

Effect of Irrigation Regimes and Levels of Sulfur on Yield Nutrient Uptake and Water Use Efficiency of Gobi Sarson

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Abstract

Field experiment conducted for two years *rabi* of 2005-06 and 2006-07 on sandy loam soil at Jammu to study the influence of irrigation regimes and levels of sulfur on yield, nutrient uptake, harvest index and water use efficiency (WUE) of gobi sarson. Significant increase in yield was recorded by the application of three irrigations, one each at branching, flowering and seed development during both the years of study. On an average there was 8.59 q/ha increase in seed yield over no irrigation/rainfed conditions. The crop responded to sulfur application up to 80 kg/ha though application of 40 kg/ha sulfur was statistically at par with higher levels of sulfur in terms of seed yield. Uptake of N, P, K and S increased by irrigating crop thrice recording maximum uptake. Increasing levels of sulfur increased the uptake of N, P, K and S but the higher levels of S being at par with 40 kg/ha sulfur. Similarly, irrigating gobi sarson twice recorded similar harvest index during both the years where as sulfur fertilization of 20 and 40 kg/ha produced similar harvest index during 2005-06 and 2006-07. Water use efficiency (WUE) of 5.33 kg/ha-mm was recorded with when crop was irrigated twice (flowering + seed development) in 2005-06 where as it was 2.40 kg/ha-mm when irrigated thrice (branching + flowering + seed development) where as higher level of sulfur fertilization recorded almost similar WUE.

Key words : Irrigation, Harvest index, WUE, Nutrient uptake, Gobi sarson.

Gobi sarson's productivity is low in large parts of Jammu division of J and K state. This is due to its occupation of marginal lands, imbalanced and low rate of fertilizer application and moisture scarcity as it is grown mostly under rainfed conditions. The productivity of these crops can be improved considerably by suitable input management like water (1) and nutrients particularly nitrogen and sulfur (2). The nutrient availability and their uptake by plants could be enhanced by maintaining proper soil moisture level, which ultimately improves the crop productivity. Keeping these points in view, the experiment was designed with various levels of irrigation and sulfur with gobi sarson under agro-climatic condition of Jammu district.

Methods

The field experiment was conducted in split plot design with three replication during *rabi* season of 2005-06 and 2006-07 at WMRC experimental block, Jammu with DGS-1 as test variety during both the

years of experimentation. The soil of the experimental site was sandy loam in texture with pH 7.1, low in N and medium in P, K and S. The treatments consisted of four levels of irrigations viz. rainfed or no irrigation, one irrigation at flowering, two irrigations, one each at flowering and seed development stage and three irrigation, one each at branching, flowering and seed development stage in main plots and five levels of sulfur, 0, 20, 40, 60 and 80 kg/ha in sub-plots. The recommended fertilization dose of 60 kg N, 40 kg P₂O₅ and 20 kg K₂O/ha were supplied through urea, DAP and murate of potash. All the phosphatic and potassic fertilizers along with half of fertilizer N was applied as basal and remaining half of N during branching except under rainfed conditions where 2/3rd N along with full amount of phosphatic and potassic fertilizers was applied as basal and 1/3rd N applied after 30 days of sowing. Sulfur was applied in the form of gypsum as basal before sowing. A uniform depth of 6 cm irrigation water was applied through Parshalls flume of 6.5 cm throat width. N, P and K content of seed and stover was determined by standard proce-

Table 1. Effect of irrigation regimes and sulfur fertilization on seed yield, oil content and harvest index of gobi sarson var DGS-1.

Treatments	Seed yield (q/ha)		Stover yield (q/ha)		Harvest index (HI)	
	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07
Irrigation Regimes						
Rainfed	5.59	5.37	23.25	18.95	0.19	0.22
Flowering	8.96	8.83	27.77	26.04	0.24	0.25
Flowering+ seed development	12.33	11.31	31.56	28.04	0.28	0.28
Branching+ flowering+seed development	14.25	13.89	44.60	41.94	0.24	0.24
CD (5%)	1.55	0.96	0.84	1.02	0.056	0.044
Sulfur Levels (kg/ha)						
0	7.22	7.02	22.01	21.90	0.24	0.24
20	9.94	9.44	27.42	28.53	0.26	0.24
40	11.35	10.57	33.84	29.45	0.25	0.26
60	11.42	10.95	37.82	31.75	0.23	0.25
80	11.48	11.17	38.14	32.61	0.23	0.24
CD (5%)	0.26	0.39	1.16	1.52	0.022	0.023

dures and nutrient uptake was worked out by multiplying content values by respective grain and straw yield. Sulfur content was determined by turbidometric method (3). Water use efficiency was computed as

$$\text{Water Use Efficiency (kg/ha-mm)} = \frac{\text{Yield (kg/ha)}}{\text{Total water applied (mm)}}$$

Where total water applied = Irrigation water applied

(mm) + Rain water (mm) except in rainfed treatment where no irrigation water was applied.

Results and Discussion

Yield Performance

The seed yield of gobi sarson was significantly increased over rainfed/no irrigation, one irrigation and two irrigations when the crop was irrigated thrice, one each at flowering, Seed development and branching as compared to one or two irrigations at flowering and flowering and branching. This trend was witnessed during both the years of experimentation (Table 1). Stover yield showed similar trend as that of seed yield during both years of study. The decrease in yield under rainfed conditions or with one or two irrigations compared to three irrigations may be due to greater depletion of available soil moisture. Panda et al. (4) reported similar results.

In both the years, the seed as well as stover yield increased with increase in the levels of sulfur from 0 kg/ha to 80 kg/ha. Maximum increase in seed and stover yield was with 80 kg/ha S which was statistically at par with 40 and 60 kg/ha during both the years of study (Table 1). On an average there was 58.17% increase in yield with the application of 80 kg/ha S over control. It could be due to beneficial role played by sulfur fertilization in various metabolic processes in plant (5). Panda et al. (4) reported similar results.

Harvest Index

The maximum harvest index was registered when

Table 2. Effect of irrigation regimes and levels of sulfur on uptake of nitrogen, phosphorus, potassium and sulfur by gobi sarson.

Treatments	Nitrogen (kg/ha)				Phosphorus (kg/ha)				Potash (kg/ha)				Sulfur (kg/ha)			
	Seed		Stover		Seed		Stover		Seed		Stover		Seed		Stover	
	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07
Rainfed	15.98	15.08	13.02	10.80	3.29	3.22	3.72	2.65	2.34	2.25	55.33	42.06	2.34	2.20	6.74	4.73
Flowering	26.25	25.60	14.16	13.54	5.46	5.38	4.44	4.16	4.12	3.70	59.70	57.80	4.12	3.88	8.05	6.77
Flowering+ seed development	36.99	33.70	15.46	13.45	8.38	7.80	5.04	4.20	6.16	4.75	63.75	62.24	6.16	5.42	9.15	7.29
Branching+ flowering+ seed development	46.25	45.69	21.40	19.71	10.68	10.12	8.02	6.71	9.69	6.25	90.09	93.52	8.22	7.63	13.38	10.90
Cd (5%)	0.43	0.56	1.21	1.01	0.32	0.41	0.40	0.36	0.35	0.22	3.22	4.15	0.35	0.21	0.73	0.51
Sulfur Levels (kg/ha)																

Table 2. Continued.

Treatments	Nitrogen (kg/ha)				Phosphorus (kg/ha)				Potash (kg/ha)				Sulfur (kg/ha)			
	Seed		Stover		Seed		Stover		Seed		Stover		Seed		Stover	
	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07
0	20.86	20.21	10.78	10.95	4.54	4.21	2.86	3.06	4.04	3.79	42.69	41.61	4.04	3.51	5.94	5.25
20	29.32	27.37	10.96	13.84	6.46	5.75	4.11	4.41	5.06	5.09	54.01	54.77	5.06	4.81	7.95	7.13
40	35.75	32.87	17.93	15.40	7.71	7.18	6.09	5.00	6.35	5.81	75.12	57.42	6.35	5.49	10.49	7.36
60	36.54	34.71	20.42	17.41	7.87	7.22	7.56	6.03	6.39	6.02	86.98	63.18	6.39	5.69	11.72	8.57
80	36.85	35.52	20.58	17.60	7.92	7.59	7.62	6.19	6.42	6.03	87.72	64.89	6.41	5.80	11.82	8.80
CD (5%)	1.46	1.55	0.69	0.85	0.26	0.30	0.30	0.26	0.24	0.41	1.17	1.02	0.24	0.11	0.31	0.33

crop was irrigated twice, once each at flowering and seed development stage during both the years of experimentation. However, sulfur fertilization at 20 kg/ha and 40 kg/ha during 2005-06 and 2006-07 produced higher Harvest Index of 0.26 each compared to control (Table 1). Singh et al. (6) also reported similar results.

Nutrient Uptake

With the increase in supply of irrigation water, nutrient uptake by crop has also shown an increasing trend. However, the uptake pattern of N, P, K and S nutrients varied with different regimes of irrigation. The uptake of N, P, K and S increased significantly

both in seed and stover during both the years of experimentation with increasing number of irrigations (Table 2), the highest value was recorded when the crop given three irrigations which was superior to 2, 1 and no irrigation. The highest uptake with three irrigations, one each at branching, flowering and seed development was primarily due to higher seed and stover yields of gobi sarson compared to other levels of irrigations. The results are in conformity with those of Panda et al. (4).

Increasing sulfur levels up to 80 kg/ha increased N, P, K, and S uptake, both in seed and stover in both years of experimentation, the increase being significant up to 40 kg/ha except N and S in seed during first year of experimentation where it was significant up to 20 kg/ha. Probably the increase in the supply of these nutrients not only increased their concentration in plant but also resulted in higher dry matter accumulation and thus yields. Similar findings were reported by Panda et al. (4) and Singh et al. (6).

Table 3. Water requirement and water use efficiency of gobi sarson as influenced by irrigation regimes and levels of sulfur.

Treatments	Total water applied (mm)		Water Use Efficient (kg/ha-mm)	
	2005-06	2006-07	2005-06	2006-07
Irrigation Regimes				
Rainfed	111	397	5.03	1.35
Flowering	171	457	5.23	1.93
Flowering+seed development	231	517	5.33	2.18
Branching+Flowering+seed development	291	577	4.89	2.40
CD (5%)	—	—	—	—
Sulfur Levels (kg/ha)				
0	201	487	3.59	1.44
20	201	487	4.94	1.93
40	201	487	5.64	2.17
60	201	487	5.68	2.24
80	201	487	5.71	2.29
CD (5%)	—	—	—	—

Water Requirement and Water-Use-Efficiency

Water requirement varied from 111 mm to 291 mm during 2005-06 and 397 mm to 577 mm during 2006-07 between rainfed/no irrigation and when crop was irrigated thrice one each at branching, flowering and seed development. During *rabi* 2005-06 there was 111 mm rainfall which was less than 32 years average rainfall (287 mm) whereas in *rabi* 2006-07 *rabi* rainfall was 397 mm which was more than the average (7). However, water use efficiency (WUE) was found maximum during *rabi* of 2005-06 when the crop was irrigated twice one each at flowering and seed develop-

ment (5.33 kg/ha-mm) where as it was 2.40 kg/ha-mm in *rabi* 2006-07 when the crop was irrigated thrice, one each at branching, flowering and seed development. Parihar and Tripathi (1) and Kumar et al. (8) also reported that increase in soil moisture could increase the WUE up to certain level, but it tends to decline thereafter (Table 3).

Though there was no variation in water requirement between different fertilizer treatments, the WUE was recorded higher at higher level of sulfur fertilization, with almost similar WUE at 60 and 80 kg/ha S application (Table 3) during both the years of study.

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