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Yield Performance of Different Irrigation Methods and Sulphur Sources on Lentil, Chickpea and Mustard

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Abstract

A field experiment was conducted during 2002-2003 to study the performance of different irrigation methods and sulphur sources on the yield of lentil, chickpea and mustard in silty clay loam soils. Four methods of irrigation viz., rainfed, surface irrigation (check-basin), Low Energy Water Application (LEWA) device and sprinkler irrigation as main plot treatments, and three sources of sulphur viz., SSP @ 20 kg S ha^{-1}, SSP @ 10 kg ha^{-1} + Granular Sulphur @ 10 kg ha^{-1}, Granular Sulphur @ 20 kg S ha^{-1} and control as sub-plot treatments were evaluated in a split plot design replicated thrice. Five cm irrigation scheduled at 50% depletion of available moisture content was applied 35 days after sowing for all the crops under surface irrigation. Almost all growth attributes, yield attributes and yields of all three crops were significantly superior when irrigation was provided by LEWA over sprinkler irrigation and surface irrigation. LEWA irrigation produced 1.65, 1.59 and 1.54 t ha^{-1} grain yield of lentil, chickpea and mustard, respectively, which was 20% higher over surface method. LEWA irrigation could save 30 to 50 per cent energy requirement over surface method. Among the sulphur sources, application of SSP @ 10 kg S ha^{-1} + Granular Sulphur @ 10 kg S ha^{-1} was significantly superior over Granular Sulphur @ 20 kg S ha^{-1} and produced 16% higher grain yield of mustard. Lentil and chickpea grain yields were at par and were 15 per cent higher over other treatments, respectively. The interaction effect of methods of irrigation and sources of sulphur was non-significant. Hence, for obtaining higher yields of lentil, chickpea and mustard, these crops may be irrigated by LEWA along with application of SSP @ 10 kg S ha^{-1} + Granular Sulphur @ 10 kg S ha^{-1}.

Key words: *Yield performance, irrigation methods, pulse and oilseed crops, growth, yield attributes.*

INTRODUCTION

The yield of lentil, chickpea and mustard is very low because they are grown on marginal soils with poor technology. The area under these crops is not likely to go up in the near

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future. This is also true for the irrigation resources along with the competition with other food crops. Increasing the productivity of pulses and oilseeds is the only feasible option though increasing the crop productivity demands higher inputs, which are also costly and limited. Now the challenge before us are to increase the pulses and oilseed production, at least double it, in next decade so as to feed the fast growing population along with maintenance of soil health in the long run. Their yields can be increased considerably, if little irrigation are applied along with sulphur applications. The opportunity for increasing the water use efficiency at farm level lies in adopting suitable method of water application. Application efficiency and uniformity of water application (distribution efficiency) are the important factors affecting the spatial and lumped storage of water in the root zone of a cropped field and hence needs to be given due consideration in selection of an irrigation system. The sprinkler system is suitable for almost all crops and also provide greater control over application rate than do furrow or other surface method of irrigation. However, constraint in its adoption is high-energy requirement. In India farm holding of the majority of the farmers is very small. Extensive check basin irrigation to different crops is being practiced in Haryana, Punjab, Rajasthan, Uttar Pradesh and Bihar. The average width of the check basins in these states varies between 6 to 8 m. Majority of the growers comprising of large number of small and marginal categories still forced to practice surface methods of irrigation incurring not only huge wastage of water but also different form of energy used for pumping. Considering the conditions of small holders, there is urgent need to test low cost water and energy efficient device i.e., LEWA which offers more uniform (>95%), application of water at low pressure (0.2-0.4 kg cm^{-2}).

Sulphur deficiency is becoming widespread due to continuous use of sulphur free fertilizers, coarse textured soil, low organic matter in soil, crop rotation including pulses and oilseeds, high- yielding varieties, intensive multiple cropping system, high sulphur requiring crops, leaching and erosion losses. Presently, sulphur deficiency is widespread in Indian soils and is on the rise. For pulses and oilseeds RAU, Pusa has already recommended basal application of 20 kg S ha^{-1} for S-deficient fields of Bihar. SSP is the usual fertilizer containing 12% S serves to fill up the deficiency to some extent. All sources except elemental S and pyrites contain S in the water-soluble, readily available sulphate ($SO_4^{=}$). This form is also the form in which plant roots absorb S. The choice of the fertilizer should be based upon agronomic suitability, timely local availability, ease of transport, and prices. Granular Sulphur is readily available in Bihar in pure form containing 90% S which is not lost as runoff with irrigation water in the fields. It has good compatibility with other fertilizers. However, the market price of SSP and Granular Sulphur is at par. Hence their field evaluation is necessary to understand yield performance of different irrigation methods and sulphur sources on lentil, chickpea and mustard.

MATERIAL AND METHODS

A field experiment was conducted during 2002-2003 at farm of ICAR-RCER, Patna. The treatments consisted of four methods of irrigation viz., rainfed, surface irrigation

(check-basin), Low Energy Water Application (LEWA) device and sprinkler irrigation in main plots, whereas three sources of sulphur viz., SSP @ 20 kg S ha^{-1}, SSP @ 10 kg ha^{-1} + Granular Sulphur @ 10 kg ha^{-1} Granular Sulphur @ 20 kg S ha^{-1} and control as sub-plot treatments were evaluated in a split plot design replicated thrice. The recommended doses of fertilizers (pulses: 20 kg N ha^{-1} and 40 kg P_2O_5 ha^{-1} in the form of urea and SSP, mustard. 30 kg N ha^{-1} and 40 kg ha^{-1} each of P_2O_5 and K_2O as basal dose and rest 30 kg N ha^{-1} as top dressing at the pod formation stage) were followed. Five cm irrigation scheduled at 50% depletion of available moisture content was applied 35 days after sowing for all the crops under surface irrigation. A total of 7.2 cm rainfall was received during the crop season. 'Narendra Masur -1' 'RAU-52' and 'Pusa Bold' varieties of lentil, chickpea and Indian mustard respectively were sown on 5 November. The soil of the experimental field was silty clay loam in texture with pH-7.0, medium in available N (296 kg ha^{-1}), rich in available K_2O (385 kg ha^{-1}) and low in available S. The top 15 cm soil layer had a bulk density of 1.52 g cm^{-3}, field capacity 37.0% and permanent wilting point 17% on oven dry basis.

RESULTS AND DISCUSSION

Lentil

The results revealed that irrigation methods had a marked effect on growth attributes like plant height and dry matter accumulation per plant, over rainfed one with exception of 1000-seed weight. Yield attributes like number of pods per plant, grain weight per plant and grain yield was significantly superior when irrigation was provided by LEWA over sprinkler irrigation and surface irrigation. However, the straw yield and number of grains remained at par between each LEWA and sprinkler methods of irrigation. 1000-seed weight was maximum when S was applied through SSP + Granular Sulphur which was significantly higher over all other sulphur sources. The number of grains per plant, grain weight per plant and grain yield was also maximum in case of SSP + Granular Sulphur which was statistically at par with Granular Sulphur alone. (Table 1).

Chickpea

Irrigation methods had a marked effect on all the growth, yield attributes and yield. But there was no significant difference in 1000-seed weight indicating that it is genetically controlled and varietal character. Yield was signinificantly higher with SSP+ Granular Sulphur over other sulphur sources but at par with Granular Sulphur alone. Next in order was SSP, which was at par with Granular Sulphur. However, with use of SSP+ Granular Sulphur all other growth and yield attributes were significantly superior over all other sources except that of 1000-seed weight (Table 2). Non-significant difference in 1000-seed weight has also been reported by Shivkumar (2001).

Mustard

Number of pods per plant, grain weight per plant and yield was significantly higher under LEWA, which was significantly at par with sprinkler with the exception of grain

weight per plant. However, irrigation methods failed to achieve significant difference for growth viz., plant height and dry matter accumulation per plant and yield attribute i.e., number of grains per plant. Significantly higher yield as well as growth and yield attributes were recorded when S was applied through SSP+ Granular Sulphur, which was at par with Granular Sulphur alone (Table 3). Sharma (1994) and Khanpara et al (1993) also reported increased yield of Indian mustard through sulphur application.

Table 1
Effect of Different Irrigation Methods and Sulphur Sources on Growth Yield Attributes and Yield of Lentil

Treatment	Plant Height (cm)	Dry matter accumulation plant^{-1} (g)	Grain plant^{-1} (No.)	Pods plant^{-1} (No.)	Grain weight plant^{-1} (g)	1000-seed weight (g)	Yield (kg ha^{-1}) Grain	Straw
Irrigation Methods								
Rainfed	30.13	5.67	90.61	91.40	1.57	17.63	1088	1172
Surface	35.00	6.52	92.58	95.33	1.68	17.80	1379	1350
Sprinkler	36.54	6.65	93.77	96.36	1.77	18.14	1597	1469
LEWA	38.36	6.78	94.68	97.30	1.84	8.17	1650	1532
CD 5%	NS	0.75	1.43	0.69	0.04	0.23	36.18	131
Sulphur Sources								
SSP	34.87	6.13	92.63	94.79	1.70	17.74	1285	1315
No S	33.83	5.77	90.64	92.89	1.61	17.39	1252	1261
SSP+Granular Sulphur	36.41	7.03	94.62	96.92	1.83	18.52	1698	1511
Granular Sulphur	34.92	6.70	93.75	95.78	1.73	18.08	1477	1436
CD 5%	NS	NS	1.14	NS	0.11	0.22	227	NS

Table 2
Effect of Different Irrigation Methods and Sulphur Sources on Growth Yield Attributes and Yield of Chickpea

Treatment	Plant height (cm)	Dry matter accumulation plant^{-1} (g)	Grain plant^{-1} (No.)	Pods plant^{-1} (No.)	Grain weight plant^{-1} (g)	1000-seed weight (g)	Yield (kg ha^{-1}) Grain	Straw
Irrigation Methods								
Rainfed	45.13	9.63	81.36	43.88	19.73	1.55	1028	1412
Surface	46.43	9.79	83.91	45.67	20.71	1.56	1331	1583
Sprinkler	47.33	9.96	84.23	46.15	21.68	1.55	1562	1602
LEWA	47.73	10.09	85.79	47.25	22.56	1.56	1587	1633
CD 5%	1.16	0.15	0.81	0.87	0.33	NS	24	52
Sulphur Sources								
SSP	46.63	9.69	83.05	45.02	20.93	1.56	1233	1519
No S	45.61	9.47	80.58	43.63	19.99	1.54	1197	1473
SSP + Granular Sulphur	47.67	10.28	86.16	48.19	22.02	1.56	1647	1660
Granular Sulphur	46.71	10.04	85.50	46.10	21.73	1.56	1432	1578
CD 5%	0.48	0.11	0.43	0.73	0.21	NS	230.3	76

Table 3
Effect of Different Irrigation Methods and Sulphur Sources on Growth Yield Attributes and Yield of Mustard

Treatment	*Plant height (cm)*	*Dry matter accumulation plant^{-1} (g)*	*Grain plant^{-1} (No.)*	*Pods plant^{-1} (No.)*	*Grain weight plant^{-1} (g)*	*1000-seed weight (g)*	*Yield (kg ha^{-1}) Grain*	*Straw*
Irrigation Methods								
Rainfed	175.96	51.11	18.95	279.58	7.38	3.98	1000	3626
Surface	177.18	52.38	19.24	284.33	7.49	4.02	1300	3720
Sprinkler	180.4-2	50.91	19.83	287.08	7.59	4.04	1530	3810
LEWA	182.21	50.81	20.25	290.08	7.64	4.04	1543	3848
CD 5%	NS	NS	NS	4.78	0.02	NS	17.17	116
Sulphur Sources								
SSP	175.03	51.28	17.55	267.83	7.44	4.03	1210	3658
No S	171.03	49.97	16.81	264.42	7.23	3.89	1150	3449
SSP+Granular Sulphur	185.95	52.76	22.47	307.17	7.77	4.15	1615	3955
Granular Sulphur	183.76	51.20	21.43	301.67	7.67	4.02	1390	3842
CD 5%	2.21	0.95	1.70	6.00	0.11	0.08	224.31	103

LEWA irrigation could save 30 to 50 per cent energy requirement over surface method. Singh et al (2004) have also observed superiority of LEWA over sprinkler method on accounts of its enegy and cost requirement. Among the sulphur sources, application of SSP @ 10 kg S ha^{-1} + Granular Sulphur @ 10 kg S ha^{-1} was significantly superior over Granular Sulphur @ 20 kg S ha^{-1} and produced 16% higher grain yield of mustard. Lentil and chickpea grain yields were at par and were 15 per cent higher over other treatments, respectively. The interaction effect of methods of irrigation and sources of sulphur was non-significant.

It can be inferred from the results that for obtaining higher yields of lentil, chickpea and mustard, these crops may be irrigated by LEWA along with application of SSP @ 10 kg S ha^{-1} + Granular Sulphur @ 10 kg S ha^{-1}.

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