8.78	0.460	2.87	0.394	82.65
T-21	10.07	0.648	4.15	0.564	91.82
T-22	9.18	0.545	2.38	0.404	88.57
T-23	8.00	0.269	2.64	0.438	78.87
T-24	9.96	0.566	2.47	0.335	67.34
T-27	10.97	0.505	2.76	0.327	64.95
T-30	14.18	0.854.	7.01	0.265	103.40
T-31	10.88	0.501	3.97	0.411	71.87
T-33	11.12	0.597	3.92	0.374	74.82
T-34	10.25	0.489	2.75	0.327	62.92
T-36	12.17	0.770	4.28	0.280	99.30
T-37	10.30	0.649	4.05	0.311	97.35
LSD (0.05)	**0.97**	**0.08**	**0.57**	**0.12**	**9.79**

The increase in photosynthesis can be attributed to the increasing leaf area. Thus biomass production and leaf yield of plants are the outcome of physio-biochemical processes (Blum, 1996). Similarly minimum stomatal resistance was found in genotypes T-30 (0.265 $S.cm^{-1}$) followed by T36 (0.280 $S.cm^{-1}$) which clearly indicated that the genotypes have the capacity of opening more stomatal aperture leading to higher rate of photosynthesis. Leaf area was also found maximum in T-30 (103.40 cm^{-2}). The results thus support the findings of Chattopadhyay *et al.* (1996) and Ghosh *et al.* (2006). Total chlorophyll content in leaves is one of the important criteria for quantifying the photosynthetic rate. Among 20 genotypes, significant difference was observed in respect to total chlorophyll content in the leaves, which varied from 1.13 to 1.91 mg g^{-1} fresh weight and highest was recorded in T-30 (1.91 mg g^{-1} fresh weight) followed by T-37 (1.68 mg g^{-1} fresh weight). Total soluble protein content in leaves was found maximum in T-36 (33.92 mg g^{-1} fresh weight) followed by T-30 & T-37 (32.47 and 30.95 mg g^{-1} fresh weight, respectively). Leaf protein is of great importance for silkworm larvae because of their active utilization for the synthesis of silk protein. (Shimura, 1978; Setua *et al.*, 1998). Total soluble sugar content in leaves was maximum in T-30 (47.72 mg g^{-1} fresh weight). Carbohydrate content in mulberry plants is maximum utilized by the chawki (young age) silkworm larvae for physiological combustion and for making fat of the silkworm body. Leaf water status, an important criterion for estimating the quality of leaf, was found maximum in T-30 (81.06 %), while leaf moisture plays a vital role in improving the quality and palatability of mulberry leaf for the silkworm. Generally, the leaves of polyploids are thick, coarse, dark green in colour and larger in size exhibiting more water content and more number of stomata per unit area (Dwivedi *et.al*,1988 and 1989). Of course photosynthetic rate and its related nutritional parameters of mulberry play a vital role in improving the silkworm growth and quality of silk production. It is evident from earlier reports that genotypes having higher photosynthesis, stomatal conductance and water use efficiency were found to be high yielder. The performance and biomass production potential of genotypes depend on the maintenance of higher physiological status and economical utilization of resources.

Table 2: Study on leaf quality of mulberry genotypes

Genotypes	Total chlorophyll (mg g^{-1} fresh wt.)	Total soluble protein (mg g^{-1} fresh wt.)	Total soluble sugar (mg g^{-1} fresh wt.)	Leaf moisture (%)
T-1	1.34	22.69	29.29	74.08
T-2	1.32	27.32	42.93	75.41
T-7	1.21	24.17	39.30	75.60
T-11	1.13	28.87	41.88	75.69
T-12	1.48	24.10	46.69	74.47
T-13	1.22	24.09	39.85	74.26
T-15	1.53	29.64	37.01	73.15
T-17	1.45	28.15	42.69	75.19
T-20	1.33	27.07	35.17	75.27
T-21	1.64	30.83	44.27	72.40
T-22	1.47	27.73	40.86	75.73
T-23	1.30	27.39	35.17	74.67
T-24	1.47	25.06	40.98	73.70
T-27	1.21	26.10	35.59	76.53
T-30	1.91	32.47	47.72	81.06
T-31	1.58	28.58	39.55	73.67
T-33	1.12	25.04	35.59	76.53
T-34	1.12	25.66	40.25	74.31
T-36	1.68	33.92	47.30	78.64
T-37	1.60	30.95	42.93	75.16
LSD (0.05)	**0.93**	**2.04**	**2.21**	**2.21**

Thus, from the above study it could be inferred that the genotypes (T-30, T-36 , T15, T12 and T-37) having maximum photosynthetic rate, photosynthetic water-use efficiency and stomatal conductance with better quality *i.e.*, total soluble protein, carbohydrate and leaf moisture may be exploited for future breeding programme and hence the study on photosynthesis and its related gas exchange parameters, leaf water status and quality parameters of leaf may be given more emphasis for screening and developing a superior genotype.

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