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Short Communication

Potassium-magnesium interaction in coleus [*Solenostemon rotundifolius* (Poir) J.K. Morton] productivity

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Abstract

An experiment entitled 'Potassium-magnesium interaction in coleus (*Solenostemon rotundifolius*) productivity' was conducted during the period of July to November 2020 at Agronomy Farm, College of Agriculture, Vellanikkara, Thrissur, with an objective to assess the effect of potassium and magnesium sulphate application on tuber yield of coleus. The treatments consisted of twelve combinations of potassium chloride and magnesium sulphate doses laid out in RBD. Potassium (K_2O) was applied at rate of 60 kg/ha (soil test based), 100kg/ha (PoP recommendation) and a check (no potassium). Magnesium sulphate was applied at four doses 0 kg/ha, 10 kg/ha, 20 kg/h and 40 kg/ha. Growth parameters such as plant height, drymatter production of shoot, dry matter production of tubers as well as total dry matter production were significantly influenced by potassium nutrition. However, root to shoot ratio as well as LAI at peak vegetative stage did not vary significantly with potassium application. Dry matter production of both shoot and tuber increased with increasing levels of potassium. Tuber yield was the highest when potassium was applied @ 100 kg/ha followed by potassium application @ 60 kg/ha which differed statistically. Effect of magnesium sulphate application on yield was non significant. However K-Mg interaction effect was significant and the highest tuber yield was registered when K_2O was applied @ 100 kg/ha along with foliar application of $MgSO_4$ @ 10 kg/ha as well as K_2O @ 100 kg/ha with soil application of $MgSO_4$ @ 40 kg/ha which were at par.

Keywords: Coleus nutrition, Magnesium sulphate, Tuber yield

Coleus is a minor tuber crop valued for its tubers with specific aroma that fetch attractive price in the market. Hence, commercial cultivation of this short duration crop for itsvegetative purpose is common. As in the case of other tuber crops, balanced nutrition is the key to attain higher productivity and profitability in coleus production. A short crop growth period of 120 -150 days makes timely supply of nutrients especially potassium as it has a crucial role in starch synthesis as well as translocation. Deficiency of secondary nutrients especially magnesium is reported from soils of Kerala. Moreover, many research findings indicate that magnesium deficiency in plants may be not only due to low magnesium status of soil, but due to interaction of magnesium with potassium, both of which are antagonistic in reaction. This emphasizes the importance of balanced supply of potassium and magnesium especially in ashort duration tuber crop like coleus where tuber initiation and bulking starts at early stage of crop growth and development. Hence the present study was undertaken to know the effect of varied dose of K_2O and $MgSO_4$ on tuber yield of coleus. A blanket recommendation for magnesium deficient soils of Kerala is application of 80 kg of $MgSO_4$/ha irrespective of crop (KAU, 2016).

The field experiment was conducted from July 2020 to November 2020 at Agronomy Farm, College of

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Agriculture, Vellanikkara, Thrissur, located at 10^0 31'N latitude and 76^0 13'E longitude at an altitude of 40.3 m above the mean sea level. The area experiences a tropical humid climate with maximum and minimum temperature ranging between 30.2-33.0^0 C and 21.9-23.1^0 C respectively. The total rainfall received during the entire crop period was 2124.7mm. The soil of the experiment site was well-drained, sandy clay loam texture, acidic in reaction (pH 5.2). The organic carbon content of soil was 0.88% (medium), nitrogen– 113kg/ha (low) and phosphorus -78 kg/ha (high). Soil test before planting coleus indicated medium potassium status of 256 kg/ha and low in magnesium (63 mg/kg).The treatments consisted of twelve different combinations potassium (K_2O) and magnesium sulphate ($MgSO_4$) which was replicated thrice in RBD design. Potassium (K_2O) was applied @ 60 kg/ha [initial potassium status of soil was medium (256 kg/ha) so 60% of the recommended dose of potassium as per PoP was given], @ 100 kg/ha (PoP recommendation) and a check (no potassium). Magnesium sulphate was applied at the rate of 10 kg/ha, 20 kg/ha, 40 kg/ha and a control (no MgSO4). Lower dose of magnesium sulphate (10 kg/ha), was applied as foliar spray (2 per cent spray) at 30 DAP as the quantity was too small for soil application. The other two doses of MgSO4 (20 and 40 kg/ha) was applied in soil as single split application. N and P_2O_5 were applied as per PoP recommendation @ 60:60 kg/ha. Half quantity of K and full P was applied basally and the remaining half of K_2O at 45 DAP along with N. A high yielding coleus variety Nidhi (4–5month duration) was used for the study.

Coleus vine cuttings of 15-20 cm length were collected from nursery and two rows of vine cuttings were planted in beds of width 60cm at a spacing of 30 cm x 15cm. Observations on biometric parameters, chlorophyll content, yield and dry matter production of coleus were recorded and the mean values were worked out. The plant height was measured from collar region near the ground to the tip of growing apical bud of vine. Dry matter accumulation per vine was recorded at 60, 90 DAP by destructive sampling of random plants. After uprooting plants they were washed and dried under shade and then oven dried at 70±5p C to contant weight. Dry weight at harvest stage was found out by adding weights of aerial and underground tubers and was expressed in grams per plant. This was multiplied with plant population to get dry matter production and expressed as kg/ha. Leaf area index (LAI) was estimated by uprooting sample plants from each plots at active vegetative stage. Total number of leaves was counted. The length and breadth of few leaves from each plant were measured and leaf area was calculated by using factor method. The average leaf area per leaf was multiplied with total number of leaves to get total leaf per vine (cm^2). Total leaf area was calculated and divided by spacing to get leaf area index. Root to shoot ratio was recorded by collecting fresh weight of shoot and root was separately recorded at 30 and 60 DAP and the ratio was worked out. Atharvest root and shoot ratio was worked out on dry weight basis. Leaf chlorophyll content at peak growth stage was estimated using DMSO method and expressed as mg/g fresh weight of leaf. Tuber weight was recorded from each treatment plot and expressed as tuber yield (t/ha).

Plant height was significantly influenced by potassium application. Taller plants were observed with potassium application @ 60 and 100 kg/ha at 60 DAP. But at 90 DAP lower value of plant height was registered at higher level of 100 kg/ha K2O. Islam et al. (2014) reported that plant height of potato decreased at later stages of growth with increasing levels of potassium application. However, Geetha and Nair (1993) reported that application of potassium at 120 kg/ha did not show much effect on plant height of coleus. Magnesium sulphate application also influenced plant height. At 90 DAP, taller plants were observed in plots which received $MgSO_4$ @ 40 kg/ha. Deficiency of magnesium resulted in stunted growth in sugarbeet (Hermans et al., 2004). Interaction of potassium and magnesium sulphate was significant only at 60 DAP. At 60 DAP maximum height was observed in treatment combination of K_2O @ 60kg/ha with no $MgSO_4$ application and K_2O at 100 kg/ha with $MgSO_4$@10 kg/ha and they were comparable statistically.

Plant growth and yield depend on leaf area as well as the total vegetative growth putforth by plants to a greater extent. Observation on leaf area index (LAI) suggests that both potassium and magnesium sulphate application did not bring about much variation in LAI of coleus. LAI of coleus was recorded at active growth stage (60 DAP) and data is presented in Table 1. Different levels of potassium and magnesium sulphate application didn't significantly influence LAI of coleus. Interaction effect of potassium and magnesium sulphate was also nonsignificant with respect to LAI of coleus. Similar results were obtained in study conducted by Geetha and Nair (1993) were application of potassium didn't influence plant spread and leaf area index of coleus. Contradicting to the results Th. Nengparmoi (2020) found that upon increasing levels of potassium LAI showed a positive response in sweetpotato.

Dry matter production of shoot, dry matter production of tubers as well as total dry matter production were significantly influenced by potassium application. Dry matter production (DMP) of coleus shoots increased with increasing levels of K2O. At 60 DAP and at harvest, plants

Table 1. Plant height and dry matter production of coleus as influenced by potassium and magnesium sulphate application

Treatment		Plant height (cm)		Root to shoot ratio	Leaf area index
		60 DAP	90 DAP	60 DAP	60 DAP
K_2O	0kg/ha	42.50[b]	75.91[a]	0.13	8.46
	60kg/ha	49.80[a]	70.75[a]	0.14	11.52
	100kg/ha	47.75[a]	61.33[b]	0.11	9.59
C.D(0.05)		2.94	3.74	NS	NS
$MgSO_4$	0kg/ha	51.11[a]	68.11[b]	0.12	10.21
	10kg/ha	49.56[a]	67.33[b]	0.10	9.75
	20kg/ha	42.16[b]	68.11[b]	0.16	10.31
	40kg/ha	43.88[b]	73.77[a]	0.13	9.17
C.D (0.05)		3.40	4.32	NS	NS

In a column, means followed by common letters donot differ significantly at 5% level in DMRT. DAP-Days after planting

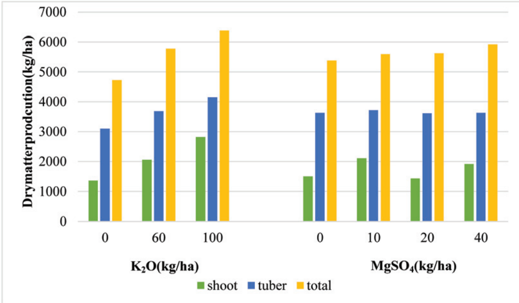

Figure 1. Effect of K_2O and $MgSO_4$ on dry matter production of coleus at harvest

which received 60 or 100 kg/ha potassium recorded higher and comparable shoot DMP compared to no K_2O application. At 60 DAP, higher DMP of 2115 kg/ha was obtained with the foliar application of $MgSO_4$ (10 kg/ha) and this was on par with soil application of 40kg/ha of $MgSO_4$. Magnesium sulphate application did not show any significant influence on DMP at 90 DAP. However at harvest, aerial DMP with the application of 40 kg $MgSO_4$ was superior compared to other rates.

Application of K_2O @ 100 kg/ha recorded higher DMP of tuber and total DMP over other K levels (Fig. 1). Effect of magnesium sulphate application on dry matter production of tuber and total dry matter production was not significant. However interaction effect of potassium and magnesium sulphate was significant with respect to tuber DMP. Higher values were registered when 100 kg/ha of K_2O was applied along with foliar application of 10 kg $MgSO_4$ and soil application of 40 kg/ha MgSO4. This might be due to the role of potassium in nutrient uptake and translocation. Higher doses of K, increased the availability of K to plants which in turn increased the drymatter production and further translocation of assimilates to the tuber bulk. Enyi (1972) in a study conducted in *Dioscorea esculenta* found a positive influence of potassium on tuber yield and attributed this to the greater leaf area and leaf duration that enhanced transfer of assimilates for tuber bulking.

Tuber yield increased significantly with increase in rate of potassium applied and showed an increase

Table 2. Interaction effect of K and $MgSO_4$ on dry matter production of tuber

Treatment	MgSO$_4$(kg/ha)				Mean	K_2O
	0	10	20	40		
K_2O (kg/ha)	0	3,301	3,356	3,160	2,573	3,097
	60	3,791	3,307	3,779	3,843	3,680
	100	3,783	4,469	3,891	4,463	4,152
Mean $MgSO_4$	3,625	3,711	3,610	3,626		

Table 3. Interaction effect of K and $MgSO_4$ on yield of tuber

Treatment	MgSO$_4$(kg/ha)				Mean	K2O
	0	10	20	40		
K_2O (kg/ha)	0	10.71	12.64	13.16	13.75	12.91
	60	13.60	13.78	15.75	16.64	15.33
	100	12.79	19.01	16.21	19.36	17.30
Mean $MgSO_4$	15.10	15.46	15.04	15.11		

of 19 per cent when 100 kg of K_2O was applied compared to control (13.80, 14.94 and 16.46 t/ha, at 0, 60 & 100 kg/ha K_2O, respectively). Application of K_2O at the rate of 120 kg/ha had yielded highest tuber yield in coleus (Geetha and Nair, 1993).

Various levels of magnesium sulphate applied did not show any influence on tuber yield. Putz et al. (1976) reported that application of magnesium in potato had increased tuber yield by 10 per cent. They also stated that magnesium is required in adequate amounts for tuber bulking and if soil is deficient in magnesium foliar application will be beneficial. Talukder et al., (2009) also found that foliar application of 10 kg/ha of $MgSO_4$ increased yield in potato and this was on par with 15 and 20 kg/ha of $MgSO_4$. Further increasing dosage tend to decrease tuber yield. Similar results were obtained by John et al. (2015) in a long term fertilizer experiment conducted in cassava and reported that $MgSO_4$ application at 20 kg/ha positively influenced tuber yield. Generally application of magnesium fertilizers increased yield of most of the tuber crops but it can vary depending on crop species (Wang et al., 2019). However, interaction effect of K_2O–$MgSO_4$ was significant and best combination was 100 kg of K_2O along with foliar application of $MgSO_4$ @ 10 kg/ha or 40 kg/ha which was on par with K_2O @60 kg along with $MgSO_4$@40 kg/ha of.

Net returns as well as B-C ratio were higher for K_2O application@ 100 kg/ha along with soil application of $MgSO_4$@ 40kg/ha or foliar

Table 4. Plant height, Dry matter production, Leaf chlorophyll content,Yield, Netreturns, B:Cratio as influenced by potassium-magnesium interaction in

Treatment (K_2O x $MgSO_4$)		Dry matter production tuber (kg/ha)	Tuberyield (t/ha)	Net returns (₹/ha)	B:C ratio
0kg/ha	0kg/ha	3,301[f]	10.71[f]	1,84,520	2.3
	10kg/ha	3,356[e]	12.64[ef]	2,53,370	2.6
	20kg/ha	3,160[g]	13.16[def]	2,49,872	2.7
	40kg/ha	2,573[h]	13.75[cdef]	2,65,379	2.8
60kg/ha	0kg/ha	3,791[d]	13.60[cdef]	2,61,484	2.7
	10kg/ha	3,307[f]	13.78[cde]	2,65,786	2.8
	20kg/ha	3,779[d]	15.75[cde]	3,23,592	3.1
	40kg/ha	3,843[c]	16.64[abc]	3,48,292	3.3
100kg/ha	0kg/ha	3,783[d]	12.79[ef]	1,93,918	2.3
	10kg/ha	4,469[a]	19.01[ab]	4,21,420	3.8
	20kg/ha	3,891[b]	16.21[bcd]	3,36,322	3.2
	40kg/ha	4,463[a]	19.36[a]	4,28,626	3.8
CD(0.05)	691	2.89			

*In a column, means followed by common letters donot differ significantly at 5%level in DMRT. DAP- Days After Planting application@10 kg/ha. The results of the study indicated that potassium applied at the rate of @100 kg/ha, even in soils with medium status of available K wa s better to increase the productivity of coleus. Also, K-Mg balance is important in coleus productivity in soils deficient in magnesium. It can be concluded that potassium at the rate of @100 kg/ha with $MgSO_4$ @10 kg/ha (foliars pray at 30 DAP) or 40 kg/ha (soil application at 30 DAP) can be recommended for higher yield, productivity and profitability of coleus cultivation in soils deficient in magnesium and medium in available K.

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