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Yield stability in mulberry over different regions of Eastern and North-Eastern India

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ABSTRACT

The leaf yield performance of 10 mulberry varieties was tested through stability analysis for different crop seasons conducting experiment in seven test centers for 5 years of Eastern and North-Eastern zones of India e.g., Berhampore, Kalimpong, Muluk in West Bengal; Koraput in Orissa; Ranchi in Jharkhand; Jorhat in Assam and Imphal in Manipur over years and it significant genotype × environment (G×E) interaction was observed. Variance for deviation from regression (S_{di}^2) of varieties C_{2017}, RFS_{175} and Thalaghatapura did not differ significantly from zero. However, the b_i values of only RFS_{175} out of these three is not significantly different from unity and may be considered to be a stable variety with moderate leaf yield. While C_{2017} having b_i value significantly higher than unity is suitable for places like Berhampore, Jorhat and Imphal having positive environmental indices, Thalaghatapura having b_i value significantly lower than unity is suitable for Koraput, Muluk, Ranchi and Kalimpong with negative environmental indices.

Keywords: Location index, mulberry, yield stability

The productivity of a genotype is the function of its adaptability to a particular environment. Stability of a genotype depends on the ability to retain certain morphological and physiological characters along with its production efficiency steadily allowing others to vary resulting in predictable G × E interactions for yield. An improved population can adjust its genotypic and phenotypic states in response to environmental fluctuations in such a way that it can give high and stable yield. The study of individual yield or yield components under certain conditions can lead to simplification in genetic explanation and determination of environmental effects.

Mulberry (*Morus* spp.) is the sole host plant for silkworm (*Bombyx mori* L.). The leaf of this plant is fed to the silkworm during its larval stage. It is a perennial plant and is cultivated by the farmers in a particular field at least for 10-12 years for the production of quality leaves. This plant is cultivated under various environmental conditions like tropical dry, tropical humid and sub-tropical regions. The yield stability in mulberry over a wide range of environments is one of the most desirable parameters to be considered for selecting a mulberry for large-scale cultivation. Sarkar *et al*. (1986) and Bari *et al.* have emphasized that a knowledge of the nature and relative magnitude of the genotype-environment interaction has great importance for selecting superior genotypes to be used commercially in diverse environmental conditions. Stable materials are therefore required to obtain least variability in leaf production per unit area over different locations. Models for estimating G×E interaction have been proposed by several workers. The model of Finlay and Wilkinson (1963); Eberhart and Russel (1966); Perkins and Jinks (1968); Freeman and Perkins (1971), have been used extensively in different plants for estimation of stability. The present study was undertaken to analyze the stability of yield in some promising mulberry varieties to select stable one for commercial exploitation in diverse environments the most.

MATERIALS AND METHODS

Eight newly evolved improved mulberry genotypes (V_1, C_{1730}, C_{2016}, C_{2017}, Anantha, RFS_{175}, Thalaghatapura and Vishala) along with two check varieties (S_{1635} and S_1) were used for the present study. The study was conducted in seven Nos. test centers covering Eastern and North-Eastern parts of India *viz*., Berhampore, Kalimpong, Muluk in West Bengal, Koraput in Orissa; Ranchi in Jharkhand, Jorhat in Assam and Imphal in Manipur. The meteorological details of these places are given in table-1. The plantation was laid in a randomized block design with three replications. The population size for each genotype Nos. A uniform spacing consisted of eighty one individuals of 90×90 cm was taken in all the test centres. Recommended package of practices were followed and data recording initiated after giving 6 months of establishment period. The stability analysis was done by utilizing the Eberhart and Russel (1966) model.

RESULTS AND DISCUSSIONS

Pooled analysis of variance (Table 2) showed that there were highly significant differences among 10 mulberry genotypes for leaf yield over 7 different environments, which indicated presence of wide variation among the genotypes for leaf yield.

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Table 1: Meteorological observations of seven test centers

Particulars	CSR&TI Berhampore	CISR, Jorhat	REC, Imphal	RSRS, Ranchi	RSRS, Kalimpong	RSRS, Koraput	DOS, WB, Muluk
Latitude	24° 6' N	94° 12' N	93° 68' N	22° 21' N	27° 04' N	17° 50' N	23°25 ' N
Longitude	88° 15' E	26° 05' E	25° 6' E	84° 92' E	88° 22' E	81° 27' E	86° 40' E
Altitude (m)	19	97	790	765	975	900	-
Soil type	Gangetic alluvial	Alluvial sandy loam	Alluvial sandy loam	Laterite	Sandy loam	Red laterite	Laterite sandy
Min. Temp (°C)	20.6	20.2	10.2	16.9	16.2	22.8	22.1
Max. Temp (°C)	32.2	28.5	25.2	28.7	23.3	27.7	28.3
Min. RH (%)	61.6	70.5	70.5	46.8	63.5	54.9	69.5
Max. RH (%)	89.5	92.6	85.5	81.3	90.0	74.5	80.3
Rainfall (mm)	1260.5	1748.5	1467.5	1819.5	1669.0	1828.0	1122.4
Rainy days	98	148	140	87	102	90	80

Table 2: Analysis of variance for leaf yield of 10 varieties of mulberry

Source of variations	DF	SS	MSS
Total	69	3450.3	
Variety	9	127.4	14.15**
Location + (Variety × Location)	60	3323.0	
Location (linear)	1	3071.6	
Variety x Location (linear)	9	128.5	14.27**
Pooled Deviation	50	122.9	2.46**
V_1	5	12.3	
C_{1730}	5	22.8	
C_{2016}	5	19.9	
C_{2017}	5	5.9	
Anantha	5	11.9	
RFS_{175}	5	3.2	
Thallaghattapura	5	6.0	
Vishala	5	14.6	
S_{1635}	5	13.5	
S_1	5	12.8	
Pooled Error	140	88.3	0.63

*Note: DF-degrees of freedom, SS- sum of squares, MSS-mean sum of squres,** Significant at 1% level.*

Linear component of genotype × environment interaction was also significant for leaf yield (Table 2). Partitioning of mean squares due to genotype × environment interaction into linear component and residual revealed that major portion of interactions was due to linear component. These two indicate that the genotypes not only exhibited difference in their overall yield performance but also highly responsive to different environments and would help prediction of performance for yield across the environments. Regression coefficient (b_i) and deviation from regression (S_{di}^2) and mean performance in leaf yield (x) are presented in table-3. The range of average leaf yield was observed between 10.57 and 15.34 t ha^{-1} year^{-1}. Five varieties e.g. V_1, C_{2017}, Thallaghattapura, Vishala and S_{1635} were significant for linear regression. The variety with high mean performance, regression co-efficient approaching unity and low deviation from regression was considered to be an average stable variety, which could be expected to perform uniformly well over variable environments. However, a variety having b_i less than unity is suitable for low yielding environments. On the other hand a variety with b_i value more than unity is expected to perform better in high yielding environments. The maximum average stability for leaf yield was exhibited by RFS_{175} followed by C_{2017} and Thalaghattapura respectively (Table 3). The genotype, RFS_{175}, having b_i less than unity (0.93, not significantly different from unity) and low S_{di}^2 (0.02), may be considered to be a stable variety with moderate leaf yield. The varieties S_{1635} and C_{2017} having b_i values (1.36 and 1.27) significantly higher than unity are suitable for places like Berhampore, Jorhat and Imphal having positive environmental indices (Table 4). Thalaghattapura having b_i value (0.73) significantly lower than unity is suitable for Koraput, Muluk, Ranchi and Kalimpong having negative environmental indices.

Table 3: Mean yield of 10 mulberry varieties and stability value

Variety	Mean yield (t ha^{-1} year^{-1})	Regression coefficient (b_i)	Variance for deviation from regression (S_{di}^2)
V_1	11.69 (9)	0.75** (7)	1.82** (5)
C_{1730}	13.33 (5)	0.97(2)	3.93** (10)
C_{2016}	12.49 (8)	1.00 (1)	3.35** (9)
C_{2017}	13.97 (3)	1.27** (8)	0.54 (2)
Anantha	13.40 (4)	0.92(4)	1.74** (4)
RFS_{175}	12.54 (7)	0.93(3)	0.02(1)
Thallaghattapura	10.57 (10)	0.73** (9)	0.58(3)
Vishala	15.34 (1)	1.23*(6)	2.29** (8)
S_{1635}	14.90 (2)	1.36**(10)	2.07** (7)
S_1	13.07 (6)	0.87(5)	1.92** (6)
Mean	**13.13**	**1.00**	**1.83**
SE	**0.64**	**0.09**	**0.63**

*Note: Figures in parentheses indicate the rank. For b_i, lower the ranks, closer to unity. * ** Significant at 5% and 1% level, respectively*

Table 4: Location index of 7 test centers

CSR&TI, Berhampore	CISR, Jorhat	REC, Imphal	RSRS, Ranchi	RSRS, Kalim-pong	RSRS, Koraput	DOS,WB, Muluk
13.15	5.55	1.29	-4.49	-4.17	-5.68	-5.66

Table 5: Leaf yield (t ha^{-1} year^{-1}) at different locations [BPR-Berhampore(WB); KPG-Kalimpong; KPT-Koraput, RNC-Ranchi; JRT-Jorhat; IMF-Imphal; MLK-Muluk (Bolpur)]

Variety	BPR	KPG	KPT	RNC	JRT	IMF	MLK	Mean
MV-1	20.51	7.33	6.65	7.87	15.91	15.58	8.02	**11.69**
MV-2	27.93	8.43	8.27	7.93	15.31	15.37	10.11	**13.33**
MV-3	27.83	8.01	8.43	8.11	15.85	11.27	7.94	**12.49**
MV-4	30.61	8.43	7.43	7.26	22.09	14.15	7.81	**13.97**
MV-5	23.68	9.71	7.98	9.10	20.65	15.92	6.74	**13.40**
MV-6	24.40	9.09	7.54	9.05	18.38	13.37	5.94	**12.54**
MV-7	19.24	6.94	6.85	8.01	16.34	11.28	5.36	**10.57**
MV-8	29.53	10.74	8.22	8.45	24.57	18.35	7.54	**15.34**
NC	34.56	9.51	7.45	10.06	20.55	14.48	7.67	**14.90**
ZC	24.49	11.41	5.70	10.62	17.21	14.47	7.59	**13.07**
Mean	**26.28**	**8.96**	**7.45**	**8.65**	**18.69**	**14.42**	**7.47**	**13.13**

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