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Yield Response of Rainfed Groundnut to Sulphur and Phosphorus Application

G. Nabi, M. Salim and Rahmatullah
Land Resources Research Institute, National Agricultural Research Centre,
Islamabad-45500, Pakistan

Abstract

A field experiment was conducted to evaluate the response of groundnut (cv. Bard 699) to N, P and S application on a Typic Torrior Then soil. Application of N and P significantly ($p < 0.05$) improved kernal and dry matter yield of groundnut. Addition of S either from potassium sulphate (SOP) or single superphosphate (SSP) further increased groundnut yield. However, S addition from SOP yielded 15 Per cent higher than SSP. Superiority of SOP over SSP was attributed to its quicker release rate of nutrients and hence better utilization by the plants. Nevertheless, combined application of N, P and S increased groundnut yield by 57 to 63 Per cent over control. It is concluded that combined application of S with N and P is beneficial for rainfed groundnut.

Introduction

Groundnut requires more sulphur (S) than several other crops (Zaman, 1996). However, crop responses to S fertilizer application are not always translated into higher yields (Ahmad, 1996; Ratanarat *et al.*, 1986, Tripathi and Hazra 1985). Instead, some of the yield attributes like number of spikes/kernals per plant, 100 grain weight, oil quality of the produce etc. show positive responses to S application (Tripathi *et al.*, 1997; Ullah, 1982, Das and Misra 1991). Nevertheless, the S relations of plants are invariably improved when the availability of S in root medium is improved (Gill *et al.*, 1993; Surendra, *et al.*, 1998; BARD, 1991). Perhaps even more important is the S effect on the utilization of other nutrients like P, Zn and B. (Islam, *et al.*, 1997).

In many arid and semi-arid regions of the world, balanced plant nutrition is one of the major constraints for attaining optimum crop yields under rainfed conditions. Under uncertain moisture availability, farmers hesitate to apply optimum fertilizer quantities of even nitrogenous and phosphatic fertilizers. Consequently, they ignore the possible benefits of the application of secondary nutrients like sulphur which plays an outstanding role in the production of oilseed crops. With relatively very low water requirement compared with some other oilseed crops, groundnut (*Arachis hypogaea* L) is an ideal crop of the rainfed areas of arid and semi-arid regions of the world. For optimum yield and improved oil quantity of this crop, its proper nutrient management needs to be addressed. Results of this field experiment on groundnut supplied with chemical fertilizers containing N, P and S are reported in this paper.

Materials and Methods

A field experiment was conducted on groundnut (*Arachis hypogaea* L. variety, BARD 699) under rainfed conditions on sandy loam soil (Soon series, *Typic Torriorthients*) with pH 7.85, Ec (1:1) 0.38 dS m^{-1}, and $CaCO_3$ 1.5 Per cent. The AB-DTPA extractable NO_3-N, P and K, were 6.0, 2.8 and 78, mg kg^{-1}, respectively. The $CaCl_2$ Extractable S was 4.2 mg kg^{-1}. The experiment was comprised of five treatments viz: including T_1 = control ($N_0P_0S_0$), T_2 = N application @ 25 Kg ha^{-1} ($N_{25}P_0S_0$), $T_3 = T_2 +$ P application @ 60 Kg ha^{-1} ($N_{25}P_{60}S_0$), $T_4 = T_3 +$ S application @ 45 Kg ha^{-1} ($N_{25}P_{60}S_{45}$) from single superphosphate (SSP) and $T_5 = T_3 +$ S application @ 45 Kg ha^{-1} ($N_{25}P_{60}S_{45}$) from potassium sulphate(SOP). Each plot comprised of 4 lines of 5 m length, 45 cm apart. Urea was mainly used as N source. In order to balance the amount of K added in T5, equivalent amounts of K was added in other treatments as KCl. The of fertilizers were mixed into the top 6cm soil by hand guided self-driven rotavator immediately before sowing seeds of groundnut. The seed sowing was done manually by dibbling 2 seeds per hill, 5 cm apart. After germination manual hoeing/weeding was done frequently to minimize weed infestation. All other agronomic operations were also carried out during crop growth. A total of 830 mm of rainfall was received during the growth period. Upon maturity, 25 plants were selected randomly from the central 2 rows, inside 0.5 m border from each treatment and were harvested. Kernals were separated from green plants and air dried to record kernal yield. Fresh plant material was washed with distilled water and blotted prior to drying at 70EC. On drying, kernals and dry plant material was weighed. Kernals were separated into kernel and kernal shells. Kernel, kernal shell and plant materials were ground in a steel mill and a sub sample of each was digested in nitric perchloric diacid mixture (2:1). Sulphur in the digest was estimated turbidimetrically (Verma, *et al.*, 1977) while P was measured by vanedomolybdate yellow colour method (Jackson, 1965).

Results

Application of all fertilizer treatments increased kernal as well as dry shoot weight. Application of N @ 25 Kg/ha increased kernal yield by 42.5 Percent kernal and dry shoot weight by 35.4 Per cent over control. Addition of P @ 60 Kg ha^{-1} with N further increased kernal yield. It produced

50.5 Per cent more kernal yield and 34.12 Per cent more dry shoot weight than control. Whereas, the addition of S @ 45 Kg S ha ^{1} either from SOP or SSP along with N and P increased kernal yield and dry shoot weight by 57.90 and 63.41 Per cent respectively over the control. Data further indicated that application of S as SSP produced 15.39 Per cent higher kernal yield than application N alone and 7.3 Per cent higher kernal yield than the application of N and P. Whereas, the application of S as K_2SO_4, produced 20.65 Per cent more kernal yield than that with the application of N and 12.62 Per cent more kernal yield than that with the application of N and P. The additional benefits of S addition in both of the sources applied are visible in terms of higher kernal yields. Amongst the two sources of S, the superiority of K_2SO_4 is visible which resulted in comparatively higher kernal yield. The data on dry shoot yield indicated that all the treatments produced higher biomass yield than control. However, the differences between various treatments were negligible.

The 100 grain weight of groundnut indicated a significant increase by all fertilizer treatments. Application of N alone caused only 4.95 Per cent increase in grain weight over control. Application of N and P resulted in 14.54 Per cent more yield and application of S as SSP increased yield by 15.46 Per cent over control. Whereas, the application of K_2SO_4 increased grain weight by 20.09 Per cent as compared with control.

Sulphur and P concentration in groundnut kernel and shoot are presented in Table 2. Data indicated that S concentration was not affected to any extent by application of N alone or N combined with P. However, P application improved P concentrations. Additions of S along with N and P increased S as well as P concentrations in kernel and groundnut shoot except P concentration in shoot which stayed unchanged. Among the two sources of S applied, S concentration by K_2SO_4 was comparatively higher t that for SSP. A significant positive correlation betw kernel yield and S concentration and P concentration (Fi was observed. It indicated that improvement of S as wel P uptake by application of treatments improved kernel y of groundnut. Increase in S concentration in ground caused by addition of fertilizer treatments also cau increase in kernal yield of groundnut.

Discussion

Soils in the rainfed arid and semi-arid regions contain very low organic matter respond remarkably to application of nitrogen and phosphorus (Sankaram, 19 Misra and Sharma, 1997). Wide spread S deficiency rainfed areas of Potohar, Pakistan, have been reported Rashid *et al.* (1995). Therefore, in addition to N and beneficial effects of S application have been demonstra which has been principally due to the comparatively hig S requirements of groundnut like other oilseed cr (Dwivedi and Bapt, 1998). In the present study, containing 4.2 mg/kg $CaCl_2$ extractable S which is gener regarded as low (Jones *et al.*1991) responded t application. The kernal yield and individual grain weigh groundnut have been particularly influenced by application of S demonstrating the utilization of this nutr in oil synthesis (Dwivedi and Bapt, 1998). The superio of SOP as a S fertilizer compared to SSP may have b due to its higher solubility in soil. Although, the benefit the supply of potassium through K_2SO_4 application can be ruled out.

Application of S has improved the S status of b groundnut shoot and kernel. It also improved the P con of groundnut plant although the nutrient were statistic nonsignificant. Nevertheless, it signifies the ability adequate S status of plants to facilitate the utilizatio

Table 1: Effect of sulphur application on kernal yield (g), dry matter yield (g), 100 kernal weight (g) and 100 kernal s weight in groundnut.

Treatments	Kernal yield (g)	Dry matter yield (g)	100 Kernal weight (g)	100 Kernal shell weigh
$N_0P_0S_0$ (Control)	10.42^{d}	13.90^{b}	33.32^{b}	19.63^{b}
$N_{25}P_0S_0$	18.11^{c}	20.30^{a}	34.76^{b}	20.90^{b}
$N_{25}P_{60}S_0$	20.46^{bc}	21.10^{a}	39.19^{ab}	21.47^{ab}
$N_{25}P_{60}S_{45}$ (SSP)	23.73^{b}	19.52^{a}	39.50^{ab}	21.64^{ab}
$N_{25}P_{60}S_{45}$ (K_2SO_4)	28.67^{a}	20.27^{a}	41.23^{a}	22.65^{ab}

Table 2: Effect of sulphur application on sulphur and phosphorus concentration in kernal and straw in groundnut.

Treatments	Elemental concentrations			
	Sulphur concentration (μg g ^{1})		Phosphorus concentration (μg g ^{1})	
	Kernal	Plant shoot	Kernal	Plant shoot
$N_0P_0S_0$ (Control]	2681^{b}	2476^{b}	2212^{b}	1825^{b}
$N_{25}P_0S_0$	2767^{b}	2501^{b}	2315^{ab}	1948$^{a b}$
$N_{25}P_{60}S_0$	2891^{b}	2470^{b}	2460^{a}	1928
$N_{25}P_{60}S_{45}$ (SSP)	3414^{a}	2928^{a}	2545^{a}	2143^{a}
$N_{25}P_{60}S_{45}$ (K_2SO_4)	3716^{a}	3119^{a}	2616^{a}	2160^{a}

Figures with same letters do not differ significantly at $p<0.01$.

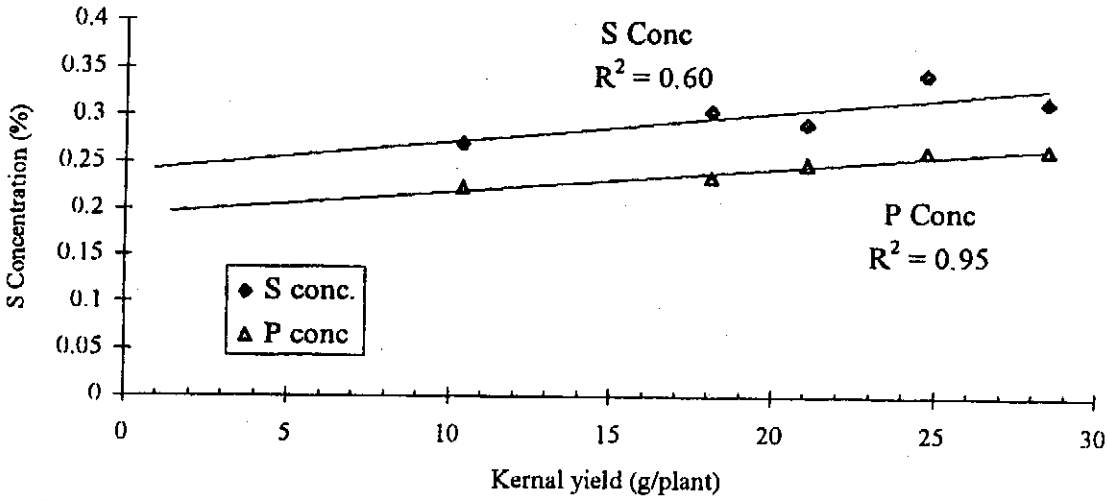

Fig. 1: Relationship between kernal yield of groundnut and its S and P concentration in plants

other nutrients especially by the oilseed crops (Pasricha and Fox 1993). The significant positive correlation between S and P uptake and the groundnut kernal yield amply signifies the need of the application of S for optimum yields of oilseed crops on soils in arid and semi-arid rainfed regions containing marginal levels of S.

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