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Effect of sources, levels and methods of application of potassium on yield, quality and nutrients concentration in index leaves of groundnut

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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. Pod yield in groundnut was not significantly influenced by different potassium nutrition treatments. However, split application of 150 per cent RDK, half as basal and half at 30 DAS through muriate of potash with 2 per cent foliar spray of potassium sulphate at 60 DAS recorded highest pod yield (3,617 kg ha^{-1}) closely followed by basal application of 150 per cent RDK along with 2 per cent foliar spray of potassium sulphate (3,574 kg ha^{-1}). Split application of 150 per cent RDK through MOP plus 2 per cent foliar spray of SOP at 60 DAS significantly enhanced the oil (47.84 %) and protein (37.98 %) contents in kernel with 6.07 and 6.89 per cent increase, respectively over control. Major nutrients concentration in the index leaves of groundnut did not vary significantly due to split application of potassium. Foliar application of potassium sulphate either at 1.0 or 2.0 per cent concentration significantly increased their concentration in the index leaves of groundnut. The pod yield and quality showed a significant positive correlation with the nutrient concentrations (N, P, K and S) in index leaves before and after foliar application of SOP.

Keywords: Correlation**,** groundnut, index leaves, nutrients, pod yield, potassium, quality

Introduction

Plants require nutrients for the normal maintenance of their physiological and biochemical processes. The available amount of these elements is often insufficient in soils and must be supplied as fertilizers, essential inputs for the successful crop production. Among the three major nutrients, potassium (K) has a special position as evident by its role in increasing the crop yield by adding tolerance to various biotic and abiotic stresses. Potassium plays a major role in growth and yield as it is involved in assimilation, transport and storage tissue development. Potassium as a macronutrient is required directly or indirectly for several metabolic functions of plant such as in photosynthesis, protein synthesis and activation of several enzymes.

Groundnut is an unpredictable legume, since its response to nutrient application is always not optimistic. Groundnut crop responds well to potassium (K) application and addition of K increases its concentration at all growth stages. But, the existing practice of applying entire dose of K at the time of sowing results in considerable loss because of its fixation in soil dominated by smectite group of clays. This affects the potassium availability to crops thus resulting in reduction of yield. Therefore, split application of muriate of potash increases the availability of potassium and enhances K use efficiency.

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 [1, 2] on a Vertisol. The soil of the experimental field was clay texture (Typic Haplustert) 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. The gross and net plot size were 3.6 × 3.0 m and 3.0 × 2.8 m, respectively. Treatments included were split application of 100 and 150 per cent recommended dose of potassium through muriate of potash on 30^{th} days after sowing and foliar application of potassium sulphate at 1.0 and 2.0 per cent concentration on 60^{th} 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. At harvest pod and haulm yields were recorded. Kernel oil and protein contents were determined by nuclear magnetic resonance (NMR) spectrometer against a standard reference sample and expressed in per cent. In groundnut index leaf tissues were collected from recently matured leaflets with 25 sample size at maximum branching growth stage. The nitrogen content in kernel was estimated by Micro Kjeldahl method (Tandon, 1998) [5], phosphorus content by Diacid digestion followed by vanado molybdophosphoric yellow colour method (Tandon, 1998) [5], potassium content by Diacid digestion followed by Flame photometery (Tandon, 1998) [5] and sulphur content by Diacid digestion followed by Turbidimetery (Tandon, 1998) [5].

Results and Discussion

Pod Yield

Data indicated that (Fig 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) [3]. 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) [4].

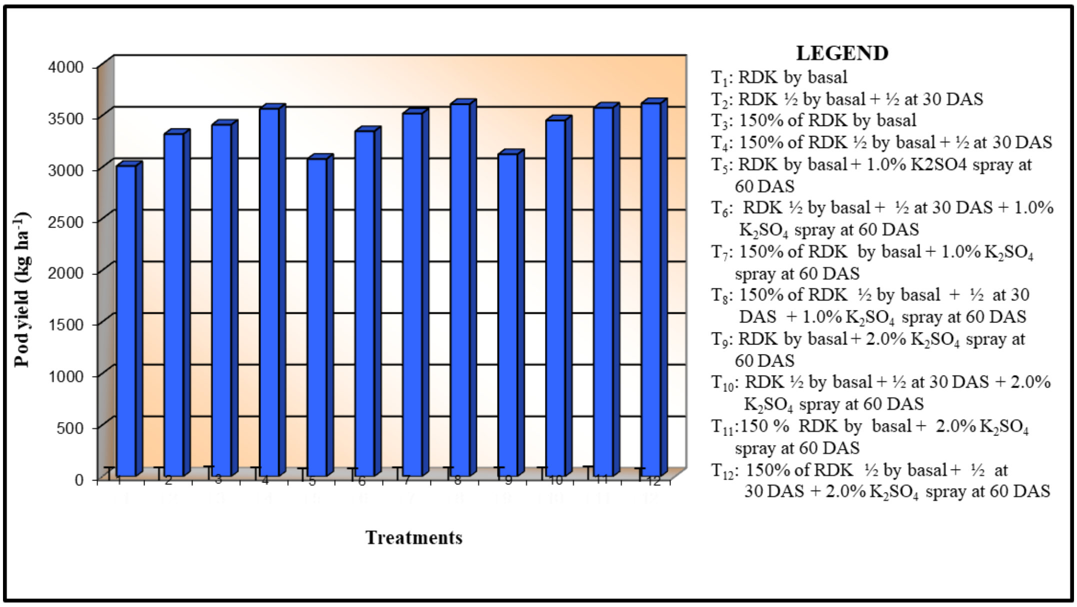

Fig 1: Effect of potassium nutrition on yield of groundnut

Quality

The oil and protein contents of groundnut were significantly influenced by different potassium treatments (Fig 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). 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) [6].

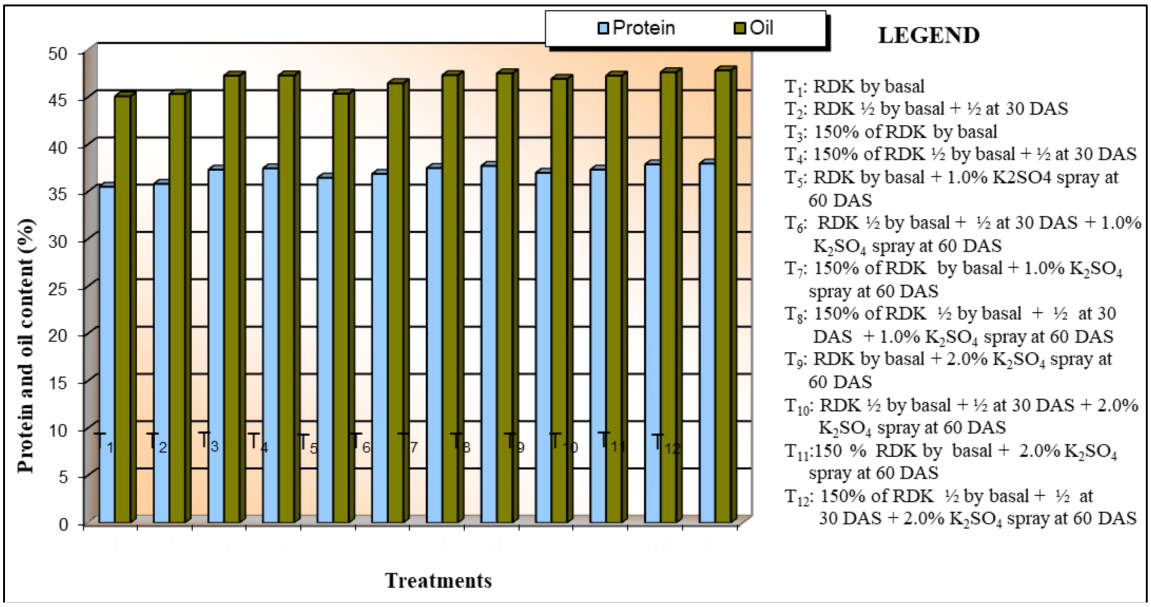

Fig 2: Effect of potassium nutrition on quality of groundnut

Nutrient concentrations in index leaves

Major nutrients concentration in the index leaves of groundnut did not vary significantly due to split application of potassium. Before split, the concentrations of N, P, K and S in index leaves were 3.52, 0.32, 2.66 and 0.31, respectively (Fig 3-6). Split application of potassium both at 100 and 150 per cent RDK significantly increased their content in index leaves (Fig 3-6) and the highest values were recorded in the treatment receiving split application of 150 per cent RDK through muriate of potash along with 2.0 per cent foliar spray of SOP (T_{12}). This might be due to increase in the available potassium content in the soil due to its reduced fixation and higher uptake by the groundnut crop. The present findings are similar to the reports of Ashwitha (2016) [1] in tobacco.

There was significant variation in the N, P, K and S concentrations of the index leaves in groundnut before foliar nutrition with potassium sulphate (Fig 3-6). In general, the treatments with split application of potassium recorded higher values than the treatments with only basal application. This might be due to higher availability of these nutrients due to split application. The data on the concentration of the major nutrients after foliar spray clearly indicated the higher concentration of these nutrients in index leaves (Fig 3-6). These nutrients were directly absorbed by plant either through cuticle or stomata. Foliar application of potassium sulphate either at 1.0 or 2.0 per cent concentration significantly increased their concentration in the index leaves of groundnut when compared to the treatments without foliar nutrition except P. As the potassium sulphate contains 50 and 18 per cent of K and S, respectively. Its foliar application resulted in the higher concentration of these nutrients. As the water soluble forms of these nutrients (K and S) are directly absorbed by the leaves (Chetana, 2016) [2]. There was reduction in the P concentration in the index leaves after foliar nutrition due to dilution effect.

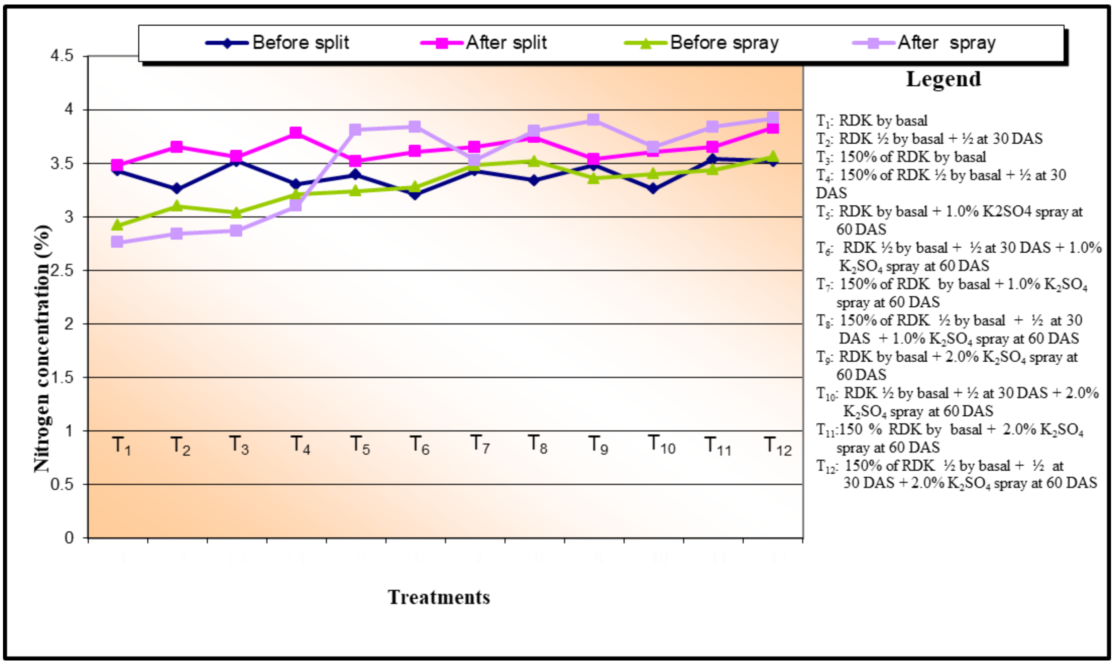

Fig 3: Effect of potassium nutrition on nitrogen content in index leaves of groundnut

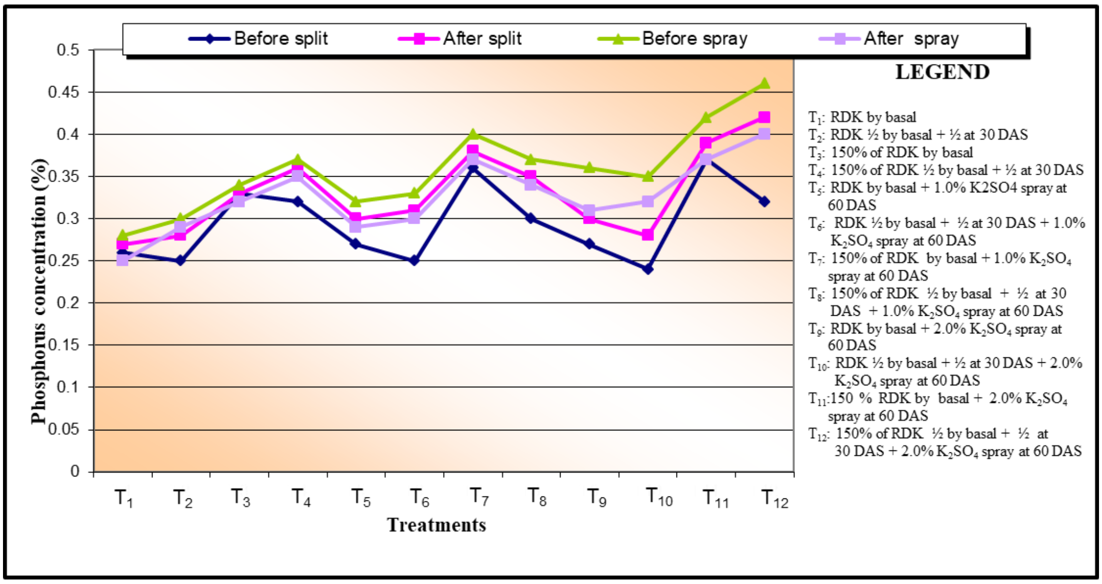

Fig 4: Effect of potassium nutrition on phosphorus content in index leaves of groundnut

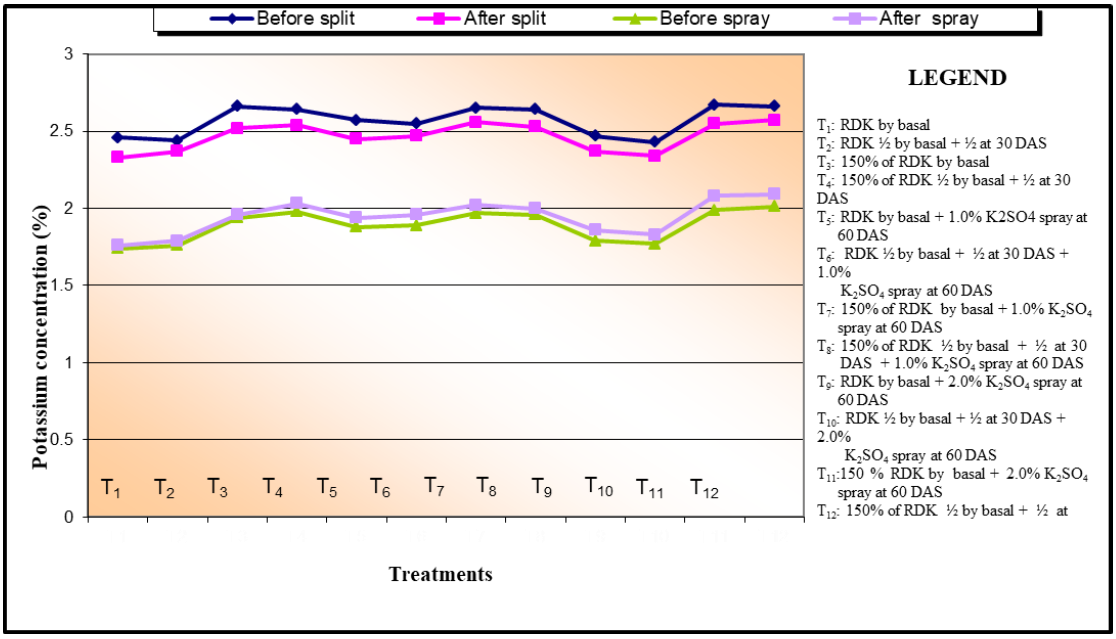

Fig 5: Effect of potassium nutrition on it's content in index leaves of groundnut

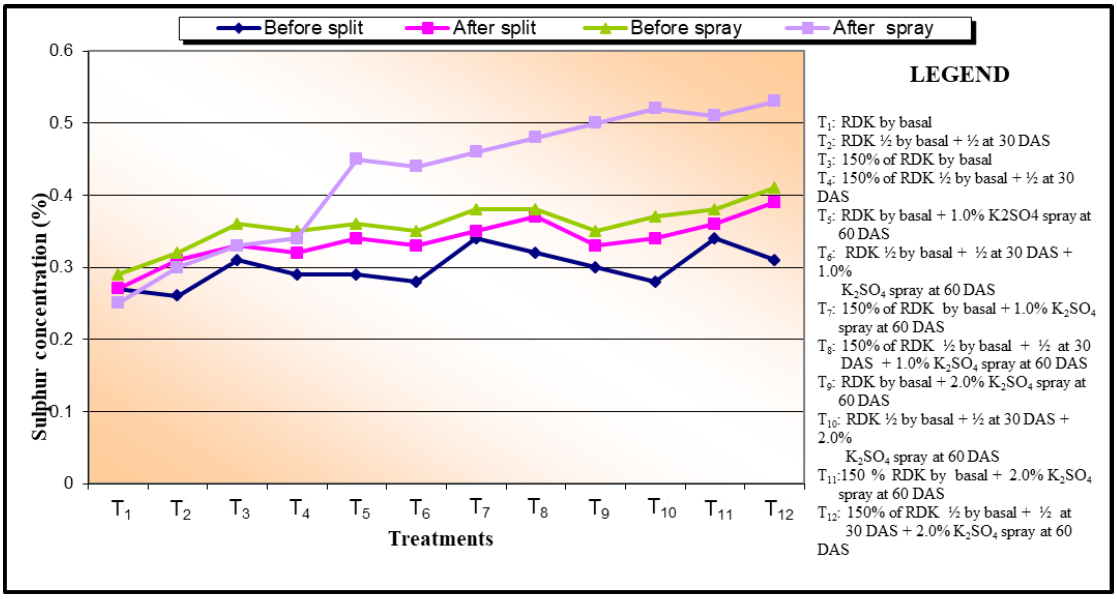

Fig 6: Effect of potassium nutrition on sulphur content in index leaves of groundnut

Correlation Studies

Pod yield and quality of groundnut did not show any relationship with the concentration of nutrients (N, P, K and S) in index leaves before split application of MOP on 29th DAS (Table 1). After split application of MOP on 40th DAS (Table 2), the nitrogen and potassium contents of groundnut showed a significant positive correlation with the pod yield and quality of groundnut. This might be due to higher availability and uptake of potassium from soil and also due to synergetic effect on nitrogen which might have resulted in increased dry matter production hence increased pod yield and also improved the quality of groundnut. The pod yield and quality of groundnut also showed a significant positive correlation with the nutrient concentrations (N, P, K and S) in index leaves of groundnut before (Table 3) and after (Table 4) foliar application of potassium sulphate. Spilt and foliar application of potassium closely synchronized with the peak potassium requirement of plant. Hence, there was increased uptake of potassium by roots as well as by plant canopy. Further, potassium increased the available nitrogen and phosphorus. There was also direct supply of sulphur through the water soluble fertilizer. Hence, there was improvement in the yield and quality of the crop due to their increased availability. Nitrogen and sulphur nutrients play significant role in protein and oil synthesis, respectively.

Table 1: Correlation between nutrients concentration in index leaves Vs yield and quality of groundnut before split application of MOP

Nutrient concentration	Yield	Oil content	Protein content
Nitrogen	0.442	0.327	0.330
Phosphorous	0.439	0.350	0.380
Potassium	0.458	0.433	0.330
Sulphur	0.389	0.466	0.310

Table 2: Correlation between nutrients concentration in index leaves Vs yield and quality of groundnut after split application of MOP

Nutrient concentration	Yield	Oil content	Protein content
Nitrogen	0.558*	0.535	0.510
Phosphorous	0.473	0.455	0.515
Potassium	0.643*	0.568*	0.564*
Sulphur	0.407	0.548	0.450

*. Correlation is significant at the 0.05 level (5 %)

Table 3: Correlation between nutrients concentration in index leaves Vs yield and quality of groundnut before spray of SOP

Nutrient concentration	Yield	Oil content	Protein content
Nitrogen	0.641*	0.621*	0.788**
Phosphorous	0.554*	0.650*	0.786**
Potassium	0.749**	0.706*	0.808**
Sulphur	0.550	0.572*	0.510

* Correlation is significant at the 0.05 level (5 %)

**. Correlation is significant at the 0.01 level (1 %)

Table 4: Correlation between nutrients concentration in index leaves Vs yield and quality of groundnut after spray of SOP

Nutrient concentration	Yield	Oil content	Protein content
Nitrogen	0.689*	0.687*	0.801**
Phosphorous	0.674*	0.682*	0.811**
Potassium	0.861**	0.869**	0.871**
Sulphur	0.672*	0.742**	0.710**

*. Correlation is significant at the 0.05 level (5 %)

**. Correlation is significant at the 0.01 level (1 %).

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