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Soil test based sulphur fertilization for targeted yields of mulberry

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ABSTRACT

A field experiment was conducted in Gangetic alluvial soil at Berhampore, West Bengal to calibrate the sulphur requirement for irrigated mulberry, variety S_{1635}, based on soil fertility status. The biomass production of mulberry at different levels of sulphur fertilization was studied. The data were subjected to Mitscherlich-Bray equation to estimate the important parameters responsible for mulberry growth and production, with respect to theoretical maximum yield (A), efficiency factor for soil nutrient (c_1) and efficiency factor for added fertilizer nutrient (c). Based on the soil test value (b) and by utilizing the estimated c_1 and c values, a ready reckoner of sulphur fertilization recommendation for mulberry has been prepared. The greater efficiency of soil nutrient (0.0403) over S-fertilizer (0.011747) suggested the more share of biomass production from the soil nutrient.

Key words: Efficiency factor, irrigated condition, Mitscherlich-Bray concept and ready reckoner,.

Mulberry leaf is the exclusive food for silkworm, *Bombyx mori* L. Application of fertilizers is one of the most efficient means of increasing mulberry productivity. Lack of proper information on fertilizer requirement might cause adverse effects both on soil and mulberry plants causing nutrient toxicity and deficiency either by over-use or through inadequate use. Economic rationality is a more comprehensive approach for fertilizer use, which includes soil test, field research and economic evaluation of results (Velayutham and Reddy, 1990). While increasing the nutrient supply of mulberry through fertilization, attention must be given to the indigenous supply of soil nutrients. A soil test gives the relative amounts of available nutrient status of the soil.

The Mitscherlich-Bray approach is the basis for arriving at such soil test based fertilizer prescription. Substantial reports on the soil test based nitrogen, phosphorus and potassium fertilizers recommendations for targeted yields of mulberry through Mitscherlich-Bray concept are available (Bose and Majumder, 1999; Bose *et al.*, 2006a; Bose *et al.*, 2006b; Bose *et al.*, 2008a; Bose *et al.*, 2008b; Kar *et al.*, 2000). But, no work has so far been done in this respect for sulphur, though it is well established that sulphur influences not only the yield of mulberry leaf, but, also its quality. Hence, an attempt has been made in the present investigation to find out the soil test based S requirement for mulberry grown under irrigated Gangetic alluvial soil of Eastern India to observe the variation in biomass yield of mulberry under varying levels of sulphur fertilizer. Therefore, an attempt has also been made to develop sulphur fertilizer ready- reckoner using Mitscherlich-Bray equation

MATERIALS AND METHODS

For quantitative evaluation of efficiency of soil tests and fertilizer responses to mulberry (*Morus alba* L.), variety S_{1635}, grown under irrigated Gangetic alluvial soil, through Mitscherlich-Bray equation, an experiment was conducted with S series at Berhampore, West Bengal during 2005-2009. The initial soil characteristics and the concerned references for the analytical methods adopted are presented in Table 1. Mulberry was grown with graded levels of sulphur (0, 20, 30 and 40 kg ha^{-1} $year^{-1}$) as ammonium sulphate. All the treatments including the control received equal recommended doses of N, P_2O_5 and K_2O @ 336 : 180 : 112 kg ha^{-1} $year^{-1}$, which were applied in five equal split doses along with FYM @ 20 mt ha^{-1} $year^{-1}$. The NPK were applied in the form of urea, diammonium phosphate and muriate of potash.

The experiment was laid out in RBD with five replications and the plantation was maintained following the recommended package of practices. Treatments were applied in five equal splits. Leaf and shoot yield data were recorded crop wise. Annually five crops were harvested. Annual biomass yield was computed by pooling three years' data. The biomass yield was subjected to Mitscherlich-Bray equation, viz., $\log (A-y) = \log A - c_1 b - cx$, based on the principle that native and added nutrients exhibited 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 derived. After finding the c_1 and c values, the quantity of nutrients to be added to obtain maximum possible mulberry yield (Bray, 1949) have been worked out for different soil test values.

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Table 1: Initial physicochemical characteristics of experimental soil

Characteristics	Status	Reference of the analytical method followed
Texture	Sandy clay loam	Black, 1965
pH (1:2.5)	8.27	Jackson, 1973
EC (dS m^{-1})	0.15	Jackson, 1973
Organic carbon (g kg^{-1})	5.13	Black, 1965
Alkaline $KMnO_4$ –N (kg ha^{-1})	177.0	Subbaiah and Asija, 1956
Olsen-P (kg ha^{-1})	35.0	Jackson, 1973
NH_4OAC –K (kg ha^{-1})	352.0	Jackson, 1973
$CaCl_2$-S (kg ha^{-1})	19.0	Chesnin and Yien, 1951

Table 2 : Mulberry biomass yield and efficiency coefficients of soil and sulphur fertilizer

Sulphur applied (x) (kg ha^{-1} $year^{-1}$)	Yield(y) (mt ha^{-1} $year^{-1}$)	Calculated log y	1 / x	c_1	c	c_1/c
0	55.03	1.7406	---	0.0403	---	
20	59.45	1.7742	0.050		0.01073	
30	61.19	1.7867	0.033		0.01126	3.4307
40	63.04	1.7996	0.025		0.01325	
Mean				0.0403	0.011747	

Theoretical maximum yield (A): 66.40 mt ha^{-1} $year^{-1}$

Table 3. Sulphur fertilizer recommendation (kg ha^{-1} $year^{-1}$) chart on mulberry biomass yield and leaf yield target

Soil test value for sulphur (kg ha^{-1})	Mulberry biomass yield, %			Leaf yield target (37.0 mt ha^{-1} $year^{-1}$)
	85	90	95	
	Fertilizer sulphur (kg ha^{-1} $year^{-1}$) required			
5	53	94	94	94
10	36	76	76	76
15	19	59	59	59
20	2	42	42	42
25	0	25	25	25
30	0	8	8	8
35	0	0	0	0

RESULTS AND DISCUSSION

Quantitative evaluation of coefficient of efficiency factors

The theoretical maximum yield (A) was obtained by extrapolating the plot of log y versus 1/x and subsequent calculations had been done to work out the coefficient of efficiency factors for soil (c_1) and fertilizer (c) (Table 2). Comparing the efficiency of soil and fertilizers, it was observed that the soil efficiency was greater over the fertilizer efficiency factor, which indicated higher share from the soil nutrient than the applied nutrient.

Organic sulphur accounted for 70 to 99 percent of the total sulphur, forming a major fraction (Arora and Takkar, 1988). The lower values of available sulphur may be due to differences in soil environmental conditions, high rainfall and topography which depleted sulphur from the soil rhizosphere. Carbon bonded sulphur constituted 70 percent of organic sulphur which indicate that it forms stable and reserve pool and could only be available after mineralization (Bhogal et al., 1996).

The reason for increased efficiency of soil S might be due to the application of FYM, which might have contributed for mineralization of the soil S during its decomposition.

$$\text{Sulphur requirement} = \frac{\text{Log A} - \log (\text{A} - \text{y}) - (0.0403\text{b})}{0.011747}$$

From the equation, it is possible to work out the doses for a given soil test value (b) for obtaining the maximum possible yield (Bray, 1949). Bose *et al.* (1999, 2006a, 2006b, 2008a, 2008b) earlier found out the N, P and K requirements for specific mulberry leaf yields by knowing the N, P and K soil test values and other parameters of this equation, *viz.*, A , c_1 and c.

Fertilizer recommendation

The site-specific S fertilizer recommendation, based on c_1 for b and c for x through Mitscherlich-Bray equation, was computed based on the percentage of theoretical maximum mulberry biomass yield and specific leaf yield target for mulberry (Table 3) for the common range of soil test values from 5 to 35 kg ha^{-1} of $CaCl_2$–S.

With an increase in soil test values for S, there was a corresponding decrease in S requirement and thus 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.

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