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Short Communication

Response of sweet potato [*Ipomoea batatas* (L.) Lam.] to magnesium sulphate nutrition

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Abstract

An experiment was conducted during September 2019 to December 2019 at the Agronomy Farm, College of Agriculture, Vellanikkara, Thrissur with an objective to assess the influence of $MgSO_4$ application on plant growth and tuber yield of sweet potato. Varied doses of $MgSO_4$ @ 0, 40, 60, 80 and 100 kg/ha were tested together with two levels of $N:P_2O_5:K_2O$. NPK levels were Package of Practices Recommendation (POP) of $N:P_2O_5:K_2O$ (75:50:75 kg/ha) as well as its soil test based application of 65:12:20 kg/ha. There were ten treatment combinations replicated thrice in RBD. The vine length did not differ significantly during the growing period. However dry matter production at harvest (*i.e., shoot* ,tuber and total) ,showed significant difference. In general, all the treatments which received lower $N:P_2O_5:K_2O$ dose of 65:12:20 kg/ha registered lower and comparable dry matter production. Tuber yield was higher at recommended NPK dose of 75:50:75 kg/ha. Application of $N:P_2O_5:K_2O$ @ 75:50:75 together with MgSO4 @ 40 kg/ha resulted in significantly higher yield of 32.91 t/ha, which was 15 per cent higher compared to no magnesium sulphate application.

Key words: Magnesium sulphate, Sweet potato, Tuber yield.

Sweet potato [*Ipomoea batatas* (L.) Lam.] is an important tuber crop cultivated in tropics and warm temperate regions of subtropics from 40^{o}N to 30^o S latitudes. This short duration crop can produce more edible energy per hectare per day than wheat, rice or cassava and has a prominent place in both intensive production systems as well as subsistence farming conditions. It is an important food crop of the world after wheat, rice, maize, potato, barely and cassava (CIP, 2017). It has tremendous potential for utilization in food, feed and industrial sectors.

The nutrient demand of sweet potato is fairly high due to its high production potential. Of the various secondary nutrients, the requirement of calcium is usually met through liming and sulphur is added through various complex fertilizers like ammonium phosphate sulphate. Hence Mg deficiency is more prevalent. It is also documented that Mg deficiency in sweet potato could be the consequence of either low content of Mg in the soil or an oversupply of K and Ca (O'Sullivan et al*.,* 1997). The deficiency of secondary nutrients is generally encountered in highly leached acid soils in Kerala and the blanket recommendation for crops grown in magnesium deficient soils is 80 kg $MgSO_4$/ha. However the requirement may vary depending on crop as well as the level of primary nutrients applied, especially potassium. As the research on supplementation of magnesium sulphate in enhancing the productivity of sweet potato is limited, the study was taken up. The experiment was conducted during the period from September 2019 to December 2019 at Agronomy Farm, College of Agriculture, Vellanikkara, Thrissur. The farm is located in the Agro Climatic Zone (ACZ)-II (Mid laterites). The average maximum temperature during the crop period was 32°C and average minimum temperature was 21.5°C. The total rainfall during the crop period was 226.6 mm.

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Randomized block design (RBD) was adopted with ten treatments and three replications. The plot size was 5.25 m x 3 m, variety used was 'Sree Kanaka' and vines were planted on mounds taken at a spacing of 75 cm x 75 cm. Three vine cuttings were planted per mound. The soil of experimental area was sandy loam with acidic pH (4.9) and electrical conductivity of 0.42 ms/m. The soil was medium in available N (270 kg/ha), high in available P (61 kg/ha) and K (405 kg/ha). The available Mg status in the soil was low (43 mg/kg soil). Treatments T_1 to T_5 were soil test based recommendation of $N:P_2O_5:K_2O$ ie; 65:12:20 kg/ha along with varied dose of $MgSO_4$ *i.e.,* 0,40,60,80 and 100 kg/ha respectively. (As per soil test results, 84% of nitrogen, 25 % of P_2O_5 and 25 % of K_2O of POP recommendation was applied). T_6 to T_{10} received the recommended dose (KAU, 2016) of N:P2O5:K2O (75:50:75) along with varied dose of MgSO4 *i.e.*, 0,40,60,80 and 100 kg/ha respectively.

The field was ploughed twice and cowdung @ 10 t/ha was applied basally at the time of mound preparation and lime @1.5 t/ha was applied one week later and incorporated . The fertilizer nutrients were applied in two split doses. Full dose of P_2O_5 and K_2O with half dose of N were applied at the time of planting. Magnesium sulphate dose was applied at one month after planting along with remaining half dose N, as per the treatments .

Observations on various parameters like vine length, dry matter production (shoot and tuber) and tuber yield of sweet potato were noted and the mean values were worked out. The data collected were subjected to analysis of variance and computed statistically by utilizing statistical package of OP Stat.

Vine length

Vine length was measured at two and three months after planting and significant difference in vine length could not be observed at different stages and the average vine length was 161 cm at 60 DAS and 204 cm at 90 DAP (Table 1). Nitrogen is the major nutrient promoting vegetative growth and the difference in N levels was too narrow (65 &75 kg/ha) to make significant difference in vegetative growth of vine. This also indicate that the vegetative growth was not much affected by magnesium status of soil.

Shoot dry matter production

The observations were recorded at harvest stage of crop. The effect of N:P2O5:K2O doses was evident and in general shoot dry matter production was more in treatments which received $N:P_2O_5:K_2O$ at 75:50:75 (Table 2). The response to varied doses of $MgSO_4$ application also was observed, but only at $N:P_2O_5:K_2O$ application of 75:50:75 kg/ha. Treatment T_6 which received $N:P_2O_5:K_2O$ @ 75:50:75, but no $MgSO_4$ (128 g/plant) was inferior

Table 1. Vine length of sweet potato at different stages of growth

Treatment	Nutrient doses $N : P_2O_5 : K_2O$ (kg/ha) +$MgSO_4$ (kg/ha)	Vine length (cm) 30DAP	60DAP	90DAP
T_1	65: 12: 20 + 0	43.2	115.7	179.7
T_2	65: 12: 20 + 40	44.6	134.3	189.8
T_3	65: 12: 20 + 60	55.8	193.3	233.4
T_4	65: 12: 20 + 80	43.2	150.2	182.2
T_5	65: 12: 20 + 100	40.5	163.1	202.5
T_6	75: 50:75 + 0	46.3	171.1	208.1
T_7	75: 50: 75 + 40	55.6	186.4	222.9
T_8	75: 50: 75 + 60	47.0	155.8	202.1
T_9	75: 50: 75 + 80	45.5	175.1	216.9
T_{10}	75: 50: 75 + 100	52.9	165.4	207.2
		NS	NS	NS

Values followed by same alphabets do not differ significantly

Table 2. Effect of nutrient management on dry matter production of sweet potato

Treatment	Nutrient doses	Dry matter at harvest (g/plant)		
	N : P_2O_5 : K_2O (kg/ha) +$MgSO_4$ (kg/ha)	Shoot dry weight	Tuber dry weight	Total dry weight
T_1	65: 12: 20 + 0	110.1^{cd}	139.3^{de}	249.4^{cd}
T_2	65: 12: 20 + 40	97.6^{d}	121.6^{e}	219.1^{d}
T_3	65: 12: 20 + 60	126.4^{bc}	162.6^{bcd}	289.0^{bc}
T_4	65: 12: 20 + 80	101.2^{d}	149.2^{cde}	250.5^{cd}
T_5	65: 12: 20 + 100	102.3^{d}	134.7^{de}	237.0^{d}
T_6	75: 50: 75 + 0	128.2^{bc}	176.2^{bc}	304.3^{b}
T_7	75: 50: 75 + 40	146.8^{ab}	220.5^{a}	367.3^{a}
T_8	75: 50: 75 + 60	150.9^{a}	150.9^{bcde}	301.9^{b}
T_9	75: 50: 75 + 80	145.2^{ab}	160.6^{bcd}	305.8^{b}
T_{10}	75: 50: 75 + 100	128.9^{abc}	183.9^{b}	312.7^{b}

Values followed by same alphabets do not differ significantly

to T_7, T_8, T_9 and $T_{10,}$ which received varying doses of $MgSO_4$ and the dry matter production in these treatments were in the range of 128.90-150.90 g/ plant. Among the soil test based N:P_2O_5:K_2O application, the treatment differences were narrow and the effect of $MgSO_4$ application was not pronounced. Dry matter production with no $MgSO_4$ application (T1) was comparable to T_5, which received 100 kg $MgSO_4$ (102.29 g/plant). This again shows the limited role of secondary nutrients in deciding shoot growth of sweet potato

Tuber dry matter production

Tuber dry matter (Table 2) showed wide variation from 121.60 g/ plant (T2) to 220.50 g/plant ($T_{7)}$. Here also, the general trend of higher dry matter production (DMP) with application of higher N:P2O5:K2O dose of 75:50:75 could be seen. The treatment which received 40 kg $MgSO_4$ + N:P2O5:K2O @ 75:50:75 was the superior treatment (T7) with DMP of 220.50 g/ plant and varied statistically from all others. No magnesium application resulted in comparable tuber dry matter production to that at 60 and 80 kg, which indicated that there was no response to application of higher doses of Mg. This also indicate that there may be an optimum dose beyond which ionic interactions may affect availability of other nutrients and thus yield (Xie et al., 2021).

Total dry matter production

The dry matter production of shoot and tubers were added to get total dry matter production per plant. It was found that the same trend as in tuber dry matter production was found here also. All the treatments, which received N:P2O5:K2O dose of 65:12:20 were statistically on par, with lower dry matter production ranging from 219.1 g/plant to 289 g/plant irrespective of $MgSO_4$ levels. This can be attributed to the role of primary nutrients in plant dry matter production. The same trend was observed at higher levels of NPK with higher dry matter production compared to lower doses ranging from 301.9 g/plant to 367.30 g/plant.

Tuber yield and Economics

Tuber yield ranged from 19.80 t/ha to 35.91 t/ha (Table 3) with an average productivity of 26 t/ha. Application of N:P2O5:K2O @ 75:50:75 along with 40 kg $MgSO_4$ resulted in the highest yield of 35.91

Table 3. Effect of nutrient management on tuber yield of sweet potato

Treatment	Nutrient doses N : P_2O_5 : K_2O (kg/ha) + $MgSO_4$ (kg/ha)	Tuber yield (t/ha)
T_1	65: 12: 20 + 0	22.68^{de}
T_2	65: 12: 20 + 40	19.80^{e}
T_3	65: 12: 20 + 60	26.48^{bcd}
T_4	65: 12: 20 + 80	24.30^{cde}
T_5	65: 12: 20 + 100	21.93^{de}
T_6	75: 50: 75 + 0	28.68^{bc}
T_7	75: 50: 75 + 40	35.91^{a}
T_8	75: 50: 75 + 60	23.28^{cde}
T_9	75: 50: 75 + 80	26.15^{bcd}
T_{10}	75: 50: 75 + 100	29.95^{b}

Values followed by same alphabets do not differ significantly t/ha, which was statistically superior to all others The next best treatments were T_3, T_6, T_9 and $T_{10,}$ where average yield was 27.75 t/ha. This was 23% low compared to best treatment. Though the treatment $T_{3,}$ which received lower $N:P_2O_5:K_2O$ dose recorded 26.49 t/ha, this in turn was comparable to T_1 which registered tuber yield of 22.70 t/ha with no MgSO4 and which was one among the treatments which were inferior statistically. According to Laxminarayana and John (2014), with application 15, 30 and 45 kg/ha of $MgSO_4$, sweet potato yield increased by 7, 11 and 8% respectively, and the highest mean tuber yield (11.9 t/ ha) and vine yield (18.1 t /ha) was obtained from 30 kg/ ha of MgSO4. AI-Esailyl and EI-Naka (2013) reported that application of magnesium as MgO @ 24 kg/ha significantly increased vine length, fresh and dry weight of plant as well as tuber yield of sweet potato.

The results indicate poor response to applied $MgSO_4$ at lower levels of primary nutrients, especially K. This may be due to poor availability K from soil reserves to meet the immediate demands of the crop, though soil was high in available k. Sweet potato is a short duration crop with high K requirement. Also, tuber initiation starts as early as 4-6 weeks after planting. Hence, the entire dose of K is recommended as basal dose to meet plant demands at early tuber initiation and bulking.

Also, the amount of a nutrient in soil does not reflect the quantity of nutrient available for plant uptake and plant species and even cultivars differ in their sensitivity to nutrient levels in soil. In sweet potato it is reported that in comparison to N or P deficiency, K deficiency has much larger effect on storage root yield than growth of tops and correction of an apparently mild deficiency may result in larger yield increase, as K has major role in starch synthesis as well as translocation

On an average 25% yield increase could be realized with N:P2O5:K2O application @ 75:50:75 compared to lower dose of 65:12:20 kg/ha. A significant and positive effect of applied MgSO4 on tuber yield could be observed only at N:P2O5:K2O level of 75:50:75 along with $MgSO_4$@ 40kg/ha. The higher doses of 60,80 and 100 kg of MgSO4 resulted in lower yield levels. Similar trend of lower tuber yield at higher dose of $MgSO_4$ is reported by Talukder et al. (2009), who found that in potato higher tuber yield was obtained with 10 kg $MgSO_4$ that was on par with 15 and 20 kg $MgSO_4$ and tuber yield tended to decease with increasing rate of Mg application. This may be probably due to antagonism in interaction between K-Mg or some other intricate nutrient interactions in soil (Xie et al., 2021). O'Sullivan et al. (1997) reported that K-Mg ratio is important in plant nutrition as it affect nutrient availability and efficacy of applied K. Hence confirmative trials are needed to arrive at an optimum magnesium dose for sweet potato, in soils deficient in this secondary nutrient.

The cost of Magnesium sulphate fertilizer is Rupees 18 per kg. Hence there is considerable increase in net income as well as B-C ratio (from 3.3 to 4.1), over no magnesium sulphate application at NPK dose of 75:50:75 kg/ha.

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