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# Effect of graded doses of potassium on growth, yield and nutrient uptake of mulberry (*Morus alba* L.) in eastern sub-Himalayan region

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## ABSTRACT

*A field experiment was conducted on a brown forest soil having medium level of available K under rainfed condition in the Regional Sericultural Research Station, Kalimpong, West Bengal to study the effect of graded doses of potassium on mulberry (Morus alba L.). Graded doses of potassium (0 to 60 kg $K_2O$ $ha^{-1}yr^{-1}$) along with recommended doses of nitrogen and phosphate were applied. Analysis of three years' pooled data revealed significant positive influence of application of up to 60 kg $K_2O$ $ha^{-1}yr^{-1}$ on growth attributes, yield, nutrient uptake, net return and benefit cost ratio.*

***Key words*** : Mulberry, potassium, rainfed condition, sub-Himalayan region

Mulberry, a deep-rooted perennial plant, is cultivated for its leaves to be used as feed for silkworm larvae. Nutritional quality of mulberry leaves influence the healthy growth of silkworm larvae and thereby good cocoon production (Bongale *et al.*, 1996).

Nutrient deficiency and moisture stress under rainfed conditions during the dought period of the subtropics reduce leaf yield of mulberry to a considerable extent. 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 soil moisture availability and irrigation resources of the sub-tropics, finding out the appropriate doses of nutrients in mulberry has attained significant importance in recent years.

Potassium is essential for normal growth and development of mulberry plants and because of its high requirement by plants and its important physiological role, it has been termed as 'master cation' in plants (Yadav, 1983). Shortage of potassium results in soft branches and poor quality leaves in mulberry (Anonymous, 1988). To obtain optimum mulberry leaf yield, proper quantity of K fertilizer need to be supplied to plants along with nitrogen and phosphatic fertilizers. Therefore, studies were carried out to evaluate the effect of different levels of potassium on growth attributes, yields, nutrient uptake, net return, benefit: cost ratio of mulberry in relation to changes in the nutrient status of soil and the results are presented in this paper.

## MATERIALS AND METHODS

Field experiment was conducted during 2002 - 2005 at Regional Sericultural Research Station, Kalimpong, West Bengal with mulberry (variety $BC_259$) as a test crop planted at 90 cm x 90 cm spacing in a Randomized Block Design with four replications under rainfed condition and maintained following the recommended package of practices.

In addition to FYM at 10 t $ha^{-1}$ $year^{-1}$, 150 kg N and 50 kg $P_2O_5$ $ha^{-1}$ $year^{-1}$were applied through urea and single super phosphate respectively, in all the treated plots. Graded dose of fertilizer K (0, 15, 30, 45 and 60 kg $ha^{-1}$ $year^{-1}$) was applied through muriate of potash in designated plots. Growth attributes, namely, plant height, number of shoots $plant^{-1}$, number of leaves $plant^{-1}$, length of longest shoot, number of nodes $plant^{-1}$ and leaf area were recorded. Leaf and shoot yield data were recorded crop wise. Three crops were harvested annually and the annual yield was computed by pooling three years' data. Nitrogen, phosphorus and potassium contents in leaf were analyzed following standard procedures (Piper, 1966) and the uptake of these nutrients was calculated. Initial and post-harvest soil samples were analyzed following standard procedures (Jackson, 1973; Black, 1965; Subbiah and Asija, 1956). Finally, the benefit : cost ratio has been worked out.

## RESULTS AND DISCUSSION

### Growth attributes

Plant height, length of longest shoot and leaf area were increased significantly over control plots due to the application of 60 kg $K_2O$ $ha^{-1}$ $year^{-1}$. The number of shoots $plant^{-1}$, number of leaves $plant^{-1}$ and number of nodes $plant^{-1}$ showed increasing trend from 30 kg to 60 kg $K_2O$ $ha^{-1}$ $year^{-1}$ over control (Table 2).

### Productivity

The mulberry leaf yield (pooled over three years) increased significantly due to K application from 45 kg to 60 kg $K_2O$ $ha^{-1}$ $year^{-1}$ over control, the maximum being with 60 kg $K_2O$ $ha^{-1}$ $year^{-1}$, whereas the mulberry shoot yield increased significantly due to K application from 15 kg to 60 kg $K_2O$ $ha^{-1}$ $year^{-1}$

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over control, the maximum being with 60 kg $K_2O$ (Table 3). However, moisture contents of leaf and shoot did not increase significantly due to K application (Table 3).

The increase in growth and yield of mulberry may be due to the involvement of potassium in metabolic functions related to enzyme activation, water relations, energy transformations, translocation of assimilates, nitrogen metabolism, protein and starch synthesis (Subbaswamy *et al.*, 2001; Bose *et al.*, 2009).

**Nutrients uptake and ratios**

Application of 30 to 60 kg $K_2O$ $ha^{-1}$ $year^{-1}$ significantly increased the potassium content of leaves and its uptake by mulberry (Table 4). Similar observations have been made by Kumar *et al.* (2007). However, the nitrogen and phosphorus contents and their uptake by mulberry were not significantly influenced by application of potassic fertilizer (Table 4).

The K:N uptake ratio in mulberry leaf varied from 0.459 to 0.552 with the graded doses of K. A synergistic interaction effect coupled with a higher or preferential K uptake, *i.e.*, luxury consumption of K may be responsible for a gradual increase in these ratios (Table 4). The K : P uptake ratio in mulberry leaf varied from 5.001 to 6.240 under various doses of K.

**Soil studies**

The initial physicochemical characteristics of the experimental soil are presented in table 1 and the changes in physicochemical properties of the post-harvest soil are presented in table 5. The pH, EC, organic carbon content of the soil did not show any significant change due to graded levels of potassium addition (Table 5). Available potassium content in the K – added plots increased significantly over control, which corroborates the findings of Yaduvanshi and Swarup (2006). However, its status was statistically on par from 30 kg to 60 kg $K_2O$ $ha^{-1}$ $year^{-1}$. Mulberry, being a deep-rooted crop is capable of mining K from deeper layers of soil; besides leaching of K as well as limited soil moisture conditions prevalent in rainfed areas could be ascribed for such a phenomenon. Available N and P contents in the post-harvest soil showed non-significant change due to K levels. However, a marginal depletion from initial N status was noticed at 60 kg $K_2O$ $ha^{-1}$ $year^{-1}$ and P status was noticed at all the K levels. Depletion in soil N and P status may be attributed to crop utilization, volatilization and fixation loss (Table 5). With the application of increasing doses of potassium the C : K ratio decreased from 0.0242 to 0.0180 at 60 kg $K_2O$ $ha^{-1}$ $year^{-1}$ (Table 5). Moreover, K : N and K : P ratio increased with graded levels of K.

**Economics**

Result indicated that the graded levels of potassium have increased both the gross and net economic returns of mulberry production (Table 6). The maximum gross and net incomes of ₹ 4280.00 and ₹ 3830.00 were obtained by the application of $K_2O$ at 60 kg $ha^{-1}$ $year^{-1}$ (Table 6). The benefit : cost ratio is also maximum in case of 60 kg $K_2O$ $ha^{-1}$ $year^{-1}$ followed by 45 kg $K_2O$ $ha^{-1}$ $year^{-1}$ (Table 6).

In can be inferred from the above studies, that potassium has significant influence on mulberry leaf production and nutrients uptake up to 60 kg $K_2O$ $ha^{-1}$ $year^{-1}$ in the medium K enriched brown forest soils under rainfed condition with the highest additional net income of Rs 3830.00 $ha^{-1}$ $year^{-1}$. As such, 60 kg $K_2O$ $ha^{-1}$ $year^{-1}$ along with recommended doses of N and $P_2O_5$ may be adopted in mulberry gardens existing under rainfed conditions of eastern sub-Himalayan region to get maximum economic return.

**Table 1: Initial physicochemical characteristics of experimental soil**

| Characteristics | Status | Reference of the analytical methods followed |
|---|---|---|
| Texture | Sandy clay loam | Black, 1965 |
| PH (1:2.5) | 6.49 | Jackson, 1973 |
| EC (dS $m^{-1}$) | 0.26 | Jackson, 1973 |
| Organic carbon (g $kg^{-1}$) | 12.30 | Black, 1965 |
| Alkaline $KMnO_4$-N (kg $ha^{-1}$) | 467.00 | Subbiah and Asija, 1956 |
| Bray-P (kg $ha^{-1}$) | 37.00 | Jackson, 1973 |
| $NH_4OAC$-K (kg $ha^{-1}$) | 233.00 | Jackson, 1973 |

Table 2: Effect of different potassium levels on growth attributes of mulberry

| Levels of $K_2O$ (kg $ha^{-1}$ $year^{-1}$) | Plant height (cm) | No. of shoots $plant^{-1}$ | No. of leaves $plant^{-1}$ | Leaf area ($cm^2$ $leaf^{-1}$) | Length of longest shoot (cm) | No. of nodes $plant^{-1}$ |
|---|---|---|---|---|---|---|
| 0 | 161.20 | 5.77 | 79.00 | 238.47 | 115.02 | 92.00 |
| 15 | 167.22 | 6.12 | 86.00 | 243.50 | 117.58 | 100.00 |
| 30 | 172.72 | 6.50 | 94.43 | 251.88 | 117.93 | 110.43 |
| 45 | 174.72 | 6.45 | 92.90 | 252.83 | 119.25 | 111.05 |
| 60 | 215.43 | 6.93 | 97.50 | 294.87 | 167.12 | 115.64 |
| **LSD (0.05)** | **32.12** | **0.45** | **8.19** | **26.93** | **30.54** | **10.33** |

Table 3: Effect of different potassium levels on yields and moisture contents of mulberry

| Levels of $K_2O$ (kg $ha^{-1}$ $year^{-1}$) | Leaf yield (t $ha^{-1}$ $year^{-1}$) | Shoot yield (t $ha^{-1}$ $year^{-1}$) | Leaf moisture (%) | Shoot moisture (%) |
|---|---|---|---|---|
| 0 | 12.04 | 2.96 | 69.17 | 60.59 |
| 15 | 12.55 | 3.57 | 70.52 | 62.34 |
| 30 | 13.09 | 4.12 | 72.19 | 61.72 |
| 45 | 13.63 | 5.36 | 71.70 | 62.09 |
| 60 | 14.18 | 5.55 | 71.86 | 63.50 |
| **LSD (0.05)** | **1.31** | **0.48** | **NS** | **NS** |

Table 4: Effect of different potassium levels on nutrients contents and uptake of mulberry

| Levels of $K_2O$ (kg $ha^{-1}$ $year^{-1}$) | Nutrients concentrations (%) | | | Uptake of nutrients (kg $ha^{-1}$ $year^{-1}$) | | | Nutrient uptake ratio | |
|---|---|---|---|---|---|---|---|---|
| | N | P | K | N | P | K | K : N | K : P |
| 0 | 3.40 | 0.25 | 1.56 | 126.20 | 9.28 | 57.91 | 0.459 | 6.240 |
| 15 | 3.45 | 0.29 | 1.67 | 127.64 | 10.73 | 61.78 | 0.484 | 5.758 |
| 30 | 3.51 | 0.32 | 1.74 | 127.77 | 11.65 | 63.34 | 0.496 | 5.437 |
| 45 | 3.59 | 0.37 | 1.85 | 138.48 | 14.27 | 71.36 | 0.515 | 5.001 |
| 60 | 3.57 | 0.36 | 1.97 | 142.45 | 14.36 | 78.61 | 0.552 | 5.474 |
| **LSD (0.05)** | **NS** | **NS** | **0.17** | **NS** | **NS** | **5.10** | -- | -- |

Table 5: Physicochemical properties of the post harvest soil

| Levels of $K_2O$ (kg $ha^{-1}$ $year^{-1}$) | pH | EC (dS $m^{-1}$) | Organic carbon (g $kg^{-1}$) | Available nutrient contents (kg $ha^{-1}$) | | | Nutrient ratio | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | N | P | K | C : K | K : N | K : P |
| 0 | 6.40 | 0.28 | 12.15 | 480.0 | 42.15 | 211.19 | 0.0575 | 0.440 | 5.01 |
| 15 | 6.28 | 0.30 | 12.07 | 472.0 | 40.20 | 217.33 | 0.0555 | 0.460 | 5.41 |
| 30 | 6.45 | 0.25 | 11.64 | 463.0 | 39.11 | 220.24 | 0.0528 | 0.476 | 5.63 |
| 45 | 6.30 | 0.31 | 12.04 | 452.0 | 37.35 | 228.00 | 0.0528 | 0.504 | 6.10 |
| 60 | 6.32 | 0.27 | 11.88 | 441.0 | 35.52 | 230.40 | 0.0516 | 0.522 | 6.49 |
| **LSD (0.05)** | **NS** | **NS** | **NS** | **NS** | **NS** | **8.81** | -- | -- | -- |

Table 6: Economics of application of different potassium levels to mulberry

| Levels of $K_2O$ (kg $ha^{-1}$ $year^{-1}$) | Increase in leaf yield over control (t) | Increase in monetary return over control (₹) | Cost of treatments (₹) | Net return (₹) | B:C |
|---|---|---|---|---|---|
| 0 | - | - | - | - | - |
| 15 | 0.51 | 1020 | 112.50 | 907.50 | 8.07:1.00 |
| 30 | 1.05 | 2100 | 225.00 | 1875.00 | 8.33:1.00 |
| 45 | 1.59 | 3180 | 337.50 | 2842.50 | 8.42:1.00 |
| 60 | 2.14 | 4280 | 450.00 | 3830.00 | 8.51:1.00 |

*Cost of 1 kg of mulberry leaf is ₹2.00/-*

*Cost of 1 kg of muriate of potash is ₹4.50/-*

**REFERENCES**

Anonymous. 1988. Mulberry Cultivation. FAO, **73/1**, p. 52.

Black, C. A. 1965. Methods of Soil Analysis. Part II. American Society of Agronomy, Inc., Madison, Wisconsin, USA. pp. 849-1378.

Bongale, U. D., Krishna, M. and Chaluvachari. 1996. Effect of multinutrient foliar spray on chlorosis in M5 variety of mulberry. *Indian J. Seric.*, **35**: 9-12.

Bose, P. C., Dash, B. D., Kar, R., and Bajpai, A. K. 2009. Effect of potassium on growth, yield and nutrient uptake of mulberry (*Morus alba* L.) in eastern ghate region of Orissa. *J. Crop and Weed*, **5**: 34-37.

Jackson, M.L. 1973.Soil Chemical Analysis,Prentice Hall of India Pvt. Ltd., New Delhi, pp.53-81.

Kumar, S., Rana, N.S., Chandra, R. and Kumar, S. 2007. Effect of phosphorus and potassium doses and their application schedule on yield, juice quality and nutrient use efficiency of sugarcane – ratoon crop sequence. *J. Indian Soc. Soil Sci.*, **55**: 505 –08.

Piper, C. S. 1966. Soil and Plant Analysis, Hans Publishers, Bombay, pp. 251-01.

Subbaswamy, M. R., Singhvi, N. R., Vedavyasa, K., Srinivasan, E. B. and Sarkar, A. 2001. Non-exchangeable potassium source as a soil testing tool for potassium management in mulberry. *In: Proc. Natl. Sem. on Mul. Seri. Res. India* held on 26-28 November, 2001, Bangalore, pp. 208-12.

Subbiah, B. V. and Asija, G. L. 1956. A rapid procedure for the estimation of available nitrogen in soil. *Curr. Sci.*, **25**: 259-61.

Yadav, R. C. 1983. Sulphate of potash - a quality fertilizer for quality crops. *Farmer and Parliament*, **18:** 14-15.

Yaduvanshi, N. P. S. and Swarup, A. 2006. Effect of long term fertilization and manuring on potassium balance and non-exchangeable K release in a reclaimed sodic soil. *J. Indian Soc. Soil Sci.*, **54**: 203 – 07.