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Effect of Different Sources and Levels of Sulfur on Barley

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ABSTRACT

A field experiment was conducted during *rabi* season 2020-21 at Research farm of Lovely Professional University, Phagwara, Punjab to evaluate the effect of different sources and levels of sulfur on barley. With Factorial Randomized Block Design, the experiment comprising three sources of sulfur gypsum, single super phosphate (SSP), bentonite and four levels of S (0, 7.5, 15, 22.5 kg S ha^{-1}) replicated thrice. Application of bentonite sulfur recorded significantly the highest grain yield of barley (5.2 t ha^{-1}) over gypsum and SSP (4.9 t ha^{-1}). Significantly higher grain yield of barley was obtained with application of 22.5 kg S ha^{-1}. Various plant parameters viz., plant height, no. of tillers per of plant, chlorophyll content, leaf area index, spikelet per spike, drymatter yield, straw yield, grain yield were significantly higher with bentonite and at 22.5 kg S ha^{-1}.

Keywords : Grain yield sources, Sulfur, Barley, Bentonite, Gypsum.

INTRODUCTION

Hordeum vulgare L., also known as barley or groats, is a cereal plant in poaceae family which produces an edible grain. It is widely cultivated grain that is used for malting and forage. Barley is a cool-season annual crop that can be used as a forage crop or as a cover crop to increase soil fertility (Ghanbari *et al.* 2012). It ranks fifth in grain production globally, behind maize, wheat, rice and soybean (Ofosu-Anim and Leitch 2009, Zeid 2011, Soleymani and Shahrajabian 2011). With a production of 17 million tonns, Canada is one of the world's largest barley producers and exporters. Barley is grown in about 70 million hectares in the world and its global production is 160 million tons. Developing countries accounts for about 18 % (26 million tons) of total barley production and 25% (18.5 million hectares) of the total harvested area in the world (USDA 2004). It is grown in almost every part of the country, with the exception of tropical areas. Barley is a popular cereal in India, where it is grown on about 0.7 million hectares. The higher Himalayas, eastern parts of Rajasthan, central parts of eastern Uttar Pradesh and northwestern parts of Bihar are the main barley-growing areas in the country.

Barley expects cool weather during its early stages of development and warm, dry weather when it reaches maturity. It thrives in both temperate and subtropical climates on the planet. This crop requires less water than wheat. Barley thrives in dry climates due to its drought resistance. In India, development is occurring in the plains and at higher altitudes in the Himalayas, up to 4000 meters. It is primarily grown in areas where wheat cultivation does not yield a profit. Barley grain is primarily used for animal

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feed, malt and human consumption. Malting is the second most common application for barley. It is also an important species for animal feed, as well as malting and exportation. In dry areas, crop quality and post-harvest operations are critical for human nutrition; in wet areas, crop quality and post-harvest operations are critical for economic growth and farmer income. Barley grain contain 12.5%, 11.5% albuminoids, 1.3% fat, 74% carbohydrates, 3.9% crude fiber and 1.5% ash.

Sulfur (S), one of the most important nutrients for all plants and animals, it is the fourth most important nutrient for agricultural crop production after nitrogen, phosphorus and potassium. Sulfur is a structural component of organic compounds, some of which are synthesised exclusively by plants and provide essential amino acids to humans and animals (methionine cystine and cysteine). It is a component of the vitamins biotin and thiamine (B1) and is involved in chlorophyll formation and enzyme activation (Hegde and Sudhakara babu 2007). Sulfur increases oil and protein content, flour quality for milling and baking and forage nutritive value, among other things. Because of its role in increasing crop production, not only of oil seeds, pulses, legumes and forages, but also of many cereals, sulfur role in Indian agriculture is gaining importance. Sulfur deficiency has become a growing problem in agriculture in recent years. Cereals have a high yield potential and a low sulfur requirement in general. Although cereals have a low sulfur requirement to produce one tonne of cereals, their uptake per unit area approaches that of oilseeds, owing to their higher productivity (Sutar *et al.* 2018).

MATERIALS AND METHODS

The experiment trial was conducted research farm of Lovely Professional University Punjab, during *rabi* season of 2020-2021. It is situated 300 meters above sea level at 31.147° N latitude to 75.312°E longitude. The experimental plot was sandy loam in texture (clay- 4.1%, silt-11.2% and sand 84.7%) with neutral pH (7.1), normal salt content (EC = 0.73 ds/m) and medium organic carbon content (0.60%), low in available N (273 kg/ha), medium in phosphorus (8.9 kg/ha), medium in available potassium (142.3 kg/ha) and low in sulfur 1.3 ppm). The experiment was carried out with three sulfur sources (Gypsum, single super phosphate and bentonite) and four levels of sulfur (0, 7.5, 15, 22.5 kg S/ha) comprising 12 treatments which were laid out in Factorial Randomized Block Design and replicated thrice. Six rowed feed barley variety PL 807 was sown during *rabi* (2020 -21) with a row spacing of 22.5 cm. Nitrogen at 62.5 kg/ha was applied in two splits doses first half as a basal dose and second half as top dressing at 30 DAS, full dose of phosphorus (30 kg/ha) and sulfur was applied at the time of sowing. Twelve treatment combination comprises as T_1- Gypsum 0 kg ha^{-1}, T_2- Gypsum 7.5 kg/ha, T_3- Gypsum 15 kg/ha, T_4- Gypsum 22.5 kg/ha, T_5- SSP 0 kg/ha, T_6- SSP 7.5 kg/ha, T_7- SSP 15 kg/ha, T_8- SSP 22.5 kg/ha, T_9 - Bentonite 0 kg/ha, T_{10} - Bentonite 7.5 kg/ha, T_{11}- Bentonite 15 kg/ha, T_{12}-Bentonite 22.5 kg/ha. Data was collected in each treatment at 30, 60, 90 DAS and at the time of harvest of the crop from each plot Fivs were tagged in each plot to record various parameters viz., plant height, leaf area index, chlorophyll content, Compound growth rate (CGR), Relative growth rate (RGR) spike length, no. of spikelets per spike, dry matter yield, grain yield, straw yield.

RESULTS AND DISCUSSION

Plant height of barley

The data from Table 1 revealed that barley responded significantly to different sources and levels of sulfur except at 30 DAS. Among sources bentonite recorded significantly highest plant height at 60 and 90 DAS (35.8, 88.8 cm) DAS, which remained par with gypsum and lowest was recorded at SSP (33.5 and 82.3) at 30, 60 DAS. Source of bentonite increased the plant height by 5.6, 6.8 % over gypsum and SSP at 60 DAS and 5.23, 7.92 % at 90 DAS over gypsum and bentonite. The data also revealed that plant height at 60 and 90 DAS increased significantly with increase in levels up 22.5 kg S ha^{-1}. However at application of 22.5 kg S ha^{-1} recorded the highest plant height at 60 and 90 DAS (38.2, 93.5 cm) significantly lowest plant height was recorded at control (30.9, 79.7 cm). Application of 7.5, 15, 22.5 kg S ha^{-1} increased the plant height to the magnitude of 6.75, 14.22, 23.69 % over control without sulfur at 60 DAS, 3.0, 6.9,

Table 1. Effect of different sources an levels of sulfur on plant height and chlorophyll content in Barley.

	Plant height (cm)			Chlorophyll content (SPAD value)		
Treatments	30 days	60 days	90 days	30 days	60 days	90 days
Sources						
S_1- Gypsum	13.5	33.8	84.4	34.2	34.7	33.7
S_2- SSP	13.7	33.5	82.3	31.6	33.32	33.0
S_3- bentonite	13.3	35.8	88.8	34.1	36.4	36.4
CD	NS	1.14	2.71	NS	1.37	1.20
SE	0.16	0.38	0.92	1.58	0.46	0.41
CV	4.13	3.91	3.76	16.50	4.6	4.14
Levels						
L_1- 0 kg S/ha	13.1	30.9	79.7	33.2	31.8	33.3
L_2- 7.5 kg S/ha	13.6	30.0	82.1	35.3	34.6	34.3
L_3- 15 kg S/ha	13.6	35.34	85.2	30.6	35.6	33.8
L_4- 22.5 kg S/ha	13.8	38.2	93.5	34.2	37.1	36.2
CD	NS	1.31	3.13	NS	1.58	1.3
SE	0.18	0.44	1.06	1.83	0.54	0.47
CV	4.13	3.91	3.76	16.50	4.65	4.14
Interaction (S*L)						
CD	NS	NS	NS	NS	NS	NS
SE	0.32	0.77	1.85	3.17	0.93	0.82
CV	4.13	3.91	3.76	16.50	4.65	4.14

17.3% at 90 DAS over control. Interaction between different sources and levels of sulfur is found to be non-significant at 30, 60, 90 DAS. Application of sulfur might increased the metabolic activity which made to increase photosynthesis thus showing a positive effect on plant height. Similar results have also been recorded byTogay *et al.* (2008) conducted experiment on effect of sulfur applications on nutrient composition, yield and some yield components of barley and found that highest plant was recorded up to 160 kg S ha^{-1}. Kumar *et al.* (2020) conducted experiment on response of barley varieties to different levels of sulfur and concluded that increasing the sulfur levels up to 30 kg ha^{-1} resulted the highest plant height.

Chlorophyll content of barley

Different sources and levels did not exhibit significant effect on chlorophyll content at 30 DAS. But its effect was found significant at later stages of crop (Table 1). Application of bentonite source recorded highest chlorophyll content at 60 and 90 DAS (36.4, 36.4). Lowest chlorophyll content was recorded at SSP at 60 and 90 DAS (33.32, 33.0). Bentonite source increased the chlorophyll content by 4.8, 9.2% over gypsum and SSP at 60 DAS. 7.9, 10.3% over gypsum and SSP at 90 DAS. Increase in levels has a significant impact on chlorophyll content. Application of 22.5 kg S ha^{-1} gave highest chlorophyll content at 60 and 90 DAS (37.1, 36.2), lowest was recorded at control plot (31.8, 33.3). Increase in chlorophyll content with increase in sulfur levels 7.5, 15, 22.5 kg S ha^{-1}. Increased the chlorophyll content to the magnitude of 8.8, 11.8, 16.8% over control at 60 DAS. 3.1, 1.4, 8.8% over control at 90 DAS. Interaction between source and levels found to be non-significant at 30, 60, 90 DAS.

Dry matter accumulation of barley

Data from Fig. 1 (a, b, c) shown that sources and levels of sulfur revealed a non-significant effect on dry matter accumulation at 30 DAS. Bentonite source recorded highest dry matter at 60 and 90 DAS (2.93, 7.16 ton ha^{-1}) and remained par with gypsum. However SSP recorded lowest dry matter at 60 and 90 DAS (2.79, 7.02 ton ha^{-1}). Bentonite source increased dry matter accumulation by 1.3, 5.0% over gypsum and SSP at 60 DAS. 1.5, 1.9 % over gypsum and SSP at 90

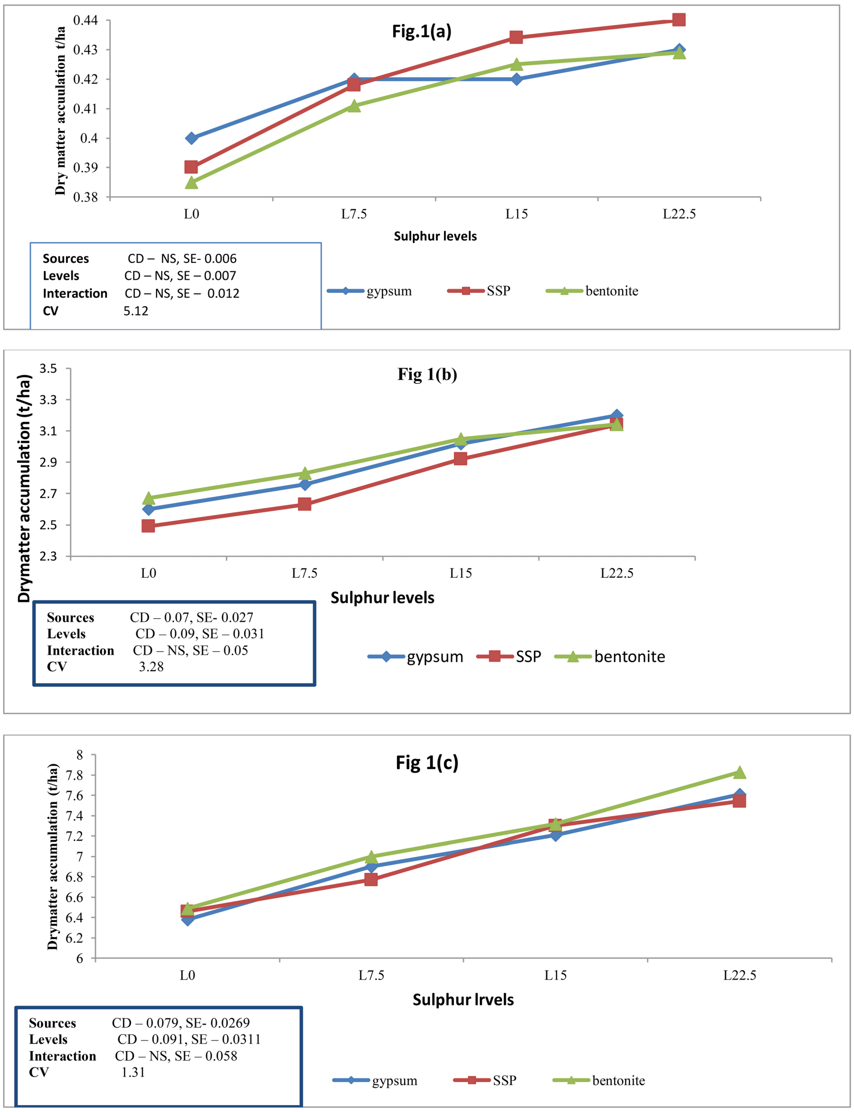

Fig. 1 (a,b,c). Effect of different sources and levels of sulfur on dry matter accumulation (t/ha) at 30 (1a), 60 (1b), 90 (1c) DAS.

DAS. Various levels of sulfur exhibited significant influence on dry matter except at 30 DAS. Application of Sulfur up to 22.5 kg S ha^{-1} gave highest dry matter accumulation at 60 and 90 DAS (3.1, 7.6 ton ha^{-1}). On the other hand lowest dry matter was recorded in control at 60, 90 DAS (2.5, 6.4 ton ha^{-1}). Application of 7.5, 15, 22.5 kg S h^{-1} increased the dry matter accumulation by 6.9, 15.8, 22.4% over control at 60 DAS. 6.9, 13.5, 18.9 % over control at 90 DAS. Interaction effect of different sources and levels was found to be non-significant on dry matter accumulation at 30, 60, 90 DAS. A steady and balanced supply of nutrients from the beginning resulted in vigorous plant growth, increased leaf area and the number of tillers and thus increased dry-matter accumulation. These findings are strengthened by Togay *et al.* (2008) stated that application of sulfur levels up to 160 kg ha^{-1} increased the dry matter accumulation in barley crop. Sutar *et*

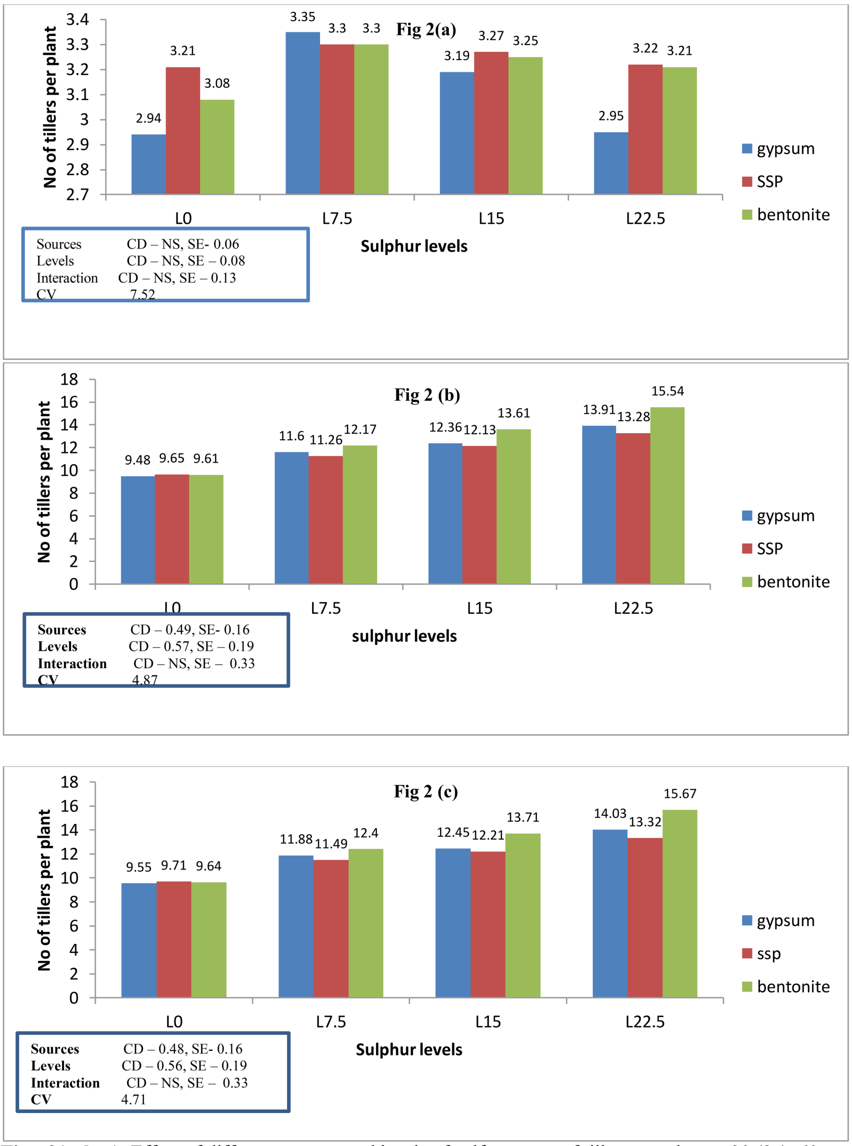

Fig. 2 (a, b, c). Effect of different sources and levels of sulfur on no. of tillers per plant at 30 (2a), 60 (2b), 90 (2c) DAS.

al. (2018) conducted a experiment in maize crop to observe the effect of different sources and levels and found that sulfur source bentonite with 50 kg S ha^{-1} resulted the highest dry matter per plant.

Number of tillers of barley

Data relating effect of different sources and levels of sulfur and interaction on total no. of tillers per plant at 30, 60, 90 DAS was furnished in Fig. 2 (a, b, c) sources and levels shown non-significant effect at 30 DAS. Source of sulfur through bentonite recorded significantly the highest number of tillers plant^{-1} at 60 and 90 DAS (12.7, 12.8), which remained par with gypsum. Lowest number of tillers was recorded in SSP at 60, 90 DAS (11.5, 11.6). Bentonite source increased the tiller count by 7.6, 10.1% over gypsum and SSP at 60 DAS. 7.2, 10.0% over gypsum and

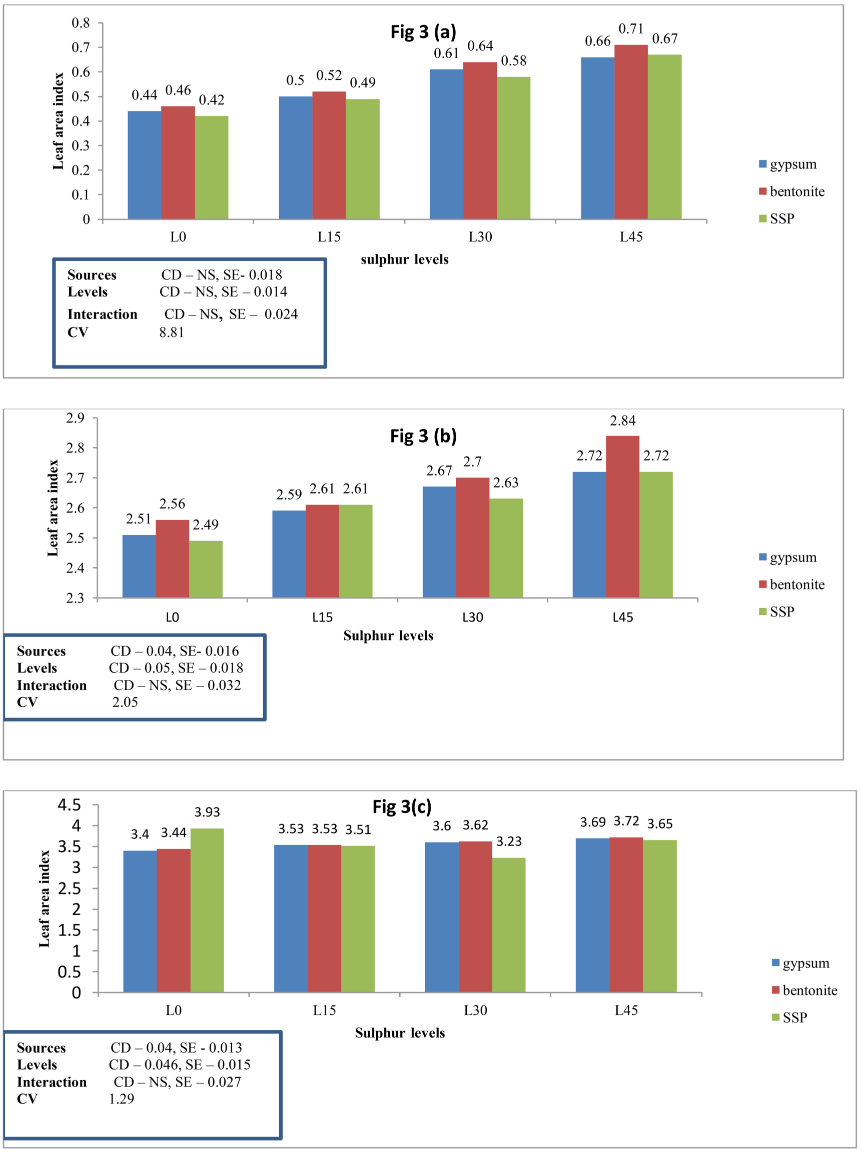

Fig. 3 (a, b, c). Effect of different sources and levels of sulfur on leaf area index at 30 (3a), 60 (3b), 90 (3c) DAS.

SSP at 90 DAS. The results revealed that levels of sulfur had non-significant effect on total number of tillers per plant at 30 DAS. Number of tillers per plant increased with increasing in sulfur levels up to 22.5 kg ha^{-1} at 60 and 90 DAS (14.2,14.3). Lowest number of tillers were recorded at control (9.5, 9.6). Application of sulfur 7.5, 15, 22.5 kg S ha^{-1} increased tillers count by 21.8, 32.5, 49.0% over control at 60 DAS. 23.7, 32.8, 48.9% over control at 90 DAS. Interaction between source and levels was found to be non significant at all growth stages. Tillering caused by the expansion of axillary buds and is closely related to the nutritional conditions of the main stem during its early growth cycle, which can be improved with application of sulfur. These findings are consonance with Kumar *et al.* (2020) conducted experiment in

Table 2. Effect of different sources an levels of sulfur on CGR , RGR at 30–60, 60–90 DAS in Barley.

	Crop growth rate (g m^{-2} day^{-1})		Relative growth rate (g g^{-1} day^{-1})	
Treatments	30-60 days	60-90 Days	30 -60 days	60-90 days
Sources				
S_1- Gypsum	8.22	13.8.	0.0279	0.0128
S_2- SSP	7.9	14.0	0.0273	0.0133
S_3- bentonite	8.25	14.2	0.0281	0.0130
CD	0.20	0.32	0.000484	0.000348
SE	0.60	0.10	0.000165	0.000119
CV	2.94	2.69	2.05	3.14
Levels				
L_1- 0 kg S/ha	7.30	12.8	0.0271	0.0131
L_2- 7.5 kg S/ha	7.80	13.7	0.0273	0.0132
L_3- 15 kg S/ha	8.3	14.4	0.0280	0.0131
L_4- 22.5 kg S/ha	9.05	15.0	0.0286	0.01284
CD	0.23	0.37	0.00055	NS
SE	0.07	0.12	0.00019	0.000137
CV	2.94	2.69	2.05	3.14
Interaction (S*L)				
CD	NS	0.64	NS	NS
SE	0.13	0.21	0.00033	0.00023
CV	2.94	2.69	2.05	3.14

barley crop and found that application of sulfur up to 30 kg ha^{-1} gave maximum tiller count per row length. Ram *et al.* (2014) conducted experiment in rice crop and concluded that bentonite with increasing levels of sulfur gave more no of tillers $plant^{-1}$.

Leaf area index (LAI) of barley

Both the sources and levels significantly influence LAI at all the growth stages except 30 DAS. Presented in Figs. 3 (a, b, c). Among sources, significantly a higher LAI was recorded with bentonite 60 and 90 DAS (2.75, 3.7) which remained par with gypsum. Among sources least LAI was recorded in SSP at 60, 90 DAS (2.6, 3.6). Bentonite source increased the LAI by 1.8, 1.9% over gypsum and SSP at 60 DAS. 0.5, 1.9% over gypsum and SSP at 90 DAS. Among levels sulfur application up to 22.5 kg S ha^{-1} given higher LAI at 60, 90 DAS (2.8, 3.7), least LAI was recorded at control (2.5, 3.5). Sulfur application 7.5, 15, 22.5 kg S ha^{-1} increased the LAI by 3.8, 4.6, 9.2 % over control at 60 DAS. 3.9, 6.5, 7.6% over control at 90 DAS. Interaction between sources and levels was found to be non-significant at 30, 60, 90 DAS. The increase in leaf-area index with increasing sulfur levels could be due to a more balanced and adequate nutrient supply, resulting in better carbohydrate utilization and protoplasm creation. Adequate sulfur application may have aided plants in achieving vigorus foliage growth, thereby increasing the LAI. These findings are also reported by Sutar *et al.* (2018) in maize crop to observe the effect of different sources and levels and they found that highest LAI was recorded in bentonite source along with 50 kg S ha^{-1}.

Compound growth rate and relative growth rate of barley

Results from Table 2 revealed that CGR was significantly influenced by both sources and levels at 30–60 and 60–90 DAS. Sources of sulfur showed significant effect on CGR at 30–60 and 60–90 DAS, Bentonite source shown highest CGR at 30–60, 60–90 DAS

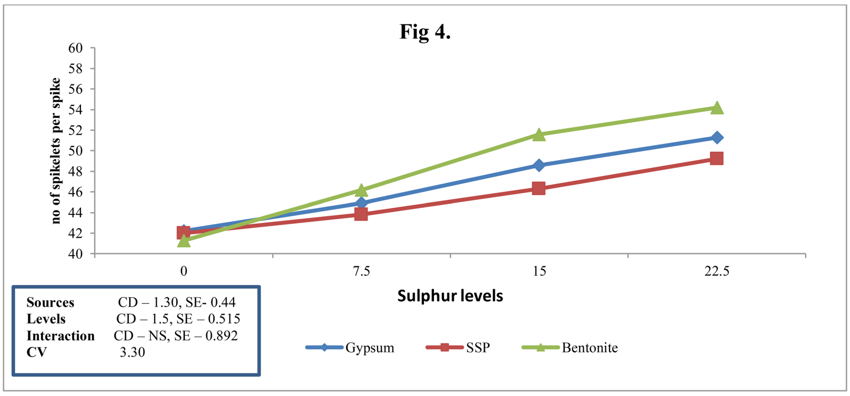

Fig. 4. Effect of different sources and levels of sulfur on number of spikelets per spike.

(8.2, 14.2 g m^{-2} day^{-1}) lowest CGR was recorded at SSP (7.9, 14.0 g m^{-2} day^{-1}). Bentonite source increased the CGR by 0.3, 4.16% over gypsum and SSP at 60 DAS. 3.1, 1.2% over gypsum and SSP at 90 DAS. Various levels of sulfur exhibited significant influence on CGR at 30–60 and 60–90 DAS. Application of sulfur up to 22.5 kg significantly recorded highest CGR at 30–60, 60–90 DAS (9.0, 15.0 g m^{-2} day^{-1}). Among levels lowest CGR was recorded at control (7.30, 12.8 g $m^{-2}day^{-1}$). Application of 7.5, 15, 22.5 kg S ha^{-1} increased CGR to the magnitude of 6.8, 14.6, 23.9% over control at 60 DAS. 7.3, 12.6, 17.1% over control at 90 DAS. Interaction between source and levels found to be non-significant at 30–60 DAS. At 60–90 DAS the interaction between source and levels is significant.

Results from Table 2 revealed that relative growth rate was significantly influenced by both the sources and levels at 30–60 DAS. At 30–60 DAS among sources bentonite gave highest RGR at 30-60 DAS (0.028 g g^{-1} day^{-1}) at 60–90 DAS SSP gave highest RGR (0.0130). Among levels 22.5 kg S ha^{-1} gave highest RGR at 30–60 DAS (0.0286 g $g^{-1}day^{-1}$). At 60–90 DAS 7.5 kg gave highest RGR (0.0132 g g^{-1} day^{-1}). Change in levels and interaction between source and levels was found to be non-significant at 30–60 and 60–90 DAS.

Number of spikelets per spike of barley

An appraisal of data (Fig. 4) indicated that different sources and levels was found to be significant on no.of

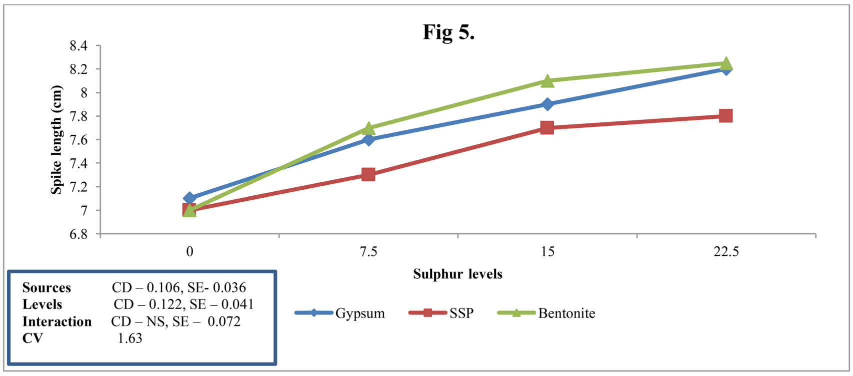

Fig. 5. Effect of different sources and levels of sulfur on spike length (cm).

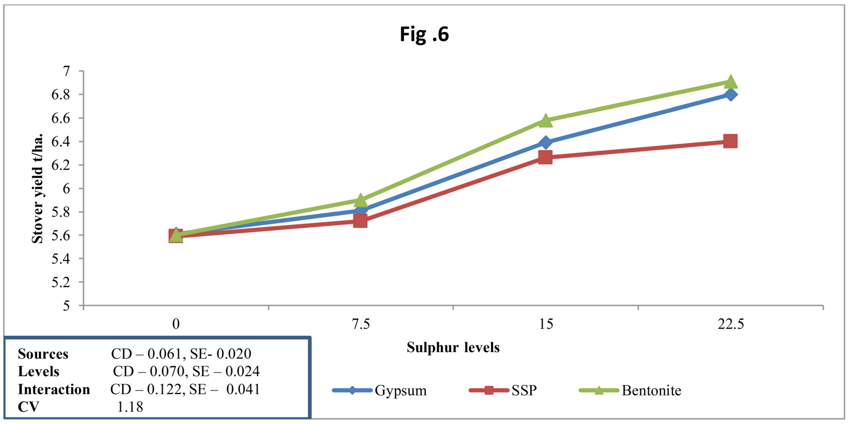

Fig 6. Effect of different sources and levels of sulfur on stover yield ton ha^{-1}.

spikelets per spike. Among sources bentonite gave more no. of spikelets per spike (48.3) which was par with gypsum and lowest was given by SSP (45.3). Source of bentonite increased no. of spikelets per spike by 3.4, 6.6 % over gypsum and SSP. Increasing levels of sulfur increased the no. of spikelets. 22.5 kg S ha^{-1} (51.6) gave more no. of spikelets per spike followed by 15, 7.5 kg S ha^{-1}, lowest spikelets was recorded at control (41.8). Application of 7.5, 15, 22.5 kg S ha^{-1} increased number of spikelets per spike to the tune of 7.4, 16.6, 23.2 % over control. Interaction between source and levels was found to be non-significant. Similar results were given by Kumar *et al.* (2020) conducted experiment in barley crop and found that application of sulfur up to 30 kg ha^{-1} gave the highest no. of spikelets per spike.

Length of spike of barley crop

Data pertaining to effect of different sources and levels of sulfur on length of spike was furnished in (Fig. 5). Significantly highest spike length was recorded in bentonite source (7.8 cm) and is par with gypsum and lowest was recorded at SSP (7.5 cm). Source of bentonite increased spike length by 0.7, 4 % over gypsum and SSP (Fig. 5) revealed that 22.5 kg ha^{-1} gave highest spike length (8.0 cm) and lowest was recorded in control (7.1 cm). The magnitude increase in spike length by the application of 7.5, 15, 22.5 kg S ha^{-1} over control to the tune of 6.4, 11.2, 13.6 %. Interaction between source and levels was failed to manifest their significant effect on length of spike in barley. Similar results were given by Kumar *et al.* (2020) reported that maximum spike length was obtained with the application of sulfur upto 30 kg S ha^{-1} in barley crop. Togay *et al.* (2008) stated that application of sulfur levels up to 160 kg ha^{-1} increased the spike length of the spike in barley crop.

Grain yield of barley crop

The data pertaining grain yield (t ha^{-1}) are given in (Figs. 6, 7) was influenced by the effect of different sources and levels of sulfur. Among sources highest grain yield was recorded in bentonite treatment (5.2 t ha^{-1}), which remain par with gypsum. Significantly lowest was recorded in SSP (4.9 t ha^{-1}). Source of bentonite increased grain yield by 1.5 and 4.8% over gypsum and SSP respectively. Among levels grain yield increased with gradual increase in levels up to 22.5 kg S ha^{-1}. 22.5 kg S ha^{-1} recorded highest grain yield in levels (5.5 t ha^{-1}). Lowest was recorded in control (4.6 t ha^{-1}). Application of 7.5, 15 and 22.5 kg S ha^{-1} recorded higher yield by 7.3, 13.6, 20.5 % over the control. Interaction between sources and levels was found to be significant at grain yield. Increase in grain yield through bentonite may be due to minimum leaching, high concentration and slow release of sulfur into the soil solution, sulfur status of experimental field was low (1.28 ppm), sulfur

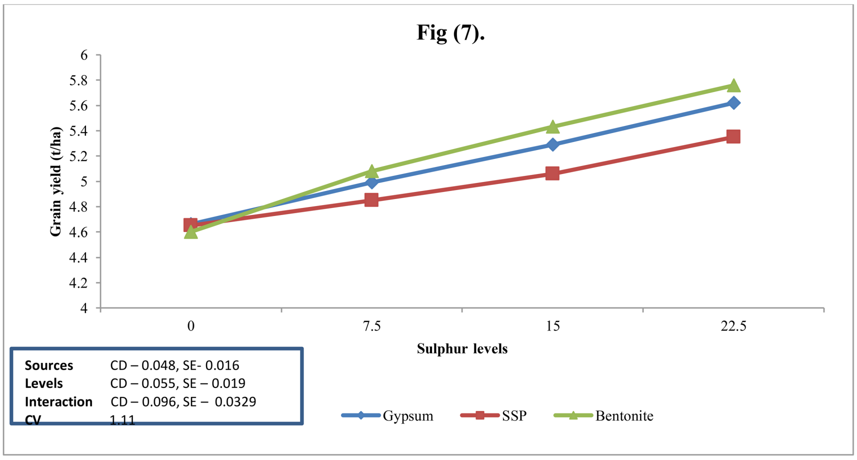

Fig. 7. Effect of different sources and levels of sulfur on Grain yield ton ha^{-1}.

application could have improved the nutritional environment of rhizosphere and plant system. Increasing the sulfur levels significantly increased grain yield of barley from 0–22.5 kg S ha^{-1}. Sutaliya *et al.* (2003) found that highest grain yield was recorded from 45 kg S ha^{-1} in barley. Togay *et al.* (2008) conducted experiment on effect of sulfur applications on nutrient composition. Yield and yield components of barley and stated that application of sulfur levels up to 160 kg ha^{-1} increased the straw yield. Bhagyalakshmi *et al.* (2010) in rice crop, Skwierawska *et al.* (2008) found that sulfur application had an important stimulating effect on spring barley grain and straw yields as compared to NPK fertilizer alone. Sutar *et al*. (2018) in maize and he found that maize gave highest grain yield by bentonite source and by increasing levels of sulfur up to 50 kg ha^{-1}. Kumar *et al*. (2020) conducted experiment on response of barley varieties to different levels of sulfur and stated that application of sulfur up to 30 kg ha^{-1} increased the grain yield over control.

Sraw yield of barley

Data recording effect of different sources and levels of sulfur. On straw yield (t ha^{-1}) are given in (Fig .6) sources of sulfur caused their significant influence. Highest straw yield was recorded in bentonite source (56.7 t h^{-1}), which was par with gypsum significantly lowest was recorded in SSP (54.4 t ha^{-1}). Source of sulfur through bentonite increased straw yield to the magnitude of 1.55 and 4.26% over gypsum and SSP. Increase in the levels of sulfur increased the straw yield. 22.5 kg S ha^{-1} gave highest straw yield (60.9 t ha^{-1}), lowest was recorded in control plots (50.8 t ha^{-1}). Application of 7.5, 15, 22.5 kg S ha^{-1} increased straw yield to magnitude of 3.8, 14.6 and 19.9% over control. Interaction between source and levels was found to be significant in straw yield. Increase in grain yield through bentonite may be due minimum leaching, high concentration and slow release of sulfur into the soil solution, sulfur status of experimental field was low (1.28 ppm), sulfur application could have improved the nutritional environment of rhizosphere and plant system. Increasing the sulfur levels significantly increased grain yield of barley from 0–22.5 kg S ha^{-1} to similar results are also reported by Togay *et al.* (2008) stated that application of sulfur levels up to 160 kg ha^{-1} increased the straw yield in barley. Bhagyalakshmi *et al.* (2010) in rice crop, Sutar *et al.* (2018) conducted research in maize and he found that maize gave highest straw yield by bentonite source and by increasing levels of sulfur up to 50 kg ha^{-1}. Kumar *et al.* (2020) stated that application of sulfur up to 30 kg ha^{-1} increased the straw yield in barley crop.

CONCLUSION

Positive effect was found on growth and yield of barley by the application of sources and levels.

Among sources bentonite application helped in maximizing the growth and yield parameters. With increase in levels of sulfur up to 22.5 kg ha^{-1} yield and growth parameters have also increased. Application of bentonite source with 22.5 kg S ha^{-1} helped in maximizing growth and yield parameters in barley.

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