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Pakistan Journal of Biological Sciences, 2 (2): 462-465, 1999 **Research Article**

Relationship Between Seed Sulphur and Phosphorus and Seed Yield of *Brassica napus* on Two Alfisols Fertilized with Different Sulphur Sources

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Abstract

Field experiments on two Alfisols at different locations were conducted to study the response of Westar and CON-I varieti of *Brassica napus* to S application (0 and 37 kg ha^{-1}) as ammonium sulphate, gypsum and single superphosphate. Vario S fertilizers, *Brassica* varieties and location of the experiment had a significant ($p<0.05$) main and interactive effect on th grain and oil yield of *Brassica*. Different S-amendments in increasing grain yield of *Brassica* followed the order: ammoniu sulphate > gypsum > single superphosphate. Westar was a better grain-yielding and a more S-responsive variety *Brassica* than CON-I. Both grain and oil yield of *Brassica* were higher on a site (Fateh Jang) containing low $CaCO_3$ and hig plant-available P. Sulphur concentration in seed was found in strong antagonism with seed P ($r = -0.79^{**}$, n= 16).

Introduction

Brassica is an important oilseed crop grown in different parts of the world. It requires more sulphur (S) than several other agronomic crops (Gill *et al.,* 1991). In Pakistan it is mainly produced in Potowar region where wide-spread deficiency of S has recently been reported by Rashid *et al.* (1995). Soils of the region are invariably alkaline calcareous in nature which are fertilized with high analysis fertilizers such as urea, di-ammonium phosphate and nitrophos to grow *Brassica*. Some S-containing materials such as gypsum, ammonium sulphate and single superphosphate are also used in small amounts (NFDC., 1995). However, information on the response of genetically different varieties of Brassica to various S-containing fertilizers on alkaline calcareous soils is not available. Therefore, the present paper deals with relationship of P and S in seed to grain yield and the response of two Brassica varieties to three S sources at two field sites.

Materials and Methods

Field trials were conducted on a farmer's field at Fateh Jang (Site 1., 33°35' N 72° 40' E) and at experimental farms of National Agricultural Research Center (NARC), Islamabad (Site 2., 33°42' N, 73° 08E). Range of temperature during the coldest month of January is from 4 to 16°C and during the hottest month of June the temperature ranges between 23 to 39°C. The mean annual rainfall of about 1000 mm pouring mainly (70%) during monsoon and it varies from 600 to 1750 mm (Siddiqui, 1998). The soil in both the experimental fields identified as Guliana series at site 1 and Gujranwala series at site 2 was Udic Haplustalf. Representative composite surface (0-15 cm) samples collected before sowing from both fields were air-dried, ground to pass through a 2-mm sieve and characterized for some selected properties reported in Table 1. Soil texture was analyzed by hydrometer (Day, 1965), $CaCO_3$ by acid dissolution (Allison and Moodie, 1965) and organic matter content by Walkly-Black method (Allison, 1965). Soil pH was measured in 1:1 soil : water suspension by calomel-glass electrode assembly using a Beckman pH mete Electrical conductivity was measured in 1:1 soil : wat extract. Sulphur extracted by $CaCl_2$ was estimated by Ba turbidimetric method of Verma *et al.* (1977). Plant- availa content of P and K extracted according to Soltanpour a Schwab (1977) by ammonium bicarbonate-DTPA (A DTPA) were estimated by molybdophosphoric blue col method and by flame photometry, respectively.

In addition to 0 (control), 37 kg S ha^{-1} was applied ammonium sulphate, gypsum, and single super phospha to Westar and CON-I varieties of Brassica. Urea and ammonium phosphate were used to apply uniform levels 100 kg N ha^{-1} and 30 kg P ha^{-1} after taking into acco N and P added with ammonium sulphate and sin superphosphate, respectively. All the fertilizers were si dressed at the time of sowing. Various treatments w imposed in quadruplicate according to randomized compl block design (RCBD). The two varieties of *Brassica na* (Westar and CON-I) were planted in rows 5 m long and cm apart and the plants were thinned 10 days a germination. Twenty five days after germination 25 mg kg^{-1} and 2 mg B kg^{-1} were applied as foliar spray. The c was also sprayed twice with Malathion to check agai caterpillar and aphids. At maturity 3 m length of central rows were harvested for each treatment and thres mechanically to record grain yield. The grain samples w extracted mechanically for their oil content. Sub-sample whole grain were also digested with nitric : perchloric (2:1) mixture. Sulphur in the digest was estimated by B turbidimetric method of Verma *et al.* (1977). Phosph was estimated by vanadomolybdate yellow color met (Jackson, 1965).

For treatment differences data for grain and oil yield statistically analyzed for analysis of variance accordi randomised complete block design and LSD was use mean separation. Least square method was used correlation and regression analysis of S and P conte seed against grain yield of Brassica (Steel and T 1980).

Results

The soils of both field sites were medium-textured, non-saline and alkaline in reaction. The amount of S extracted by $CaCl_2$ and lime content were very different for the two field sites. Site 1 also had slightly higher content of plant-available P than that of site 2 (Table 1).

Table 1: Physico-chemical properties of soil at the two experimental sites.

Property	Site 1:Fateh Jang	Site 2: NARC
Texture	Loam	Silt Loam
$pH_{(1:1)}$	7.82	7.61
$EC_{(1:1)}$, $dS\ m^{-1}$	0.75	0.61
$CaCO_3$, %	0.71	8.00
Organic Matter,%	0.78	0.85
$CaCl_2$ extractable S, $mg\ kg^{-1}$	8.40	8.00
AB-DTPA extractable P, $mg\ kg^{-1}$	4.80	3.00
AB-DTPA extractable K, $mg\ kg^{-1}$	47.8	59.2
U.S. Soil Taxonomy [Soil series]	Udic Haplustalf [Guliana]	Udic Haplustalf [Gujranwala]

Table 2: Linear correlation coefficients between *Brassica* seed yield, oil yield and concentrations of S and P in *Brassica* seeds [n = 16].

	Seed yield	Oil yield	% S	% P	S : P
Oil yield	0.99	-	-	-	-
% S	-0.70	-0.69	-	-	-
% P	0.74	0.75	-0.79	-	-

For 14 d.f. a correlation of 0.623 is required for significance at $p < 0.01$.

Table 3: Linear regression equations describing grain and oil yield of *Brassica* as a function of concentrations of S and P in seed [n = 16].

Dependent variable	Regression	R^2
Grain yield	$Y = 2253.13 - 2703.84\ X_1$	0.48
	$Y = -101.30 + 3667.78\ X_2$	0.55
Oil yield	$Y = 1010.69 - 1224.58\ X_1$	0.48
	$Y = 67.97 + 1691.84\ X_2$	0.57
	$Y = -6.54 + 0.45\ X_5$	0.99

X_1 = % S in seed; X_2 = % P in seed; X_3 = S : P ratio in seed; X_4 = P : S ratio in seed and X_5 = seed yield

Grain yield: Westar and CON-I varieties of Brassica responded differently to S addition from the three sources at the two locations (Fig. 1). Grain yield of Westar was significantly ($P<0.01$) better than that of CON-I. Obviously, Westar was more responsive to S application than CON-I variety. Improvement in grain yield of Westar and CON-I varieties of *Brassica* by S addition from the three sources was highly site specific (Fig. 1). The Fateh Jang site had a higher initial plant-available P, low S and less free lime as compared to the other site (Table 1). For example application of 37 kg S ha^{-1} as ammonium sulphate in the present study always increased grain yield of *Brassica.* But it increased grain yield of Westar variety over control by 19 per cent at NARC site and by 23 per cent at Fateh Jang site. However, improvement of grain yield in CON-I variety was drastically low by S application at both the sites. It increased grain yield of CON-I variety over control by 12 per cent at the NARC site and by 5 per cent at the Fateh Jang site (Fig. 1). Different S-containing fertilizers, *Brassica* varieties and location of the experiment had significant ($P<0.05$) main and interactive effect on the grain yield of Brassica (Fig. 1). Brassica seed yield was significantly ($P<0.01$) improved by S addition from the three S-amendments except a 8.44 Percent decrease by single superphosphate applied to CON-I variety of Brassica at Fateh Jang site. Relative increase in grain yield over control by S addition from the three sources ranged from a < 1 percent to 23 per cent. The order of increasing Brassica seed yield by various S-amendments was: ammonium sulphate > gypsum > single superphosphate. Ammonium sulphate and gypsum were non-significantly different from each other. These results agree with Salim *et al.* (1997) who have reported ammonium sulphate as a better source to control S deficiency commonly found in the Rawalpindi-Islamabad region of Potowar (Rashid *et al.*, 1995).

Oil yield: Per cent Oil in grain was decreased by adding S from different sources. Differences among the three sources were not significant. However, oil yield expressed as kg ha^{-1} increased significantly ($p < 0.01$) with S addition from the three sources. Response was more pronounced in Westar than in CON-I variety at both the locations (Fig. 1). There was a significant ($p < 0.01$) correlation between grain and oil yield of Brassica (Table 2). Maximum oil yield was obtained with ammonium sulphate application. It yielded 17 per cent more oil than control in Westar at the NARC site and 26 per cent at the Fateh Jang site. On the other hand the CON-I variety produced 12 per cent more oil yield at the NARC site and 10 per cent at the Fateh Jang site by adding S as ammonium sulphate. Addition of S as gypsum increased oil yield by 3 to 26 per cent in two varieties at both the locations.

S X P interactions: Concentration of S in seed was significantly improved by S addition from the three sources. The response of P concentration in grains to S addition from various sources was sporadic (Fig. 2). Concerning S and P concentration in the seeds, the two varieties responded differently to various S sources which was highly site-specific. Sulphur seed concentration was about one-half in both the varieties at Fateh Jang site compered with at NARC. *Brassica* seeds at the former site had higher P concentration than at the later site. Sulphur concentration in seeds had a significantly ($P<0.01$) negative correlation with grain yield, oil yield, and P concentration in seeds

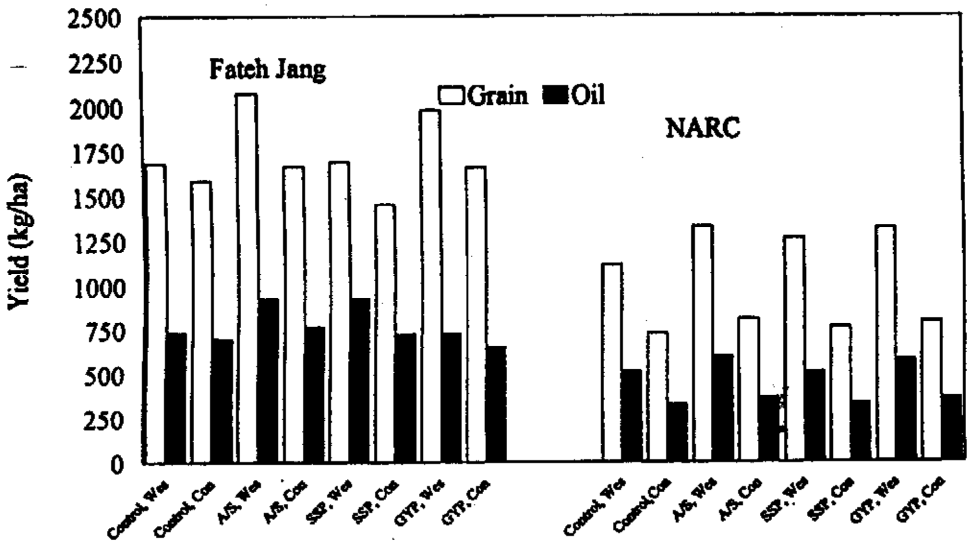

Fig. 1: Grain yield and oil yield of Westar (Wes) and CON-I (Con) varieties of *Brassica* grown at two field sites receiving sulphur from ammonium sulphate (A.S), single super phosphate (SSP) and gypsum (Gyp).

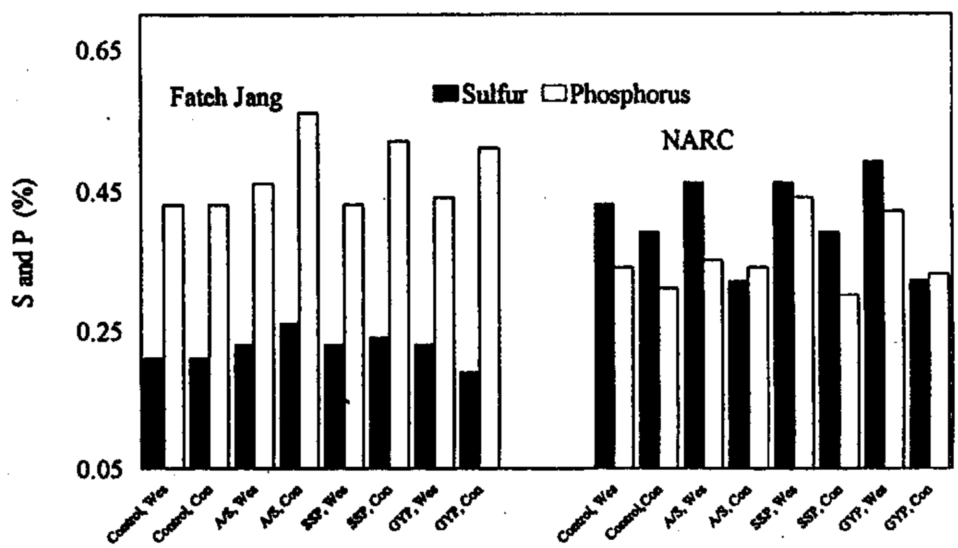

Fig. 2: Per cent sulphur and phosphorus in grains of Westar (Wes) and CON-I (Con) varieties of *Brassica* grown at two field sites receiving sulphur from ammonium sulphate (A.S), single super phosphate (SSP) and gypsum (Gyp).

antagonistic relationship of S X P in Brassica seeds. Phosphorus concentration in grains had a significantly ($p < 0.01$) positive correlation with seed yield (Table 2).

Discussion

Brassica is an important oilseed crop requiring relatively more S and P than several other agronomic crops like cereals (Gill *et al.*, 1977). Mengel and Kirkby (1987) have discussed the contribution of S in mustard oil synthesis in Cruciferae. The soils of Potowar region of Pakistan, including Rawalpindi and Islamabad, are commonly found S-deficient (Rashid *et al.*, 1995). Therefore, application of S from the three sources significantly ($P < 0.01$) increased seed yield and ammonium sulphate was the better source. Salim *et al.* (1997) have found ammonium sulphate as the best S source for sunflower. Brassica variety Westar was more responsive to S application than CON-1. Genetic differences among crop plants are important in absorption, translocation, re-translocation, distribution and assimilation of nutrients and hence, biomass accumulation (Marschner, 1995). Better response to S addition at Fateh Jang site was probably due to high initial plant available P and low

(Table 1). But S concentration in seed correlated negatively with seed yield. This result does not support Fox *et al.* (1971) who found significantly positive correlation of S in seed with cowpea yield. Rather seed yield had a significantly ($P<0.0.1$) positive correlation with P concentration in grains which had an antagonistic relation with S concentration in seed (Table 2) and it agrees with Aulakh and Pasricha (1988). Both S & P are mainly absorbed from soil solution by plant root as anions. They are involved in several plant biochemical processes such as protein synthesis (Mengel and Krikby, 1987). But phosphate can displace or reduce the adsorption of sulphate in soils (Tisdale *et al.*, 1985) and can affect sulphate absorption by plant roots (Clarkson and Sakar, 1989). Furthermore P is mainly stored in plant grains from where it excludes sulphate. This phenomenon has probably resulted in a positive relationship of Brassica seed yield with P concentration in seed rather than with S in seed. Aulakh and Pasricha (1988) regarded seeds as a physiologically more stable diagnostic tissue to identify nutritional problems of plants which is contrary to Jones (1972). But in contrast to Fox *et al.* (1971) results of this study do not favour correlating seed S with Brassica seed yield.

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