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Note

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Nitrogen Harvest Index in Some Varieties of Mulberry, *Morus* spp.

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Mulberry being the only food of silkworm, *Bombyx mori* L., is of great economic importance to the silk industry. The success in cocoon production mainly depends on the supply of quality leaves in sufficient quantity. 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. Nitrogen supports vegetative growth particularly the leaf biomass. Variation in nitrogen harvest index and other physiological and yield contributing traits were estimated in five 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. The broad sense heritability estimates revealed that harvest index showed highest heritability (88.07 %) followed by nitrogen content (82.52%), protein yield (70.28%) and nitrogen harvest index (66.52%).

Key words: Mulberry, Harvest index, Nitrogen content, Nitrogen harvest index, Protein yield

Introduction

Mulberry being the only food of silkworm, *Bombyx mori*, L., is of great economic importance to the silk industry. Mulberry silk production involves mulberry cultivation, rearing of silkworm, reeling of cocoon and weaving. Of all 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 alone.

Mulberry 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 and tropical condition. The success in cocoon production mainly depends on the supply of quality leaves in sufficient quantity. Japanese reports state that among various factors influencing a successful crop, the contribution of the leaf quality alone is around 38%.

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.

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 and Berkum, 1984).

Nitrogen is also an essential constituent of amino acids, amides, proteins, nucleic acids, nucleotides and hexoenzymes 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 is converted to silk protein (sericin and fibroin) through biological process. In the present study, variation in Nitrogen harvest index and other physiological components and their relation with harvest index, nitrogen harvest index, and total protein yield have been studied in five mulberry varieties.

Materials and Methods

Four recommended mulberry varieties namely Mysore local, Kanva-2, S-36 and V-1 along with *Morus multi-*

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caulis which has been identified as a superior combiner were used for the study. The experiment was carried out in an established plantation with 60 cm × 60 cm, spacing under fully irrigated condition following Randomized Block Design with 5 replications. Farm yard manure was applied at the rate of 20 MT/ha/yr and N:P:K at the rate of 350:140:140 kg/ha/yr were applied to the plot in five splits. "Seriboost" a commercial micronutrient formulation was sprayed at the rate of 2.5 ml/l (750 liter solution was used for spraying one hectare) twice during one cycle of growth from pruning to leaf harvest comprising of 70 days *i.e.*, 24 and 32 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 70 days after pruning. The leaves and stem were dried separately first in shade and later in an oven at 70°C for 48 hours to obtain the dry weights which were utilized for calculating harvest index. The nitrogen content and crude protein content in leaf and shoot were estimated by using Tecatar make Kjeltec system (Piper, 1942). 25 mg of leaf powder or 50 mg of stem powder were taken in a kjeltec tube and 10 ml of concentrated sulphuric acid was added to it. Samples were digested on the digestion unit till the digested solution became white in colour. Later, 2 ml of 30% hydrogen peroxide was added to it and digestion was continued till the sample became clear. 2-3 drops of Bromocresol green indicator was added to 25 ml of Boric acid solution in a 250 ml conical flask steam distilled in a micro-Kjeldahal tube. After distillation, the boric acid solution was titrated against 1/14 sulphuric acid solution till green colour of the boric acid changed to brick red. The nitrogen content of the leaf was estimated by using the following formula and then the crude protein content of the leaf was estimated.

$$\text{Nitrogen (\%)} = \frac{\text{Titer value} - \text{blank} \times 14.01}{\text{Weight of the sample (g)} \times 10}$$

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 (1977).

The leaf protein yield 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 two seasons *i.e.*, during August (rainy season) and December (winter season) and data averaged over two seasons were analyzed statistically.

Results

The mean values obtained for the various parameters along with C. D. values are presented in Table 1. Perusal

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

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)
Local	72.12	61.38	133.50	54.02	3.34	0.707	0.820	20.93	15.09
Kanva-2	91.78	98.66	190.44	48.1	3.36	0.865	0.820	21.05	19.31
Morus multicaulis	136.46	133.00	269.46	50.65	3.65	0.809	0.815	22.85	31.281
S-36	123.94	95.14	219.08	56.57	4.18	0.851	0.870	26.14	32.511
V-1	130.84	84.48	215.32	60.77	4.25	0.869	0.883	26.59	34.821
C.D. at 5%	26.20	28.40	56.19	2.256	0.26	0.142	0.029	1.644	7.24

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	0.955**	0.841**	0.636**	0.764**	0.413*	0.475*
Leaf yield	--	0.951**	0.802**	0.548**	0.219	0.275
Biological yield	--	--	0.946**	0.334	–0.0854	0.017

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

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

Character	Heritability (%)
Leaf yield	64.55
Shoot yield	56.56
Biological yield	54.05
Harvest index	88.07
Nitrogen in leaf	82.52
Nitrogen harvest index	66.99
Protein yield	70.28

of the data revealed that, in general the genotypes differed significantly with respect to all the parameters. Nitrogen harvest index was found to be significantly higher in V-1 (0.883) followed by S-36 (0.870). However, difference between S-36 and V-1 was not significant. Similarly, significantly higher harvest index was observed in V-1 (60.77%) followed by S-36 (56.70%).

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. Harvest index and nitrogen harvest index did not show significant correlation with leaf yield and biological yield. 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 for selected mulberry varieties were calculated and presented in Table 3. Highest value of 88.07% was observed for harvest index followed by nitrogen content in leaf (82.52%).

Discussion

Significant variations were observed among genotypes for all the parameters studied indicating that the parameters were genotype specific. Harvest index and nitrogen harvest index (dry wt. basis) were also found to be variety specific, indicating that some of the characters can be used for selection of genotypes. It 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 study, 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 the all the biomass component characters and harvest index indicated that highest heritability was obtained for harvest index (88.07%). 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 study indicate that harvest index has 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 heritabilitiy as protein yield was directly correlated with harvest index and nitrogen harvest index. Hence, nitrogen harvest index may also be used as a selection criteria.

In mulberry, increasing the leaf protein content apart from higher leaf yield is one of the major objectives. It is because the main constituent of silk is protein and the leaf protein is converted to silk through the biological process involving silkworm system. 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 the increase of NHI, the leaf protein can be improved.

Based on the results of the present investigation, use of biological yield and harvest index as selection criteria is recommended. Results also revealed the usefulness of the use of NHI for screening of better genotypes during the selection processes. A plant breeding programme of this nature would result in enhanced plant productivity with high quality.

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