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Research Article

Nitrogen Harvest index and Biological yield for screening of better genotypes in Mulberry (*Morus* spp.)

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Abstract

In sericulture, improvement in the production of silk depends on the improvement in leaf production ability of mulberry, the host plant of silkworm, *Bombyx mori* L. The supply of quality leaves in sufficient quantity is the key factor for success in cocoon production. In mulberry the uptake of nutrients, particularly nitrogen, from soil is comparatively more as it supports vegetative growth particularly leaf biomass. Variation in nitrogen harvest index, physiological and yield contributing traits were estimated in eleven mulberry genotypes. Considerable variation was observed for nitrogen harvest index, protein yield per plant and harvest index. The correlation studies indicated the protein yield per plant was significantly correlated with leaf yield, nitrogen content in leaf, nitrogen harvest index and harvest index. Estimation of broad sense heritability revealed that the biological yield showed highest heritability (99.00) followed by leaf yield (98.00), protein yield (98.00), shoot yield (97.00), nitrogen content in leaf (95.00), harvest index (93.00) and nitrogen harvest index (91.00).

INTRODUCTION

Mulberry (*Morus* spp.) is generally a diploid, belongs to the genus *Morus* of the family Moraceae. It is a fast growing deciduous plant and perennial in nature. It can be grown successfully both under temperate/tropical and irrigated/rain fed conditions. The success of cocoon crop production depends mainly on the utilization of quality leaves in required quantity. Japanese reports state that among various factors influencing a successful crop, the contribution of the leaf quality alone is around 38%.

Increasing production of raw silk to a greater extent depends on higher yields and quality mulberry leaves. Leaf yield in mulberry is a polygenic character influenced by several quantitative characters (Vijayan *et al*., 1977) and is the cumulative consequence of various physiological and biochemical processes. Mulberry silk production involves mulberry cultivation, rearing of silkworm, reeling and weaving. Out of these, mulberry cultivation plays a significant role in determining the cost of production of raw silk as about 60% of cost of cocoon production goes to mulberry leaf production (Jalaja *et al*., 2002).

The productivity of a crop is determined by its genetic make up and its response to agricultural inputs beside the environment to which it is growing. Dry matter accumulation in plant depends on the photosynthetic surface and the rate of net assimilation (Chattopadhyay *et al*., 1992).

In mulberry, where the economic product is leaf, the uptake of nitrogen from soil is very heavy and high responses to application of nutrients have been reported. It appears that a number of physiological and biochemical process of nitrogen metabolism which precede plant maturity may be used as selection criteria for enhanced N-metabolism (Cregan *et al*., 1984).

Nitrogen is an essential constituent of amino acids, amides, proteins, nucleic acids, nucleotides and hexo-enzymes which are essential cell constituents. Nitrogen supports vegetative growth particularly the leaf biomass (Bongale, 1993). Nitrogen harvest index appears to be more important in case of mulberry, as the leaf protein in converted to silk protein (sericin and fibroin) through biological process (Jalaja *et al*., 2002). In the present study, variation in harvest index, biological yield, nitrogen harvest index and other physiological components and their relation with harvest index, nitrogen harvest index and total protein yield have been studied in eleven mulberry genotypes (Ghosh *et al*., 2007)

MATERIALS AND METHODS

Eleven mulberry genotypes developed by different progenitors *viz*., C-2028, C-1730, C-2016 C-2017, C-2038, G-4, Suvarna-2, S-1635, Vishala, S-1 and Local were used for the study. The experiment was carried out in an established plantation with 90×90 cm spacing under fully irrigated condition following Randomized Block Design with 3 replications. Farm yard manure was applied at the rate of 20 mt/ha/year and N:P:K at the rate of 336:180:112 were applied to the plot in five splits. "Morizyme B" a commercial micronutrient formulation was sprayed @2.5 ml/l (750 litre solution was used for spraying one hectare) twice during one cycle of growth from pruning to leaf harvest comprising of 70 days *i.e.*, 25th and 32nd days after pruning as a part of the package (Datta *et al*., 2001). The data on leaf yield and biological yield were recorded by harvesting the randomly selected plants at 60 days after pruning. The leaves and stem were dried separately in an oven at 80ºC for 48 h to obtain the dry weights which were utilized for calculating harvest index. The nitrogen content and crude protein in leaf and shoot were estimated by using Tecater make Kjeltee system (Piper, 1942). The protein content was estimated by multiplying the nitrogen value by 6.25 *i.e.*, Crude protein = Nitrogen (%) × 6.25. Nitrogen harvest index (NHI) was calculated according to the formula suggested by Austin and Jones [7 (Austin and Jones, 1975)].

The leaf protein was calculated on dry wt. basis using the following formula and expressed in percentage.

$$\text{Protein yield (g/plant)} = \frac{\text{Leaf yield} \times \text{Leaf protein}}{100}$$

Harvest index (HI) was obtained by dividing the leaf yield with biological yield (Donald, 1962).

$$\text{HI} = \frac{\text{Leaf yield}}{\text{Total biological yield (Leaf + Stem)}} \times 100$$

The experiment was conducted for five seasons *i.e.*, spring (February), summer (May), rainy (July), autumn (September) and winter (November) and data averaged over five seasons were analyzed statistically.

RESULTS AND DISCUSSION

The mean values obtained for the various parameters along with CD and CV values are presented in Table 1. Perusal of the data revealed that, in general the genotypes differed significantly with respect to all the parameters. Nitrogen harvest index was found maximum in C-2038 (0.8871) followed by G-4 (0.8812), but the difference between them was not significant. Similarly, significantly higher harvest index was observed in C-2038 (62.27) followed by Suvarna-2 (60.58), G-4 (60.42) and S-1635 (60.19).

The correlation of leaf yield, biological yield and protein yield with its component characters presented in Table 2 revealed that biological yield was found to be significantly correlated with leaf yield and protein yield and similar findings were also observed by Jalaja *et al.* (2002). Harvest index and nitrogen harvest index did not show significant correlation with biological yield and with leaf yield the level of correlation was found weak and significant at 1% level.

Table 1. Component characters along with harvest index, nitrogen harvest and protein

Genotype	Leaf yield (g/plant) Dry wt.	Stem yield (g/plant) dry wt.	Biological yield (g/plant) dry wt.	Harvest index	Leaf nitrogen (%)	Stem nitrogen (%)	Nitrogen Harvest index	Leaf crude protein (%)	Protein yield (g/plant)
C-2038	132.53	80.29	212.82	62.27	4.50	0.944	0.8871	28.10	37.26
S-1635	92.58	61.24	153.82	60.19	4.02	0.829	0.8801	25.15	23.27
C1730	84.66	60.11	144.78	58.48	3.70	0.774	0.8707	23.15	19.60
C-2028	83.52	59.86	143.38	58.25	3.61	0.757	0.8692	22.54	18.83
C-2016	81.52	60.87	142.40	57.25	3.45	0.736	0.8627	21.58	17.60
Vishala	79.05	52.17	131.22	60.24	3.85	0.796	0.8798	24.04	19.01
Suvarna-2	78.41	51.03	129.45	60.58	3.88	0.819	0.8793	24.27	19.03
C-2017	74.47	60.74	135.21	55.08	3.32	0.729	0.8480	20.73	15.44
G4	73.84	48.36	122.22	60.42	4.08	0.839	0.8812	25.48	18.82
S-1	65.72	57.80	123.53	53.21	3.29	0.704	0.8415	20.54	13.50
Local	60.87	56.48	117.36	51.87	3.27	0.696	0.8350	20.46	12.45
CD at 5%	2.33	1.30	2.77	0.89	0.08	0.010	0.0100	0.53	0.85
CV%	1.66	1.36	1.15	0.90	1.33	0.76	0.36	1.33	2.56

Table 2. Correlation of leaf yield, biological yield and protein yield with component characters

	Leaf yield	Biological yield	Shoot yield	Nitrogen content	Harvest index	Nitrogen harvest index
Protein yield	0.985**	0.949**	0.751**	0.880**	0.752**	0.721**
Leaf yield	-	0.984**	0.827**	0.798**	0.697*	0.661*
Biological yield	-		0.915**	0.688*	0.558 NS	0.518 NS

* Significant at 5% level, * Significant at 1% level.

Table 3. Heritability estimates (broad sense) for parameters associated with harvest index

Character	Heritability (%)
Biological yield	99.00
Leaf yield	98.00
Protein yield	98.00
Shoot yield	97.00
Nitrogen in leaf	95.00
Harvest index	93.00
Nitrogen harvest index	91.00

Nitrogen content in leaf was found to be significantly correlated with both leaf yield and protein yield. The heritability estimates for parameters associated with harvest index were calculated and presented in Table 3. Highest value of 99% was observed for biological yield followed by leaf yield (98%) and protein yield (98%).

Among the genotypes significant variations were revealed for all the parameters studied indicating that the parameters were genotype specific. Harvest index and nitrogen harvest index (dry wt. basis) were found to be variety specific, indicating that some of the characters can be used for selection of genotypes and these results are in confirmation with Jalaja *et al.* (2002). There is no doubt that higher harvest index represents increased physiological capacity of plant system to mobilize and translocate photosynthetic products to organs of commercial value. Kretesz (1984) opined that until the breeders understand the detailed physiological aspects of yield, biological yield in conjunction with harvest index may be used as two simple but valuable criteria for assessment of yield potential of a plant.

In the present investigation, leaf yield and biological yield were found to be highly correlated indicating that biological yield may also be considered as one of the predictor for leaf yield.

Heritability estimates (broad sense) for all the biomass component characters indicated that highest heritability was obtained for biological yield (99%) followed by protein yield (98%) and harvest index (93%). High estimates of heritability are expected to result in high genetic advance in harvest index. Bhatt (1976) and Rosielle and Frey (1977) reported that harvest index is controlled by additive gene action. Results of the present investigation indicate that biological yield and harvest index have predictive value in selecting the plants. As high heritability was observed in harvest index, this character can also be used in selection. Nitrogen content and protein yield also showed high heritability as protein yield was directly correlated with harvest index and nitrogen harvest index. Hence, nitrogen harvest index may also be used as a selection criterion.

In mulberry, increasing leaf protein content apart from higher leaf yield is one of the major objectives because the main constituent of silk is protein and the leaf protein is converted to silk through the biological process involving silkworm. The high NHI opens up the possibility to increase the protein content without additional fertilizer application by improving nitrogen partitioning efficiency.

The direct relationship of protein yield with all the component characters including nitrogen harvest index indicates that with increase of NHI, the leaf protein can be improved.

Base on the results of the present investigation, use of biological yield and harvest index as selection criteria have been recommended. Results also revealed the usefulness of considering NHI for screening better genotypes during the selection processes.

REFERENCES

Austin RB and Jones HC, 1975. *The physiology of wheat. Annual Report.* Plant Breeding Institute, Cambridge, England.

Bhatt GM, 1976. Variation of harvest index in several wheat crosses. *Euphytica*, **25**: 41-50.

Bongale UD, 1993. Role of nitrogen in mulberry cultivation. *Indian Silk*, **30**: 14-16.

Chattopadhyay S, Das C, Sengupta T, Ghosh JK, Das KK, Sen SK and **Pavan Kuma T, 1996**. Evaluation of leaf gas exchange parameters of five Chinese mulberry germplasm in Indian Tropical conditions. *Sericologia* **36**: 723-726.

Cregan PB and Berkum Van P, 1984. Genetics of nitrogen metabolism and physiological/biochemical selection for increased growth productivity. *Theor. Appl. Genet.* **67**: 97-111.

Datta RK, Sarkar A and Singhvi NR, 2001. Study on the efficacy of Seriboost a commercial formulation, on mulberry growth & silkworm rearing. Final report based on a consultancy project for SERICARE, Bangalore. Published by CSR&TI, Mysore.

Donald CM, **1962**. In search of yield. *J. Aust. Inst. Agric. Sci.*, **28**: 171.

Ghosh MK, S Roy Chowdhuri, Shiv Nath, PK Ghosh, S Debnath, I Roy and **PL Ghosh,** 2007. Harvest index and Biological yield as selection criteria for Mulberry (*Morus* spp.). ***Indian J. Genet.*** **67**(2): 196-197.

Jalaja S Kumar, Chakraborty C and Sarkar A, 2002. Nitrogen harvest index in some varieties of Mulberry, *Morus* spp. *Int. J. Indust. Entomol.* **5** (1):131-134.

Kertesz Z, 1984. Improvement of harvest index; in Efficiency in Plant Breeding Proceedings 10th Congress of Eurcarpia. Lange, W., A. C. Zeven and N. G. Hogenboom (eds.). pp. 93-104, pudoc, Wageningen.

Piper CS, 1942. *Soil and plant analysis*. Hans Publications, Bombay.

Rosielle A A and Frey KJ, 1977. Inheritances in harvest index and related traits in oats. *Crop Sci.* **17**: 23-28.

Vijayan K, Tikadar A, Das KK, SP Chakraborti and Roy BN, 1997. Correlation studies in mulberry (*Morus spp*.). *Indian J. Genet.* **57**: 455-460.

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