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# Response of wheat (*Triticum aestivum*) to nitrogen and sulphur and their residual effect on succeeding pearlmillet (*Pennisetum glaucum*)

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## ABSTRACT

An experiment was conducted during 1996–97 and 1997–98 to study the effect of nitrogen and sulphur on productivity of wheat (*Triticum aestivum* L. emend. Fiori & Paol.] and succeeding pearlmillet [*Pennisetum glaucum* (L.) R. Br.emend. Stuntz]. Application of 120 kg N/ha enhanced the grain and straw yields of wheat by 63.5 and 30.1%, respectively, over 30 kg N/ha. Increasing levels of sulphur up to 40 kg/ha increased the grain and straw yields of wheat by 26.28 and 13.9% respectively, over 0 kg S/ha. The grain and stover yields of succeeding pearlmillet were enhanced by 0.80 and 2.00 q/ha, respectively, at 40 kg S/ha applied to preceding wheat over 17.2 and 42.9 q/ha obtained under 0 kg S/ha. Further, application of 40 kg S/ha significantly improved the available P and S content in soil after harvest of wheat and pearlmillet. Application of nitrogen to wheat did not bring any change in grain and stover yields of succeeding pearlmillet and soil fertility.

***Key words :*** Nitrogen, Pearlmillet, Residual affect, Soil fertility, Sulphur, Wheat

Wheat is considered to the backbone of nation's food security. Fertilizer is a major input, accounting for nearly 50% increase in foodgrain production. Therefore, the balanced use of fertilizer is essential for further increasing productivity. Despite the application of recommended quantities of major plant nutrients, the increase in yield is not encouraging. This indicates that in addition to major plant nutrients, there is a need to supply secondary nutrients. Sulphur is increasingly being recognized as the fourth major plant nutrient as the deficiency of sulphur in light-textured soil is about 38% in semi-arid eastern plain zone of Rajasthan (Kothari and Jethra, 1994). Sulphur application benefits more than one crop and shows a significant residual effect on the following crop (Biswas and Tewatia, 1991). Thus an experiment was conducted to study the response of wheat to nitrogen and sulphur and their residual effect on

succeeding pearlmillet.

## MATERIALS AND METHODS

An experiment was conducted during 1996–97 and 1997–98 at Agricultural Research Station, Durgapura, Jaipur, on loamy sand soil under irrigated situation. The soil was slightly alkaline (pH 7.9 and 8.0), low in available N (151.7 and 147.7 kg/ha) and S (8.4 and 7.8 ppm), medium in available P (48.4 and 30 kg $P_2O_5$/ha) and K (195.8 and 188.2 kg $K_2O$/ha). Twenty-five treatments consisting of 5 levels, each of N (30, 60, 90, 120 and 150 kg/ha) and S (0, 20, 40, 60 and 80 kg/ha), were tested in split-plot design, keeping N levels in main plot and S levels in subplot with 4 replications. In wheat, a uniform dose of 30 kg $P_2O_5$/ha through diammonium phosphate and 30 kg $K_2O$/ha through muriate of potash and half dose of N as per treatment were drilled at sowing and remaining N through urea was applied just before first irrigation at crown-root-initiation (CRI) stage. Sulphur was incorporated into soil before sowing as per treatment through agricultural grade gypsum containing 13% sulphur. Wheat variety 'Raj 3077' was sown in rows, 22.5 cm apart, using a seed rate of 100 kg/ha in November end and harvested in the first week of April. The succeeding pearlmillet variety 'MH 179' was sown in rows, 45 cm apart, using a seed rate of 4 kg/ha in the second week of July with a uniform dose 40 kg N and 30 kg $P_2O_5$/ha through urea and diammonium phosphate respectively. Soil samples were collected at 0–15 cm depth

**Table 1.** Effect of nitrogen and sulphur fertilization on performance of wheat and their residual effect on succeeding pearlmillet

| Treatment | Wheat | | | | | | Pearlmillet | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Grain yield (q/ha) | | | Straw yield (q/ha) | | | Grain yield (q/ha) | | | Stover yield (q/ha) | | |
| | 1996–97 | 1997–98 | Mean | 1996–97 | 1997–98 | Mean | 1997 | 1998 | Mean | 1997 | 1998 | Mean |
| *Nitrogen (kg/ha)* | | | | | | | | | | | | |
| 30 | 36.3 | 32.8 | 34.5 | 60.9 | 51.2 | 56.1 | 16.5 | 18.2 | 17.3 | 44.7 | 41.8 | 43.2 |
| 60 | 46.6 | 41.4 | 44.0 | 67.0 | 59.8 | 63.4 | 16.9 | 18.4 | 17.7 | 45.6 | 42.2 | 43.9 |
| 90 | 53.7 | 48.0 | 50.9 | 72.1 | 64.7 | 68.4 | 17.3 | 18.5 | 17.9 | 46.5 | 42.5 | 44.5 |
| 120 | 58.7 | 54.2 | 56.4 | 76.8 | 69.2 | 73.0 | 17.6 | 18.7 | 18.1 | 47.4 | 42.9 | 45.2 |
| 150 | 59.4 | 54.9 | 57.2 | 78.9 | 71.8 | 75.3 | 17.7 | 18.7 | 18.2 | 47.4 | 43.2 | 45.3 |
| CD (P=0.05) | 4.31 | 4.55 | 2.96 | 3.71 | 3.68 | 2.48 | NS | NS | | NS | NS | |
| *Sulphur (kg/ha)* | | | | | | | | | | | | |
| 0 | 42.0 | 39.2 | 40.6 | 65.1 | 55.9 | 60.5 | 16.4 | 17.9 | 17.2 | 44.4 | 41.4 | 42.9 |
| 20 | 48.3 | 44.1 | 46.2 | 69.9 | 60.8 | 65.4 | 17.1 | 18.5 | 17.8 | 45.9 | 42.4 | 44.2 |
| 40 | 54.1 | 48.9 | 51.5 | 72.6 | 65.2 | 68.9 | 17.4 | 18.6 | 18.0 | 46.9 | 42.8 | 44.9 |
| 60 | 55.1 | 49.4 | 52.3 | 73.9 | 67.1 | 70.5 | 17.5 | 18.7 | 18.1 | 47.2 | 42.9 | 45.0 |
| 80 | 55.3 | 49.7 | 52.4 | 74.2 | 67.7 | 70.9 | 17.5 | 18.7 | 18.1 | 47.3 | 43.0 | 45.1 |
| CD (P=0.05) | 2.24 | 2.48 | 1.72 | 1.99 | 2.45 | 1.56 | 0.79 | 0.50 | | 2.12 | 1.07 | |

**Table 2.** Effect of nitrogen and sulphur fertilization of soil fertility of the soil

| Treatment | After harvest of wheat | | | | | | | | After harvest of pearlmillet | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Available N (kg/ha) | | Available $P_2O_5$ (kg/ha) | | Available $K_2O$ (kg/ha) | | Available S (ppm) | | Available N (kg/ha) | | Available $P_2O_5$ (kg/ha) | | Available $K_2O$ (kg/ha) | | Available S (ppm) | |
| | 1996–97 | 1997–98 | 1996–97 | 1997–98 | 1996–97 | 1997–98 | 1996–97 | 1997–98 | 1997 | 1998 | 1997 | 1998 | 1997 | 1998 | 1997 | 1998 |
| *Nitrogen (kg/ha)* | | | | | | | | | | | | | | | | |
| 30 | 145.4 | 141.6 | 48.5 | 29.9 | 195.4 | 188.3 | 7.75 | 7.66 | 133.5 | 128.2 | 48.7 | 30.6 | 194.3 | 186.1 | 7.3 | 7.0 |
| 60 | 148.6 | 144.5 | 48.9 | 30.6 | 197.2 | 192.2 | 7.95 | 7.86 | 135.2 | 131.5 | 49.8 | 31.2 | 195.1 | 187.0 | 7.5 | 7.2 |
| 90 | 150.1 | 146.8 | 49.1 | 30.8 | 198.0 | 191.5 | 8.04 | 8.00 | 136.7 | 133.7 | 50.6 | 31.6 | 195.4 | 187.3 | 7.6 | 7.3 |
| 120 | 151.5 | 148.2 | 49.1 | 30.9 | 198.4 | 191.9 | 8.07 | 8.03 | 136.9 | 135.8 | 51.0 | 31.9 | 195.7 | 187.3 | 7.7 | 7.3 |
| 150 | 152.7 | 149.3 | 49.3 | 30.9 | 198.2 | 192.4 | 8.13 | 8.07 | 137.0 | 136.8 | 51.7 | 32.0 | 195.8 | 187.3 | 7.7 | 7.3 |
| CD (P=0.05) | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| *Sulphur (kg/ha)* | | | | | | | | | | | | | | | | |
| 0 | 148.5 | 144.5 | 47.5 | 28.5 | 191.9 | 186.1 | 6.63 | 6.45 | 134.7 | 131.7 | 47.5 | 28.0 | 191.2 | 185.2 | 6.1 | 5.6 |
| 20 | 149.6 | 146.1 | 48.8 | 30.0 | 196.1 | 189.2 | 7.56 | 7.44 | 135.0 | 132.5 | 49.2 | 30.2 | 194.5 | 186.5 | 6.9 | 6.7 |
| 40 | 149.1 | 146.5 | 49.2 | 31.1 | 199.1 | 191.8 | 8.24 | 8.27 | 136.0 | 133.4 | 50.7 | 32.0 | 196.2 | 187.3 | 7.7 | 7.4 |
| 60 | 150.0 | 146.6 | 49.7 | 31.6 | 199.8 | 193.1 | 8.58 | 8.66 | 136.5 | 133.9 | 51.9 | 33.4 | 197.0 | 187.9 | 8.3 | 7.9 |
| 80 | 150.9 | 146.6 | 49.8 | 31.9 | 200.3 | 194.2 | 8.93 | 8.80 | 137.1 | 134.3 | 52.4 | 33.6 | 197.3 | 188.3 | 8.7 | 8.4 |
| CD (P=0.05) | NS | NS | 1.49 | 1.57 | NS | 5.05 | 0.31 | 0.32 | NS | NS | 1.99 | 1.85 | NS | NS | 0.34 | 0.36 |

just after harvest of wheat and pearl millet to determine the available N, $P_2O_5$, $K_2O$ and S contents.

## RESULTS AND DISCUSSION

### *Direct effect on wheat*

Wheat responded significantly to N application up to 120 kg/ha in terms of grain and straw yields (Table 1). Pooled data indicated that application of 120 kg N/ha recorded significantly higher grain and straw yield of 56.4 and 73.0 q/ha, respectively, registering 63.5 and 30.1% increase over 30 kg N/ha. Increasing levels of S significantly increased the grain yield of wheat up to 40 kg S/ha and straw yield up to 60 kg S/ha. The mean increase was 26.8% in grain yield due to application of 40 kg S/ha and 16.5% in straw yield with 60 kg S/ha over 0 kg S/ha. The increase in the yield of wheat was because of significant improvement in effective tillers/$m^2$, grains/spike and test weight under 120 kg N/ha over 30 kg N/ha and under 40 kg S/ha over 0 kg S/ha (control). This confirms the findings of Upadhyay and Tiwari (1996).

### *Residual effect on pearlmillet*

Application of nitrogen to wheat did not influence grain and stover yields of succeeding pearlmillet. However, sulphur fertilization recorded significant residual effect on succeeding pearlmillet (Table 1). Application of 40 kg S/ha to wheat increased the grain and stover yields of succeeding pearlmillet by 0.80 and 2.00 q/ha over 0 kg S/ha. Bapat *et al.* (1994) also observed increase in yield of soybean by 22.2% when 30 kg S/ha was added through gypsum to preceeding wheat.

### *Effect on soil fertility*

Application of nitrogen to wheat did not bring any significant variation in available $P_2O_5$, $K_2O$ and S content of the soil after harvest of wheat as well as pearlmillet. On the other land, sulphur fertilization to wheat brought out significant improvement on available $P_2O_5$ and S content of soil after harvest of both the crops. It was also observed that available $K_2O$ was not significantly affected due to application sulphur except in 1996–97 after harvest of wheat which increased significantly with the application of sulphur. Ram *et al.* (1998) also reported that sulphur fertilization improved the residual fertility of soil by lowering down the soil pH appreciably.

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