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Effect of potassium nutrition on yield, quality and economics in groundnut (*Arachis hpogaea* L.) in a Vertisol

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Abstract
A field experiment was conducted during *kharif*, 2016 at the Main Agricultural Research Station, Farm, University of Agricultural Sciences, Dharwad. The experiment was laid with twelve treatments replicated thrice in Randomized Block Design. The soil reaction was near neutral and electrical conductivity was under safer limit with clay texture. Pod yield in groundnut was not significantly influenced by different potassium nutrition treatments. However, split application of 150 per cent recommended dose of potassium (RDK) through muriate of potash in combination with 2 per cent foliar spray of potassium sulphate on 60 DAS recorded higher pod yield (3617 kg ha^{-1}) closely followed by basal application of 150 per cent RDK along with 2 per cent foliar spray of potassium sulphate. The control with recommended package of practices recorded the lowest pod yield (3009 kg ha^{-1}). Split application of 150 per cent RDK along with foliar spray of SOP at 2.0 per cent significantly enhanced oil (47.84 %) and protein (37.98 %) contents in kernel closely followed by the application of basal dose of 150 per cent RDK plus 2 per cent foliar spray. RPP recorded the lower values (oil- 45.10%, protein- 35.53%). The treatment with 150 per cent RDK through muriate of potash in split (half as basal + half at 30 DAS) plus 1 per cent foliar spray through potassium sulphate at 60 DAS (T_8) recorded higher B:C ratio (2.65) whereas control recorded the lowest B:C ratio (2.28).

Keywords: Economics, Groundnut, Quality, Pod yield, Potassium

Introduction
Potassium (K^+) is one of the essential nutrients for plant growth and vital for sustaining productivity in agriculture. Plants need large quantities of potassium, as much as, or even more than nitrogen. Potassium improves economic crop produce and its quality. Thus, application of potassium fertilizer results in higher value to product and therefore greater return to the farmer. Groundnut crop responds well to potassium (K) application and addition of K increases its concenn at all growth stages. In groundnut the concentration of potassium is higher in initial growth stages and declines at later stages indicating that, crop absorbs potassium rapidly in early stages of growth which impairs the availability of potassium at later stages of crop. Hence, an attempt is being made to increase the potassium use efficiency through foliar application of K fertilizer (K_2SO_4) along with split application of MOP. Foliar application of sulphate of potash not only reduces the cost of fertilizer but also helps to improve the yield and improves the quality of oil and protein by efficient absorption of potassium and sulphur.

Material and methods
A field experiment was conducted at the Main Agricultural Research Station, Farm, University of Agricultural Sciences, Dharwad during *kharif*, 2016 on a Vertisol. The soil of the experimental field was clay in texture, with pH 7.80 and EC of 0.32 dS m^{-1}. The organic carbon, free lime, available nitrogen, phosphorus, potassium and sulphur contents were 6.20g kg^{-1}, 5.36per cent, 180.30 kg ha^{-1}, 36.64 kg ha^{-1}, 372.00 kg ha^{-1} and 25.63 kg ha^{-1}, respectively. The experiment was laid out in randomized complete block design with twelve treatments and three replications. Treatments included were split application of 100 and 150 per cent recommended dose of potassium through muriate of potash on 30th days after sowing and foliar application of potassium sulphate at 1.0 and 2.0 per cent concentration on 60th days after sowing. Part of nitrogen was applied through Urea and DAP, while the entire dose of P and K were applied through DAP and MOP, respectively. The entire quantity of fertilizer mixture containing entire dose of nitrogen and phosphorus were applied to each plot at the time of sowing. Kernel oil and protein contents were determined by nuclear magnetic resonance (NMR) spectrometer against a standard reference sample and expressed in per cent.

Economic analysis was calculated based on the prevailing price of inputs used and produce obtained during the year 2016, the net profit per hectare and benefit cost ratio were worked out by using the following formulae.

Net profit (ha^{-1}) = Gross income (ha^{-1}) - Cost of cultivation (ha^{-1})

$$\text{Benefit: Cost (B:C)} = \frac{\text{Gross income (ha}^{-1})}{\text{Cost of cultivation (ha}^{-1})}$$

Results and discussion

Pod yield

Data indicated that (Table-1) various potassium nutrition treatments had non-significant effect on pod yield of groundnut. However, numerically higher pod yield of 3617 kg per ha was recorded in the treatment with 150 per cent RDK in split along with 2 per cent foliar nutrition of potassium sulphate at 60 DAS (T_{12}) and was closely followed by T_8 (3610 kg ha^{-1}), T_{11} (3574 kg ha^{-1}) and T_4 (3564 kg ha^{-1}). The split application of potassium through MOP at 30 DAS can meet the potassium requirement of the groundnut crop at the critical stage when flowers are developing and favor the retention of more flowers ultimately leading to more number of reproductive parts per plant and hence increases the yield (Der *et al*., 2015) [1]. Control with 100 per cent RDK as basal (T_1) recorded the lower pod yield (3009 kg ha^{-1}) in groundnut. This indicates that applying entire dose of potassium at the time of sowing results in considerable loss of potassium because of its fixation in soil dominated by smectite group of clays in Vertisol. This is obvious because of the lower availability of potassium at the later stages of crop which might reduce the uptake of nutrients by the groundnut crop (Madkour *et al*., 1992) [2].

Haulm yield

Data indicated that (Table-1), haulm yield in groundnut was significantly influenced by different potassium nutrition treatments. Haulm yield in groundnut ranged from 3955 to 4578 kg per ha. The higher haulm yield (4578 kg ha^{-1}) was recorded in the treatment that received 150 per cent RDK through MOP in split (half as basal + half at 30 DAS) in combination with 2 per cent foliar spray at 60 DAS (T_{12}) and was significantly superior over control (3955 kg ha^{-1}) with 100 per cent RDK through MOP by basal (T_1) and was on par with rest of the treatments. The higher haulm yield in groundnut crop was attributed to the beneficial effect of readily available forms of nutrients to the crop which were supplied through foliar spray. These nutrients were directly absorbed by plant either through cuticle or stomata and might have participated in photosynthesis activity in leaves of plant leading to increased haulm yield. Foliar spray of nutrients to the crop resulted in timely supply of optimum quantity of nutrients to the plant and their subsequent absorption by groundnut leaves resulting in better assimilation and translocation of nutrients (Mekki, 2015) [3].

Table 1: Effect of potassium nutrition on yield of groundnut (GPBD-4)

Treatments	Pod yield (kg ha^{-1})	Haulm yield (kg ha^{-1})
T_1: RDK by basal	3009	3955
T_2: RDK ½ by basal + ½ at 30 DAS	3319	4463
T_3: 150% of RDK by basal	3409	4479
T_4: 150% of RDK ½ by basal + ½ at 30 DAS	3564	4482
T_5: RDK by basal + 1.0% K_2SO_4 spray at 60 DAS	3078	4055
T_6: RDK ½ by basal + ½ at 30 DAS + 1.0% K_2SO_4 spray at 60 DAS	3346	4494
T_7: 150% of RDK by basal + 1.0% K_2SO_4 spray at 60 DAS	3518	4502
T_8: 150% of RDK ½ by basal + ½ at 30 DAS + 1.0% K_2SO_4 spray at 60 DAS	3610	4528
T_9: RDK by basal + 2.0% K_2SO_4 spray at 60 DAS	3123	4254
T_{10}: RDK ½ by basal + ½ at 30 DAS + 2.0% K_2SO_4 spray at 60 DAS	3452	4528
T_{11}:150 % RDK by basal + 2.0% K_2SO_4 spray at 60 DAS	3574	4538
T_{12}: 150% of RDK ½ by basal + ½ at 30 DAS + 2.0% K_2SO_4 spray at 60 DAS	3617	4578
S. Em. ±	215	235
C. D. (0.05)	NS	545
C. V. (%)	13.56	14.48

RDK – Recommended dose of potassium DAS – Days after sowing NS – Non-significant

Quality

The oil and protein contents of groundnut were significantly influenced by different potassium treatments (Table 2). The higher oil (47.84 %) and protein (37.98 %) contents in groundnut kernels were observed in the treatment which received split application of 150 per cent RDK through MOP plus 2 per cent foliar spray at 60 DAS (T_{12}) and the extent of increase was 6.07 and 6.89 per cent, respectively over control. The increase in oil content in groundnut kernels might be due to the enhanced activity of malic dehydrogenese enzyme which helps in the synthesis of fatty acids such as malate and oxaloacitate in groundnut kernels thus, resulting in the enhanced oil content (Singh, 2007) [5]. Split application of 150 per cent RDK in one split along with foliage nutrition of potassium sulphate increased the protein content in groundnut kernel and was attributed to the role of potassium in facilitating the uptake as well as assimilation of nitrogen into simple amino acids and amides which enhanced the peptide synthesis and led to protein synthesis (Umar and Moinuddin, 2002).

Table 2: Effect of potassium nutrition on quality of groundnut

Treatments	Oil content (%)	Protein content (%)
T_1: RDK by basal	45.10	35.53
T_2: RDK ½ by basal + ½ at 30 DAS	45.34	35.84
T_3: 150% of RDK by basal	47.28	37.34
T_4: 150% of RDK ½ by basal + ½ at 30 DAS	47.30	37.48
T_5: RDK by basal + 1.0% K_2SO_4 spray at 60 DAS	45.38	36.49
T_6: RDK ½ by basal + ½ at 30 DAS + 1.0% K_2SO_4 spray at 60 DAS	46.48	36.89
T_7: 150% of RDK by basal + 1.0% K_2SO_4 spray at 60 DAS	47.32	37.50
T_8: 150% of RDK ½ by basal + ½ at 30 DAS + 1.0% K_2SO_4 spray at 60 DAS	47.52	37.73
T_9: RDK by basal + 2.0% K_2SO_4 spray at 60 DAS	46.94	37.01
T_{10}: RDK ½ by basal + ½ at 30 DAS + 2.0% K_2SO_4 spray at 60 DAS	47.28	37.33
T_{11}:150 % RDK by basal + 2.0% K_2SO_4 spray at 60 DAS	47.64	37.89
T_{12}: 150% of RDK ½ by basal + ½ at 30 DAS + 2.0% K_2SO_4 spray at 60 DAS	47.84	37.98
S. Em. ±	0.74	0.61
C. D. (0.05)	2.18	1.79
C. V. (%)	10.96	8.42

RDK – Recommended dose of potassium DAS – Days after sowing NS – Non-significant

Economics in groundnut

Gross and net returns in groundnut were influenced by different potassium nutrition treatments (Table 3). The treatment with 150 per cent RDK through MOP in split (half as basal + half at 30 DAS) plus 1 per cent foliar spray through SOP at 60 DAS (T_8) recorded higher gross (Rs. 1,51,592 ha^{-1}) and net (Rs. 94,449 ha^{-1}) returns with higher B:C ratio (2.65) and was closely followed by T_{12} which received150 per cent RDK through MOP in split (half as basal + half at 30 DAS) plus 2 per cent foliar spray through SOP at 60 DAS (gross return: Rs. 1,51,547 ha^{-1}, net return: Rs. 94, 194 ha^{-1} and B:C ratio 2.64). This might be due to higher economic yield obtained in this treatment. These results are in conformity with the findings of Srinivasrao (2013) [6] and Mohapatra *et al*. (2013) [4] in groundnut.

Table 3: Effect of potassium nutrition on economics in groundnut (GPBD-4)

Treatments	Cost of cultivation (Rs. ha^{-1})	Gross returns (Rs. ha^{-1})	Net returns (Rs. ha^{-1})	B: C ratio
T_1: RDK by basal	55,376	1,26,293	70,917	2.28
T_2: RDK ½ by basal + ½ at 30 DAS	55,976	1,39,455	83,479	2.49
T_3: 150% of RDK by basal	55,733	1,43,079	87,346	2.57
T_4: 150% of RDK ½ by basal + ½ at 30 DAS	56,333	1,48,171	91,838	2.63
T_5: RDK by basal + 1.0% K_2SO_4 spray at 60 DAS	56,186	1,29,203	73,017	2.30
T_6: RDK ½ by basal + ½ at 30 DAS + 1.0% K_2SO_4 spray at 60 DAS	56,786	1,40,581	83,795	2.48
T_7: 150% of RDK by basal + 1.0% K_2SO_4 spray at 60 DAS	56,543	1,47,473	90,930	2.61
T_8: 150% of RDK ½ by basal + ½ at 30 DAS + 1.0% K_2SO_4 spray at 60 DAS	57,143	1,51,592	94,449	2.65
T_9: RDK by basal + 2.0% K_2SO_4 spray at 60 DAS	56,396	1,31,301	74,905	2.33
T_{10}: RDK ½ by basal + ½ at 30 DAS + 2.0% K_2SO_4 spray at 60 DAS	56,996	1,44,872	87,876	2.54
T_{11}:150 % RDK by basal + 2.0% K_2SO_4 spray at 60 DAS	56,753	1,49,767	93,014	2.64
T_{12}: 150% of RDK ½ by basal + ½ at 30 DAS + 2.0% K_2SO_4 spray at 60 DAS	57,353	1,51,547	94,194	2.64

RDK – Recommended dose of potassium DAS – Days after sowing

Conclusion

- Split application of 150 per cent RDK through muriate of potash in combination with 2 per cent foliar spray of potassium sulphate at 60 DAS improved the pod yield and quality of groundnut. This also resulted in higher net returns and B:C ratio.

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