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Soil test based fertilization for targeted yields of mulberry

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ABSTRACT

For quantitative evaluation of the efficiency of soil tests and fertilizer response to rainfed mulberry (*Morus alba* L.), variety BC259, through Mitscherlich-Bray equation in the sub-tropical region of West Bengal and Sikkim, two field experiments were conducted at Kalimpong, West Bengal. The Mitscherlich-Bray equation is based on the principle that the native and the added nutrients comprehend different efficiency factors. Results indicated that the greater efficiency of P- and K-fertilizers over soil contributed more share of biomass production from the applied nutrient. And, between P and K, the native soil nutrient supplying efficiency was greater in respect of P than of K. On the basis of soil test values through Mitscherlich-Bray equation, the fertilizer prescription for rainfed mulberry of sub-tropical region of West Bengal and Sikkim has been worked out.

Key Words : Phosphorus and potassium fertilization, rainfed condition, brown forest soil, sub-tropical region, Mitscherlich-Bray concept, theoretical maximum yield.

Mulberry (*Morus alba* L.) leaf is the only source of food for silkworm (*Bombyx mori* L.). The importance of mulberry as a silk crop is reflected in its large-scale cultivation throughout the world. Leaf yield potential and quality of mulberry leaves are greatly influenced by the genotypes, cultivation practices adopted, soil moisture and nutrient status of the mulberry garden soils. In view of the depletion of nutrients, soil moisture availability and irrigation resources, the necessity for soil test based fertilizer application for mulberry has attained significance in recent years. Information on soil test based fertilizer recommendafor achieving sustainable productivity.

MATERIALS AND METHODS

For quantitative evaluation of efficiency of soil tests and fertilizer responses to mulberry (Morus alba L.), variety BC_259, grown under rainfed brown forest soil, through Mitscherlich-Bray equation, two field experiments were conducted with P and K series at Kalimpong, West Bengal. The initial soil characteristics and the concerned references for the analytical methods adopted are presented in Table 1. Mulberry was grown with separate sets of treatments imposed in the different experimental plots of P and K series experiments along with FYM @ 10 mt ha^{-1} $year^{1}$ which are presented in Table 2.

Both the experiments were laid out in RBD with four replications each and the plantations were maintained following the recommended package of practices. Treatments were applied in three equal splits. The NPK were applied in the form of urea, single superphosphate and muriate of potash. Leaf and shoot yield data were recorded crop wise. Annually three crops were harvested. Annual biomass yield was computed by pooling three years' data.

The biomass yield was subjected to Mitscherlich-Bray equation, viz., $\log(A\text{-}y) = \log A - c_1b - cx$, based on the principle that native and added nutrients comprehend different efficiency factors (Bray, 1949).

An approximate estimate of A is the maximum yield obtained. By knowing the values of A, y_0 (yield in control plot) and b (soil test value), c_1 (soil efficiency) can be calculated. After assessing the c_1 value, c (fertilizer efficiency) can be calculated for each level of nutrient added and by making the average of these values, mean c can be obtained. After finding the c_1 and c values, the quantity of nutrients to be added to obtain maximum possible mulberry yield (Bray, 1949) can be worked out for different soil test values.

RESULTS AND DISCUSSION

Quantitative Evaluation of Coefficient of Efficiency Factors

The coefficient of efficiency factors for soil (c_1) and fertilizer (c) were worked out by using Mitscherlich-Bray equation (Tables 3 and 4). On comparing the efficiency of soil and fertilizers, the fertilizer efficiency was greater over the soil efficiency factor for both P and K, which leads one to infer that applied inorganic nutrients could be effectively utilized by mulberry. Between P and K, the native soil nutrient supplying efficiency was greater in respect of P than of K. The reason for

Table 1. Initial characteristics of experimental soils

Characteristics	P-experiment	K-experiment	Reference of the analytical method followed
Texture	Clay loam	Clay loam	Black, 1965
pH (1:2.5)	6.10	6.49	Jackson, 1973
Organic carbon (%)	1.16	1.23	Black, 1965
Alkaline $KMnO_4$-N (kg ha^{-1})	477	567	Subbiah and Asija, 1956
Olsen-P (kg ha^{-1})	50	67	Jackson, 1973
NH_4OAC-K (kg ha^{-1})	221	263	Jackson, 1973

Table 2. Treatments of the experiments

P_2O_5 levels (kg ha^{-1} $year^{-1}$)	K_2O levels (kg ha^{-1} $year^{-1}$)
0	0
15	15
30	30
45	45
60	60
With a common dose of N and K_2O @ 150 kg ha^{-1} $year^{-1}$ and 50 kg ha^{-1} $year^{-1}$	With a common dose of N and P_2O_5 @ 150 kg ha^{-1} $year^{-1}$ and 50 kg ha^{-1} $year^{-1}$

Table 3. Mulberry biomass yield and efficiency coefficients of soil and phosphatic fertilizer

P_2O_5 (kg ha^{-1} $year^{-1}$) applied(x)	Yield (mt ha^{-1} $year^{-1}$) (y)	Calculated log y	1/x	c_1	c	c_1/c
0	17.46	-	-	0.00460	-	
15	19.73	1.2951	0.0667		0.01018	
30	20.73	1.3166	0.0333		0.00806	0.5215
45	21.86	1.3397	0.0222		0.00824	
60	22.85	1.3589	0.0167		0.00880	
Mean				0.00460	0.00882	

Theoretical maximum yield: 25.12 mt ha^{-1} $year^{-1}$

Table 4. Mulberry biomass yield and efficiency coefficients of soil and potassic fertilizer

P_2O_5 (kg ha^{-1} $year^{-1}$) applied(x)	Yield (mt ha^{-1} $year^{-1}$) (y)	Calculated log y	1/x	c_1	c	c_1/c
0	13.81	-	-	0.00093	-	
15	16.14	1.2079	0.0667		0.00512	
30	18.02	1.2558	0.0333		0.00502	0.1802
45	19.99	1.3008	0.0222		0.00543	
60	21.03	1.3228	0.0167		0.00505	
Mean				0.00093	0.00516	

Theoretical maximum yield: 28.18 mt ha^{-1} $year^{-1}$

increased efficiency of added P might be due to the application of FYM, which might have contributed in the formation of organo-complexes with applied P-fertilizer and thus helped in the prevention of fixation of phosphorus by other cations.

Moreover, the increased efficiency of applied K was observed which might be due to the adsorption of K^+ on the decomposition of FYM. The increased efficiency coefficient of applied N was reported earlier by Bangar (1998), which indicated higher share from applied nutrient than soil.

Calibration of Nutrient Requirement Based on Soil Fertility Status

Based on the estimate of efficiency coefficient factors for soil and fertilizer, the factors were fitted into the Mitscherlich-Bray equation for calibrating the quantity of nutrients to be applied based on the soil test value (Table 5). From the Table, it is possible to work out the doses for a given soil test value (b) for obtaining the maximum possible yield (Bray, 1949). Ghosh and Misra (1996) found out the P requirement for a specific yield by knowing the P soil test value and other parameters of this equation, viz., A, c_1 and c.

Fertilizer Recommendations

The site-specific P and K fertilizer recommendations, based on c_1 for b, and c for x through Mitscherlich-Bray equation, were computed based on the percentage of theoretical maximum mulberry biomass yield (Tables 6 and 7) and specific leaf yield target for mulberry (Table 8) for the common range of soil test values from 20 to 100 kg ha^{-1} of Olsen-P and 100 to 500 kg ha^{-1} of NH_4OAC-K, respectively.

With an increase in soil test values for P and K, there was a corresponding decrease in P and K requirements. It is credible to enhance the fertilizer use efficiency and economize its use for sustainable mulberry production. In order to achieve high percentage relative yields, the equation can very well be suited under the conditions of low to high soil fertility. This has an added advantage in determining fertilizer requirements under high buildup of available nutrients in intensive cropping. This could serve as a wonderful tool for fertilizer recommendations for mulberry.

Table 5. Equation for calibration of quantities of nutrients to be applied based on soil test values

Nutrients	Equations
Phosphorus	$\frac{\log A - \log (A\text{-}y) - (0.00460b)}{0.00882}$
Potassium	$\frac{\log A - \log (A\text{-}y) - (0.00093b)}{0.00516}$

Table 6. Phosphatic fertilizer recommendation chart for mulberry

Soil test value	Mulberry biomass yield, % of theoretical maximum		
P_2O_5	70	80	90
(kg ha^{-1})	Fertilizer P_2O_5 (kg ha^{-1} $year^{-1}$) required		
20	49	69	103
40	38	58	93
60	28	48	82
80	18	38	72
100	7	27	61

Table 7. Potassic fertilizer recommendation chart for mulberry

Soil test value P_2O_5 (kg ha^{-1})	Mulberry biomass yield, % of theoretical maximum		
	70	80	90
	Fertilizer P_2O_5 (kg ha^{-1} year^{-1}) required		
100	59	83	117
200	41	65	99
300	23	47	81
400	5	29	63
500	0	11	45

Table 8. Soil-test based fertilizer recommendations for specific leaf yield target (12.00 mt ha^{-1} year^{-1}) for mulberry (variety: BC_259) under rainfed condition for sub-tropical region of West Bengal and Sikkim

Phosphate (P_2O_5)		Potash (K_2O)	
Soil test value (kg ha^{-1})	Requirement (kg ha^{-1} year^{-1})	Soil test value (kg ha^{-1})	Requirement (kg ha^{-1} year^{-1})
20	69	100	83
40	58	200	65
60	48	300	47
80	38	400	29
100	27	500	11

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