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Interrelationship of Biological Yield and Harvest Index in Mulberry and Its Association with Shoot Rearing in Silkworm (*Bombyx mori* L.)

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Studies on the interrelationship between biological yield and harvest index, and their association with shoot rearing were carried out in 9 promising mulberry genotypes, which indicated significant variations among genotypes. Biological yield had close association with leaf yield components indicating that they are inter-related for higher productivity in mulberry. Biological yield revealed highly significant positive correlation with important leaf yield components. However height of the longest branch showed negative correlation with biological yield. Genotypes with higher biological yield associated with low ratio of stem weight to leaf weight and high harvest index on dry weight basis are to be selected for shoot rearing. Biological yield recorded on fresh weight basis had less impact on the present study in comparison to dry weight basis.

Key words : Biological yield, Shoot rearing, Mulberry, Ratio of stem weight to leaf weight

Introduction

The mulberry yield, whether it is shoot or leaf is directly or indirectly conditioned by a large number of yield component characters. The primary objective of any crop improvement research programme is to exploit maximum yield potential in addition to improving the desirable features. Unlike other agricultural crops, the leaf is the main economic product in mulberry. In perennial crops such as tea and rye grass, main emphasis has been given to select genotypes with low ratio of stem weight to leaf weight. It has been reported that biological yield and harvest index in barley are inter-related (Donald and Hamblin, 1976). The components of biological yield (shoot yield) are total shoot length, number of branches per plant, inter-nodal distance. The harvest index is the ratio of leaf yield to shoot yield.

In new millennium labor has become very costly and the silkworm rearing requires more number of laborers during fifth instar *i.e.* in its complete growth period. The laborers required by the shoot rearing method during fifth instar are reduced by 60% in comparison to the leaf feeding method (Krishnaswamy *et al.*, 1973; Kumaresan *et al.*, 1999; Vindhya *et al.*, 1996). The larval duration is also reduced by 8% by adopting shoot rearing technology in comparison to leaf feeding method (Narasimhamurthy and Subramanyam, 1988).

The biological yield has got direct relationship with harvest index and leaf yield components (Takeda and Frey, 1985). In the present investigation, an attempt has been made to study the interrelationship of biological yield with harvest index and their association with shoot rearing. For the shoot rearing, the desirable genotype is the one that has more number of branches per plant, short inter-nodal distance, medium shoot length, higher leaf weight of all the branches, high moisture content of leaves and more number of leaves in the branch.

Chowdhary (1982) has observed a direct relationship between total dry matter production and yield in groundnut. Rosielle and Frey (1975), Bhat (1976), Thakral *et al.* (1979), Srivastava *et al.* (1981), Sharma and Smith (1986) and Sharma *et al.* (1987) have observed considerable variation and significant difference among biological yield, grain yield and harvest index in different wheat cultivars. Donald (1962), Wallace and Munger (1966) and Singh and Stoskof (1971) concluded that genetic improvement in economic yield of several cereal crops derives from higher percentages of biological yield being partitioned

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into plant organs, constituting economic yield.

The promising genotypes considered in the present study in the context of biological yield and shoot rearing, are the ones that were superior in leaf yield as well as rearing performance of silkworm in comparison to Kanva-2, the popular variety in South India. Identical studies have been made earlier with these genotypes on leaf yield and silkworm rearing performance by leaf feeding method (Sastry, 1984; Susheelamma *et al.*, 1989, Susheelamma *et al.*, 1990; Jalaja *et al.*, 1994; Susheelamma and Datta, 1995; Anantharaman *et al.*, 1995). In this study, we have carried out the measurements of biological yield and harvest index by shoot rearing method using popular bivoltine hybrids.

Materials and Methods

The experiment was conducted under irrigated condition during rainy, winter and summer seasons of 1999 - 2000. The experimental material utilized consisted of nine genotypes of diverse origin and are very promising in the field (Sastry, 1984; Jalaja *et al.*, 1994; Susheelamma and Datta, 1995; Susheelamma, 1999). The experiment was carried out on an existing plantation, which was planted during 1998 in randomized block design with 4 replications and each replication consisted of 9 micro plots with 90 plants per micro plot. Each micro plot had border plants to eliminate border effect and the spacing followed was 90 x 90 cm between plants. All the micro plots of different genotypes were pruned at a height of 30 cm from ground level and fresh weight of the shoot and leaf was recorded after 70 days of pruning. Later, stems and leaves were dried separately in hot air oven at 100°C for 72 hrs and dry weights of the stem and leaf were recorded separately. Harvest index was computed using the following formula (Donald, 1962):

$$\text{Harvest Index} = \frac{\text{Leaf yield of the plant}}{\text{Biological yield of the plant}}$$

The silkworm rearing was conducted with bivoltine hybrid KA $\times$ NB_4 D_2 by the methodology suggested by Krishna Swami (1978).

Results and Discussion

Interrelationship of biological yield, leaf yield and harvest index recorded on fresh weight and dry weight basis during different seasons of a year is presented in Table 1, 2 and 3. Significant difference was observed among genotypes for biological yield on fresh weight and dry weight basis during different seasons of a year is presented in Table 4. Therefore, it is reasonable that the biological yield recorded on dry weight basis is more dependable for selection of genotype for shoot rearing than fresh weight basis.

Interrelationship of biological yield, harvest index and leaf yield

The biological yield, leaf yield and harvest index from different genotypes showed considerable variations (Table 1, 2 and 3) and highly significant difference has been found

Table 1. Interrelationship of biological yield, leaf yield, harvest index and stem weight to leaf weight ratio for nine genotypes during Season 1

Name of the genotype	Biological yield* (kg)	Biological yield* (kg)	Leaf yield* (kg)	Harvest index* (%)	Biological yield** (kg)	Leaf yield** (kg)	Harvest index** (%)	Stem weight to leaf weight ratio
G1 (RFS-175)	63.20	63.20	37.82	59.92	12.45	7.60	61.00	0.63
G2 (S-1635)	62.00	62.00	31.47	50.76	11.70	6.75	57.69	0.73
G3 (S-1)	58.31	58.31	33.63	57.82	10.97	6.93	63.08	0.58
G4 (S-36)	49.32	49.32	28.13	57.03	10.30	5.55	54.00	0.86
G5 (S34)	55.83	55.83	29.85	53.46	11.19	6.15	55.00	0.81
G6 (S-13)	67.04	67.04	34.82	52.97	12.93	7.63	59.00	0.65
G7 (V-1)	61.82	61.82	34.96	56.50	12.55	7.50	59.70	0.67
G8 (K-2)	48.38	48.38	23.98	49.49	9.33	4.58	49.10	1.03
G9 (Local)	50.68	50.68	25.43	50.30	9.65	4.83	50.05	1.00
	S	S	S	S	S	S	S	S
C.D at 5%	8.03	8.03	5.82	5.56	1.52	0.95	3.87	0.78

Note: Season 1 Sept. to Oct. 1999, *Fresh weight, **Dry weight, S significant.

Table 2. Interrelationship of biological yield, leaf yield, harvest index and stem weight to leaf weight ratio for nine genotypes during Season 2

Name of the genotype	Biological Yield* (kg)	Leaf yield* (kg)	Harvest Index* (%)	Biological yield** (kg)	Leaf yield** (kg)	Harvest index** (%)	Stem weight to leaf weight ratio
G1 (RFS-175)	68.75	39.15	56.87	13.63	9.00	66.07	0.51
G2 (S-1635)	60.25	32.25	53.44	12.13	7.08	58.40	0.71
G3 (S-1)	59.75	34.50	57.74	12.38	7.25	58.53	0.70
G4 (S-36)	47.50	27.75	58.52	10.13	5.70	56.45	0.78
G5 (S-34)	53.95	30.50	56.54	11.75	6.75	57.44	0.74
G6 (S-13)	69.75	39.00	55.93	14.78	9.25	62.58	0.59
G7 (V-1)	70.50	38.75	54.94	14.25	9.00	63.10	0.58
G8 (K-2)	49.50	24.25	48.88	10.75	5.63	52.29	0.91
G9 (Local)	45.00	23.25	51.47	10.88	5.75	53.00	0.90
C.D at 5%	S 7.00	S 4.90	S 4.62	S 1.39	S 1.06	S 4.94	S 0.57

Note: Season 2 - Dec. 1999 to Jan. 2000, *Fresh weight, **Dry weight, S significant.

Table 3. Interrelationship of biological yield, leaf yield, harvest index and stem weight to leaf weight ratio for nine genotypes during Season 3

Name of the genotype	Biological yield* (kg)	Leaf yield* (kg)	Harvest Index* (%)	Biological yield** (kg)	Leaf yield** (kg)	Harvest index** (%)	Stem weight to leaf weight ratio
G1 (RFS-175)	70.79	41.33	58.38	14.00	9.08	63.92	0.54
G2 (1635)	52.50	27.00	51.43	10.37	5.50	52.98	0.88
G3 (S-1)	63.50	36.50	57.48	13.63	7.75	56.87	0.76
G4 (S-36)	45.75	26.00	56.83	11.25	6.65	59.11	0.70
G5 (S34)	50.75	28.25	55.66	12.63	6.20	52.66	1.03
G6 (S-13)	69.50	40.92	58.89	14.80	9.00	64.26	0.60
G7 (V-1)	70.00	41.00	58.60	12.50	8.95	60.30	0.50
G8 (K-2)	49.00	25.75	52.60	11.00	5.38	48.48	1.04
G9 (Local)	41.20	20.75	50.33	11.63	6.58	56.69	0.87
CD at 5%	S 6.27	S 3.51	S 3.55	S 1.11	S 0.68	S 4.82	S 0.89

Note: Season 3-Mar. to Apr. 2000, * Fresh weight, ** Dry weight, S significant.

Table 4. Variance analysis and indicated levels of significance for biological yield, leaf yield and harvest index in nine genotypes in three seasons

Source of variation	Degree of Freedom	SI			S2			S3		
		Biological yield	Leaf yield	Harves index	Biologica-lyield	Leaf yield	Harvest index	Biological yield	Leaf yield	Harvest index
Mean squares (Fresh weight basis)										
Genotype	8	181.23**	86.91**	54.48**	392.47**	154.36**	39.12**	336.97**	181.43**	67.76**
Replication	3	28.97	17.87	30.07	77.98	37.12	10.50	71.03	28.07	10.39
Error	4	30.31	15.92	14.49	23.02	11.27	10.02	18.46	05.77	05.92
Mean squares (Dry weight basis)										
Genotype	8	6.69**	5.57**	4.14**	10.59**	7.18**	62.38**	7.75**	7.61**	114.30**
Replication	3	1.13	0.60	4.63	2.31	1.50	5.92	3.32	0.48	3.22
Error	24	1.08	0.42	7.04	0.91	0.53	11.44	0.58	0.22	10.89

**significant at 1% level, *significant at 5% level, Season 1- Sept. to Oct. 1999; Season 2- Dec. 1999 to Jan. 2000; Season 3-Mar. to Apr. 2000.

Table 5. Rearing performance of different genotypes of mulberry through shoot rearing with silkworm race KA × NB_4 D_2

Name of the genotype	Larval duration (hrs)	Err by number	Err by weight (kg)	Single cocoon weight (g)	Single shell weight (g)	Shell ratio (%)	Leaf- cocoon ratio
G-1 (RFS-175)	555	8891.3	18.00	1.67	0.320	19.35	22.0 : 1
G-2 (S-1635)	563	8905.0	17.50	1.63	0.315	19.43	24.0 : 1
G-3 (S-1)	567	9033.3	15.58	1.70	0.335	19.50	23.0 : 1
G-4 (S-36)	558	8914.5	16.30	1.60	0.320	19.55	22.5 : 1
G-5 (S-34)	560	8945.0	17.00	1.63	0.325	18.60	20.0 : 1
G-6 (S-13)	540	9820.3	18.90	1.85	0.380	20.50	21.0 : 1
G-7 (V-1)	550	9012.5	18.30	1.65	0.325	19.70	22.0 : 1
G-8 (K-2)	560	8350.0	16.50	1.67	0.268	18.50	23.0 : 1
G-9 (Local)	564	8460.0	15.30	1.63	0.280	17.30	24.0 : 1
L.S. D at 0.05%	-	64.09	0.50	0.06	0.130	0.150	0.145

Table 6. Correlation coefficients (r) between biological yield and leaf yield components in mulberry for nine genotypes

Yield components	Correlations
Height of the longest branch Vs Biological yield	0.011 NS
Total Shoot length Vs Biological yield	0.647**
Number of leaves per meter length of the shoot Vs Biological yield	0.629**
Number of branches per plant Vs Biological yield	0.749**
Leaf weight of shoots Vs Biological yield	0.709**
Moisture content Vs Biological yield	0.634**

NS; non significant, *Significant at P = 0.05, **significant at P = 0.01.

between genotypes (Table 4). This observation is in confirmation with the findings of Rosielle and Frey (1975), Bhat (1976), Thakral *et al.* (1979) and Sharma *et al.* (1987) in different crops such as oat, wheat, avena sativa, etc., in which they observed significant difference between hybrids for biological yield (shoot yield), grain yield and harvest index. Unless genotypes are identified with high biological yield and harvest index, it is not possible to have higher productivity. Genotypes which showed higher biological yield also showed higher harvest index indicating interrelation among them. Similar observations have been made by Donald and Hamblin (1976), Sharma and Smith(1986) and Sharma *et al.* (1987) in wheat. There was difference between harvest index recorded on dry weight and fresh weight basis (Table 1, 2 and 3). Biological yield on dry weight basis expressed consistency in the yielding ability during different seasons with same genotypes, whereas biological yield recorded on fresh weight basis showed variation among seasons with the same genotypes (Table 1, 2 and 3). The ratio of stem weight to leaf weight among the 9 genotypes studied on dry weight basis, expressed low stem weight to high leaf weight ratio in G6 (S-13), G1 (RFS-175) and G7 (V-1). The rearing results also indicated superiority of G-6 (S-13) genotype in shoot rearing (Table 5) and this is in conformity with the findings of Anantharaman *et al.* (1995) in different mulberry varieties.

The present study has resulted in the identification of suitable mulberry genotypes G6 (S-13), G1 (RFS-175) and G7 (V-1) for shoot rearing, to have higher cocoon productivity. The correlation coefficient between biological yield and leaf yield components depicted in Table 6 showed highly significant positive correlation with total shoot length, number of branches per plant, weight of leaves of the shoot and moisture content; whereas longest branch of the shoot showed non significant correlation indicating that total shoot length is more important rather than longest branch. Therefore, it could be concluded that for selecting a genotype for shoot rearing, importance is to be given for total shoot length, number of branches per plant, number of leaves in the shoot, weight of leaves in the shoot and moisture content of the leaves in addition to the harvest index.

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