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Research Communication

Comparative performance of gypsum and micro-ionized sulphur on wheat (*Triticum aestivum*)

MADHULIKA PANDEY[1], V.P. SINGH[2], RAJEEW KUMAR[3], D.S. PANDEY[4] AND I.P. SINGH[5]

G.B. Pant University of Agriculture and Technology, Pantnagar, U.S. Nagar, Uttarakhand 263 145

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ABSTRACT

A field experiment was conducted during the winter season of 2010–11 at Pantnagar, to compare the response of gypsum and micronized sulphur in variety 'PBW 502' of wheat [*Triticum aestivum* (L.) emend. Fiori & Paol.]. Microionized sulphur as soil application@ 60 kg/ha gave higher value of shoot count, plant height, dry-matter accumulation and yield attributes and yield, NPK and S uptake, quality parameters like grain protein, starch, wet gluten, sedimentation value, hectolitre weight and economics parameters, viz. gross returns, net return, benefit: cost ratio compared to gypsum. However, foliar application of gypsum @ 2% gave higher value of the above-mentioned parameter than foliar application @ 2% of microionized sulphur. At 60 kg S application rate, micro-ionized S gave about 8% more grain yield than gypsum; however, in case of foliar application 1.5% higher yield was noticed in gypsum than micro-ionized S. Application of 40 and 60 kg S/ha either through gypsum or micro–ionized S failed to give significant difference on wheat performance.

Key words : Gypsum, Micro-ionized sulphur, Wheat

Sulphur is best known for its role in the formation of amino acids, synthesis of proteins, chlorophyll, oil content and nutritive quality (Jamal *et al.,* 2009) and seed protein and total proteins in wheat seed (Zhao *et al.,* 1999). Intensive agricultural activities and use of non-sulphur fertilizers results soil sulphur deficiency in the country. Even, sulphur-containing fertilizers do not necessarily resolve the problem because these fertilizers are susceptible to leaching losses. Use of elemental sulphur may be one option to take care of leaching problem, but it must be micronized before use.

Micro-ionized form of sulphur get oxidized to $S0_4^{2-}$ by soil micro-organism and oxidation rates increases as particle size is reduced which ultimately increase surface area. Thus, increasing the surface area results in increased $S0_4^{2-}$availability to the crops (Tisdale *et al*., 2007). Micro-ionized sulphur quickly disperses in the solution and having higher sulphur content, i.e. more than 90%. Micro-ionized sulphur increased the wheat grain yield and sulphur uptake over the no sulphur (Riley *et al*., 2000). Sulphur nutrition to the crop is influenced by sources and doses. Considering this, a study was conducted to find out the effect of micro-ionized sulphur on wheat crop.

A field experiment was conducted at Norman E. Borlaug Crop Research Centre of Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, distt. Udham Singh Nagar (Uttarakhand) during the winter (*rabi*) season of 2010–11. The experimental field was a silty clay loam (Typic Hapludolls), having pH 7.5, organic carbon 0.74%, medium in available NPK and S. Eight treatments comprised from 4 sulphur doses, i.e. 20, 40, 60 kg S/ha and 2% S as foliar nutrition supplied through 2 sources, i.e. micro-ionized S and gypsum, was tested on wheat variety 'PBW 502', in randomized block design and replicated thrice. Sowing was done on 11 November, 2010 and harvesting on 16 April, 2011. The crop was fertilized with recommended dose of NPK (150: 60: 40 kg/ha). Sulphur was applied basal in case of soil application and at flowering stage in case of foliar application by using Sulfert (micro-ionized sulphur), gypsum as the source of sulphur . The observations were recorded as per standard procedure. The quality parameters like protein, starch, wet gluten and sedimentation value (ml), were estimated through grain analyser. However, the hectolitre weight was measured by hectolitre weight apparatus.

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[3]**Corresponding author Email:** shuklarajeew@gmail.com

[1]M.Sc. Student, [2&4]Professor, [3]JRO, [5]Junior Scientist, Department of Agronomy College of Agriculture, G.B. Pant University of Agriculture and Technology, Pantnagar, U.S. Nagar, Uttarakhand 263 145

Yield-contributing characters, viz. spikes/m², spike length (cm), fertile spike lets/spike, grains/spike, grain weight/spike and 1,000-grain weight, were significantly influenced by the treatments (Table 1). However, spike length and sterile spikelets/spike showed non-significant effect of treatments. Micro-ionized S failed to give significant effect on spikes/m² at different doses of 20, 40, 60 kg S/ha, but produced significantly more spikes/m² than gypsum-treated plots. Maximum fertile spikelets/spike were noticed at micro-ionized S @ 60 kg S/ha, which was significantly higher than gypsum @ 20 kg S/ha, but at par with the other treatments. Application of S @ 20 kg/ha and 40 kg/ha through micro-ionized S gave significantly more grains/spike than gypsum, but @ 60 kg S/ha the differences between micro-ionized S and gypsum S was non-significant. Grain weight/spike was significantly higher under micro-ionized S than gypsum S, if compared at same dose of S. Increase in S dose did not influence significantly the grain weight within gypsum source and micro-ionized source. Micro-ionized S @ 20 kg S/ha gave significantly more 1,000-grain weight than gypsum S @20 kg/ha. However, in the other treatments micro-ionized S and gypsum S did not show any significant variation in 1,000-grain weight. Foliar nutrition @ 2% S through gypsum had higher value of all yield-contributing characters than micro-ionized S, but the differences were non-significant. Cui *et al*. (1999) found that application of sulphur helped to promote ears/plant, grains/ear and grain weight.

Grain yield and straw yield significantly influenced by the treatments, but non-significant effect of the treatments were found on harvest index and grain straw ratio (Table 1). Micro-ionized sulphur @ 60 kg S/ha resulted in the maximum grain yield, being significantly higher than the other treatments except micro-ionized sulphur @ 40 kg S/ha. However, straw yield at 60 kg S/ha through micro-ionized S was the maximum and found at par with the other treatments except gypsum @ 20 kg S/ha. Better yield-contributing characters and morphological parameters might be responsible for good yield under micro-ionized S treatment. Micro-ionized S contains sulphur in elemental form (90% S), which is not water-soluble, but due to micro-inized particle size, it makes very fine suspension. This creates faster conversion of elemental sulphur to sulphate and resulted in early availability of sulphur to the plant as compared to any other form of sulphur fertilizer and gypsum (Mahindra and Mahindra Production Unit, 2010–11). This ultimately gave better morphological characters and finally yield. Our results confirm the findings of Riley *et al.* (2000). Total NPK uptake was significantly affected by the treatments (Table 2). Increase in sulphur doses increased the nitrogen uptake irrespective of source of supply and it was maximum at micro-ionized sulphur @ 60 kg

Table 1. Effect of gypsum and micro-ionized sulphur on yield attributes and yield of wheat

Treatments	Spikes/m²	Spike length (cm)	Fertile spikelets/m²	Sterile spikelets/m²	Grains/spike	Grain weight/spike (g)	1,000-grain weight (g)	Grain yield (t/ha)	Straw yield (t/ha)	Harvest index (%)	Grain straw ratio
S @ 20 kg/ha through gypsum	434.4	9.5	16.2	3.8	31.1	1.2	40.0	4.51	7.65	37.1	0.58
S @ 20 kg/ha through micro- ionized sulphur	462.0	9.4	16.8	3.7	33.0	1.2	41.7	4.62	7.90	37.0	0.58
S @ 40 kg/ha through gypsum	445.6	9.5	17.3	3.7	35.7	1.3	42.8	4.80	7.99	37.7	0.60
S @ 40 kg/ha through micro-ionized sulphur	475.0	9.4	16.4	3.6	35.1	1.4	42.2	4.75	7.98	37.3	0.59
S @ 60 kg/ha through gypsum	457.6	9.4	17.4	3.4	36.9	1.5	43.0	4.99	8.22	37.6	0.60
S @ 60 kg/ha through micro-ionized sulphur	481.3	9.6	18.2	3.2	37.9	1.5	44.3	5.19	8.30	38.3	0.61
Foliar spray of S @ 2 % through gypsum	464.3	9.3	17.2	3.5	31.9	1.3	42.2	4.60	7.92	36.8	0.58
Foliar spray of S @ 2 % through micro-ionized Suplhur	457.6	9.3	16.6	3.7	31.3	1.2	41.2	4.53	7.81	36.7	0.58
SEm±	7.9	0.2	0.4	0.2	1.2	0.1	0.7	1.3	1.7	0.8	0.02
CD (P=0.05)	23.0	NS	1.3	NS	3.6	0.2	2.0	3.7	4.9	NS	NS

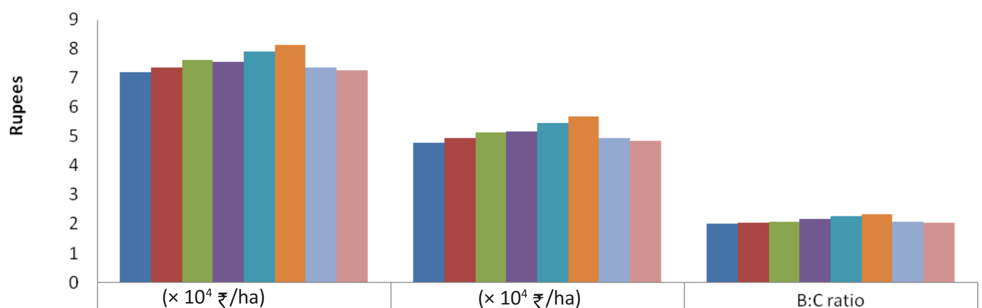
S/ha. Total nitrogen uptake found under micro-ionized S @ 60 kg S/ha was significantly higher than the other treatments. Gypsum @ 20, 40, 60 kg S/ha resulted in significantly less nitrogen uptake than same dose of sulphur through micro-ionized S. Total P and K uptake also followed the same trend as recorded in total nitrogen uptake. However, total S uptake was found non-significant due to gypsum and micro-ionized S with all the doses. Foliar nutrition of gypsum and micro-ionized S had non-significant effect on total uptake of NPKS. Salvagiotti *et al.* (2009) also reported the similar results.

Grain protein content and yield, wet gluten content, starch content and sedimentation value were significantly influenced by the treatments, but hectolitre weight was found at par (Table 2). Increase in S doses increased the grain protein content and it was maximum and significantly higher at @ 60 kg S/ha through micro-ionized S, than other treatments. Grain protein content obtained through gypsum @ 60 kg S/ha was significantly higher than 20 kg S, but it was on a par with 40 kg S /ha through gypsum. Protein yield was also maximum and significantly higher at 60 kg S/ha through micro-ionized S than the other treatments except 40 kg S/ha through micro-ionized S. In contrast to above, gypsum retained higher value of starch at lower doses, i.e. 20 and 40 kg S/ha, and lower value @ 60 kg S/ha compared to micro-ionized S. Only micro-ionized S had significant effect on starch content than the other treatments which were found non-significant among them. Gluten content was also increased with the increase in sulphur dose, and again micro-ionized S

Table 2. Effect of gypsum and micro-ionized sulphur on total nutrient uptake and quality parameters in wheat

Treatments	Total nutrient uptake (kg/ha)				Grain protein (%)	Protein yield (kg/ha)	Starch (%)	Wet gluten (%)	Sedimentation value	Hectoliter weight (g/litre)
	N	P	K	S						
S @ 20 kg/ha through gypsum	123.7	25.9	129.1	13.8	10.4	461	69.0	27.3	26.3	75.9
S @ 20 kg/ha through micro-ionized sulphur	129.4	27.7	137.3	14.6	10.5	494	69.0	27.6	27.5	75.8
S @ 40 kg/ha through gypsum	137.3	29.1	143.7	15.8	10.7	520	69.0	28.5	27.9	76.1
S @ 40 kg/ha through micro-ionized sulphur	133.3	28.5	143.8	15.0	11.2	533	68.7	28.8	27.7	76.0
S @ 60 kg/ha through gypsum	143.9	30.6	152.1	16.5	11.4	568	68.7	29.8	28.9	76.4
S @ 60 kg/ha through micro-ionized sulphur	149.6	32.0	156.6	17.4	11.7	601	70.0	30.5	29.8	76.4
Foliar spray of S @ 2% through gypsum	126.7	26.7	133.3	14.4	10.8	448	69.0	29.3	28.1	76.1
Foliar spray of S @ 2% through micro-ionized Suplhur	122.9	26.0	130.6	13.4	10.8	490	69.0	29.2	27.9	76.0
SEm±	1.8	0.5	3.2	3.2	0.08	11.2	0.19	0.20	0.2	0.3
CD (P=0.05)	5.4	1.5	9.4	NS	0.26	32.9	0.50	0.60	0.6	NS

Fig. 1. Economics of wheat as influenced by gypsum and micro ionized sulphur



	(× 10^4 ₹/ha)	(× 10^4 ₹/ha)	B:C ratio
S @ 20 kg/ha through gypsum	7.18	4.78	1.99
S @ 20 kg/ha through micro ionized sulphur	7.37	4.93	2.02
S @ 40 kg/ha through gypsum	7.61	5.13	2.07
S @ 40 kg/ha through micro ionized sulphur	7.55	5.15	2.15
S @ 60 kg/ha through gypsum	7.89	5.46	2.25
S @ 60 kg/ha through micro ionized sulphur	8.14	5.68	2.31
Foliar spray of S @ 2 % through gypsum	7.35	4.95	2.06
Foliar spray of S @ 2 % through micro ionized Suplhur	7.25	4.85	2.02

gave maximum gluten @ 60 kg S/ha which was significantly higher than the other treatments. Sedimentation value also followed the same trend. Foliar application of gypsum and micro-ionized S did not give significant difference. This result confirms the findings of Zorb *et al.* (2010). With the increased levels of sulphur sources up to 60 kg S/ha resulted higher value of gross returns, net returns and benefit: cost ratio (Fig 1). The highest value of gross returns, net returns and benefit: cost ratio found at 60 kg S/ha through micro-ionized S. Higher values of gross returns, net returns and benefit: cost ratio obtained at 20, 40, 60 kg S/ha through, sulfert than the 20, 40, 60 kg S per ha through gypsum.

It can be concluded from the results that micro-ionized S was found more effective towards the yield attributes, yield, nutrient uptake, quality and economics of wheat than gypsum. But foliar application of gypsum gave better result than foliar application of micro-ionized S. Over all, 60 kg S through micrio-inized S gave the maximum grain yield and economic returns. Therefore, microionized S can be applied as a source of sulphur.

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