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To Workout the Economics and Energetics of Lentil as Influenced by Irrigation and Foliar Spray of Nutrients and Growth Hormones

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A B S T R A C T

The field experiment was conducted during *rabi* season of 2017-18 at the Instructional Cum Research Farm, under all India Coordinated Research Project on MULLaRP, Department of Agronomy, College of Agriculture, I.G.K.V. Raipur (CG.) The use of growth regulators is becoming popular to enhance crop productivity and varieties of such substances are available in the markets which are being utilized for crop production. Foliar application should be timed to provide needed nutrients during the yield determining growth stages. Plant growth regulators are the chemicals which influence the plant growth when applied in very minute quantity. The experiment was laid out in Strip Plot Design having the combination of fourteen treatments and three replications. The treatment consisted of seven foliar nutrients spray and two irrigation levels. The experiment was comprised of factor A. Horizontal plot (Irrigation level-2) I_1-One irrigation (35 DAS), I_2-Two irrigation (35 and 65 DAS) B. Vertical plot (Foliar Spray-7) F_1-Water Spray, F_2-Nitrobenzene @ 0.3%, F_3-N: P: K:: 19:19:19 @ 1% solution, F_4-Multi micro nutrient (Fe, Mn, Zn, B, Cu, Mo) @ 0.1%, F_5-Plant growth hormones mixture (Cytokinins and Enzymes) @ 0.15%, F_6-N: P: K:: 19:19:19:@ 1% + Multi micro nutrient (Fe, Mn, Zn, B, Cu, Mo) @ 0.1%, F_7-N: P: K:: 19:19:19 + Multi micro nutrients + Plant growth hormones. Significantly maximum N, P and K uptake in seed, stover as well as in total was recorded with I_2-Two irrigations followed by I_1-One irrigation. As regards to foliar spray, significantly higher N, P and K uptake in seed, stover and in total was noted under F_7-N: P: K:: 19:19:19 + MMN + PGHM as compared to others, however, it was at par to treatmentsF_6- N: P: K:: 19:19:19: + MMN,F_3-N: P: K:: 19:19:19 @ 1% and F_4-Multi Micro Nutrients. Between the irrigation levels, significantly higher water use efficiency (86.79 kg ha^{-1}cm) was recorded with I_1-One irrigation as compared to I_2-Two irrigation (66.06 kg ha^{-1}cm). As regards to the foliar spray of micronutrients and growth hormones, maximum water use efficiency (89.56 kg ha^{-1}cm) was recorded with F_7- N: P: K:: 19:19:19 + MMN + PGHM. However, it was at par to treatment F_6-N: P: K:: 19:19:19 + MMN (82.13 kg ha^{-1}). The minimum water use efficiency (58.03 kg ha^{-1}cm) was observed with F_1- Control (water spray).

Introduction

In India, it is grown over an area of 1.27 m ha with an annual production of 0.976 mt and an average productivity of 765 kg ha^{-1} (Anonymous, 2016-17). Lentil varieties developing larger and deeper root system are advantageous for sustaining yield in nutrient-poor soils of dry areas. Nutrient uptake by crop plants is generally decreased under water-stress conditions owing to a substantial decrease in transpiration rates and impaired active transport and membrane permeability and resulting in a reduced root-absorbing power of crop plants. So there is much need to give fertilizers through soil as well foliar application. Like fertilizer, micronutrient, growth regulators are also important. Low and variable seed yield is a major problem limiting the production and rapid expansion of grain legumes including lentil in tropic. The serious problem of flower drop and poor seed setting need serious attentions. Some micronutrients and growth substances are being increasingly employed as an aid to enhance yield. Micronutrients viz., zinc boron, iron, manganese, copper, molybdenum and growth substances were found to successful as a foliar spray in some crops to overcome deficiency of particular micronutrient, increasing photosynthetic efficiency, prevent senescence.

The use of growth regulators is becoming popular to enhance crop productivity and varieties of such substances are available in the markets which are being utilized for crop production. Foliar application should be timed to provide needed nutrients during the yield determining growth stages. Plant growth regulators are the chemicals which influence the plant growth when applied in very minute quantity. There are many reports which indicate that application of growth regulators enhanced plant growth and crop yield (Ashraf *et al.,* 1989 and Hernandez, 1997).

Materials and Methods

The field experiment was conducted during *rabi* season of 2017-18 at Instructional cum Research Farm, I.G.K.V. Raipur, Chhattisgarh comprised of horizontal and vertical factor against effect of irrigation and foliar spray of nutrients and growth hormones on growth, yield attributes and yield of lentil. The treatment consisted of seven foliar nutrients spray and two irrigation levels. The experiment was laid out in Strip Plot Design having the combination of fourteen treatments and three replications. The experiment was comprised of factor A. Horizontal plot Irrigation level-2 I_1-One irrigation (35 DAS) I_2-Two irrigation (35 and 65 DAS) factor B. Vertical plot Foliar Spray-7 F_1-Water Spray F_2-Nitrobenzene @ 0.3% F_3-N: P: K:: 19:19:19 @ 1% solution F_4-Multi Micro Nutrient (Fe, Mn, Zn, B, Cu, Mo) @0.1% F_5-Plant growth hormones mixture (Cytokinins and Enzymes) @ 0.15% F_6-N: P: K:: 19:19:19:@ 1% + Multi Micro Nutrient (Fe, Mn, Zn, B, Cu, Mo) @ 0.1% F_7-N: P: K:: 19:19:19 + Multi micro nutrients + Plant growth hormones. The soil of the experimental field was *Vertisols* with low, medium and high in N, P and K, respectively and neutral in reaction. The climate of the region is sub-humid to semi-arid.

Results and Discussion

Economics

Gross return (Rs. ha^{-1})

Economics of lentil production in terms of gross return was calculated for different irrigation levels and foliar spray of micronutrients and growth hormones and data are presented in Table 1, 2, 3 and 4.

The data reveals that significantly maximum gross return (Rs. 48922.9 ha^{-1}) was received

under I_2-Two irrigations (35 and 65 DAS). Whereas, the minimum gross return (Rs. 42731.5 ha^{-1}) was received under I_1-One irrigation (35 DAS).

Concerning to foliar spray of micronutrients and growth hormones, treatment F_7- N: P: K:: 19:19:19 + MMN + PGHM received significantly maximum gross return (Rs. 54942.2 ha^{-1}).However, the minimum value of gross return (Rs.35627.0 ha^{-1}) was noted under F1- Control (water spray).

The gross return of lentil due to interaction effect of irrigation levels and foliar spray of micronutrients and growth hormones was found non- significant.

Net returns (Rs. ha^{-1})

Economics of lentil production in terms of net return was calculated for different irrigation levels and foliar spray of micronutrients and growth hormones and data are presented in Table 1. The data reveals that significantly maximum net return (Rs.30060.5 ha^{-1}) was received under I_2-Two irrigations (35 and 65 DAS) and minimum net return (Rs.24369.1 ha^{-1}) was received under I_1-One irrigation (35 DAS).

Concerning to foliar spray of micronutrients and growth hormones, treatment F_7- N: P: K:: 19:19:19 + MMN + PGHM received significantly maximum net return (Rs. 33638.2 ha^{-1}). However, it was at par to treatments F_3-N: P: K:: 19:19:19 @ 1% (Rs. 29968.6 ha^{-1}),F_6-N: P: K:: 19:19:19 + MMN (Rs 29863.1 ha^{-1}) and F4-Multi micro nutrients (Rs. 28216.6 ha^{-1}). The minimum value of net return was noted under F1- Control (water spray).

The net return of lentil due to interaction effect of irrigation levels and foliar spray of micronutrients and growth hormones was found non- significant.

Return Re^{-1} invested

Return Re^{-1} invested was calculated for different irrigation levels and foliar spray of micronutrients and growth hormones and data are presented in Table 1.

The data reveals that the irrigation levels failed to give significant impact on return Re^{-1} invested, however maximum value (2.59) was noted under I_2-Two irrigations (35 and 65 DAS). The minimum return Re^{-1} invested (2.32) was received under I_1-One irrigation (35 DAS).

As regards to foliar spray of micronutrients and growth hormones, treatment F_7- N: P: K:: 19:19:19 + MMN + PGHM received significantly highest return Re^{-1} invested (2.65), but it was at par to rest of the treatments except treatment F_1 – water spray (2.09).

The interaction effect of irrigation levels and foliar spray of micronutrients and growth hormones was found non- significant.

Sitaram *et al.*, (2013) and Kumar *et al.*, (2017) also noted that foliar spray of nutrients and growth hormones significantly increased the net returns and B: C ratio.

Energetics

Energy output: input ratio

Data calculated on energy output: input ratio of lentil at harvest has been presented in Table 5. Data shows that energy output: input ratio did vary due to irrigation levels.

However, in case of foliar spray of micronutrients and growth hormones, treatment F_7- N: P: K:: 19:19:19 + MMN + PGHM recorded significantly maximum energy output: input ratio (2.22).

Table.1 Economics of lentil as affected by irrigation levels and foliar spray of micronutrients and growth hormones

Treatment		Cost of cultivation (Rs ha^{-1})	Gross return (Rs ha^{-1})	Net return (Rs ha^{-1})	Return Re^{-1} invested
Irrigation levels					
I_1-	One irrigation (35 DAS)	18362.4	42731.5	24369.1	2.32
I_2-	Two irrigations (35 and 65 DAS)	18862.4	48922.9	30060.5	2.59
SEm±			894.4	894.4	0.05
CD (P=0.05)			5442.3	5442.3	NS
Foliar spray					
F_1-	Water Spray	17038.0	35627.0	18589.0	2.09
F_2-	Nitrobenzene @ 0.3%	18658.0	43425.0	24767.0	2.33
F_3-	N: P: K:: 19:19:19 @ 1%	18163.0	48131.6	29968.6	2.63
F_4-	Multi Micro Nutrients (MMN)	18168.0	46384.6	28216.6	2.55
F_5-	Plant Growth Hormones Mixture (PGHM) @ 0.15%	18356.0	43817.1	25461.1	2.39
F_6-	N: P: K:: 19:19:19: + MMN	19293.0	49156.1	29863.1	2.55
F_7-	N: P: K:: 19:19:19 + MMN + PGHM	20611.0	54249.2	33638.2	2.65
SEm±			1893.6	1893.6	0.10
CD (P=0.05)			2834.8	5834.8	0.32
Interaction I×F			NS	NS	NS

Table.2 Interaction table on gross return (Rs ha^{-1}) of lentil as affected by irrigation and foliar spray of micronutrients and growth hormones

A×B	I_1	I_2	Total	Mean
F_1	29048	42207	71254	35627
F_2	40712	46138	86850	43425
F_3	48032	48232	96263	48132
F_4	42508	50261	92769	46385
F_5	44086	43548	87634	43817
F_6	46652	51661	98312	49156
F_7	48084	60414	108498	54249
Total	299121	342460		
Mean	42732	48923		

Table.3 Interaction table on net return (Rs ha^{-1}) of lentil as affected by irrigation and foliar spray of micronutrients and growth hormones

A×B	I_1	I_2	Total	Mean
F_1	12260	24919	37178	18589
F_2	22304	27230	49534	24767
F_3	30119	29819	59937	29969
F_4	24590	31843	56433	28217
F_5	25980	24942	50922	25461
F_6	27609	32118	59726	29863
F_7	27723	39553	67276	33638
Total	170584	210423		
Mean	24369	30060		

Table.4 Interaction table on Return Re^{-1} Invested of lentil as affected by irrigation and foliar spray of micronutrients and growth hormones

A×B	I_1	I_2	Total	Mean
F_1	1.73	2.44	4.17	2.09
F_2	2.21	2.44	4.65	2.33
F_3	2.68	2.62	5.30	2.65
F_4	2.37	2.73	5.10	2.55
F_5	2.43	2.34	4.78	2.39
F_6	2.45	2.64	5.09	2.55
F_7	2.36	2.90	5.26	2.63
Total	16.24	18.11		
Mean	2.32	2.59		

Table.5 Energetics of lentil as affected by irrigation levels and foliar spray of micronutrients and growth hormones

Treatment		Energy output: input ratio	Energy use efficiency (kg/ MJ×10^{-3})
Irrigation levels			
I_1-	One irrigation (35 DAS)	1.90	0.06
I_2-	Two irrigations (35 and 65 DAS)	2.13	0.06
SEm±		0.05	0.001
CD (P=0.05)		NS	0.006
Foliar spray			
F_1-	Water Spray	1.66	0.05
F_2-	Nitrobenzene @ 0.3%	1.84	0.06
F_3-	N: P: K:: 19:19:19 @ 1%	2.13	0.06
F_4-	Multi Micro Nutrients (MMN)	2.10	0.06
F_5-	Plant Growth Hormones Mixture (PGHM) @ 0.15%	1.94	0.06
F_6-	N: P: K:: 19:19:19: + MMN	2.19	0.06
F_7-	N: P: K:: 19:19:19 + MMN + PGHM	2.22	0.06
SEm±		0.11	0.003
CD (P=0.05)		0.34	NS
Interaction I×F		NS	NS

However, it was found at par to treatmentsF_6- N: P: K:: 19:19:19 + MMN (2.19) ,F_3-N: P: K:: 19:19:19 @ 1% (2.13) and F_4- Multi micro nutrients (2.10). The minimum energy output: input ratio (1.66) was observed with F1- Control (water spray).

The differences in energy output: input ratio of lentil due to interaction effect of irrigation levels and foliar spray of micronutrients and growth hormones was found non- significant.

Energy use efficiency (kg /MJ×10^{-3})

Data calculated on energy use efficiency of lentil at harvest have been presented in Table 5. Data shows that energy use efficiency was influenced by various irrigation levels. Between the irrigation levels, energy use efficiency (0.06 kg MJ×10^{-3} ha^{-1}) was recorded significantly higher with I_2-Two irrigations as compared to I_1-One irrigation (0.06 kg/MJ×10^{-3}).

As regards to the foliar spray of micronutrients and growth hormones, none of the treatments gave significant effect on energy use efficiency.

The differences in energy use efficiency of lentil due to interaction effect of irrigation levels and foliar spray of micronutrients and growth hormones was found non- significant.

Sharma *et al.,* (1998) and Gupta (2000) also observed similar findings.

Conclusions of the study are as follows:

1. Due to production of more yield, net return and Return Re^{-1}invested were also recorded highest with irrigation level I_2-Two irrigations at 35 and 65DAS and foliar spray of F_7-N: P: K:: 19:19:19 + MMN + PGHM followed by F_3-N: P: K:: 19:19:19 @ 1%.Similarly, F_4-Multi micro nutrients and F_6-N: P: K:: 19:19:19 + MMN also recorded comparable values of net return and return Re^{-1}invested.
2. Between the irrigation levels, non-significant effect was noted with regards to energy output: input ratio. As regards to foliar spray of micronutrients and growth hormones, treatment F_7- N: P: K:: 19:19:19 + MMN + PGHM recorded significantly maximum energy output: input ratio. However, it was found at par to treatment F_6-N: P: K:: 19:19:19 + MMN,F_3-N: P: K:: 19:19:19 @ 1% and F_4-Multi micro nutrients. The minimum energy output: input ratio was observed with F_1- Control (water spray).
3. Between the irrigation levels, energy use efficiency (0.06 kg /MJ×10^{-3}) was recorded significantly higher with I_2-Two irrigations as compared to I_1-One irrigation (0.06 kg MJ×$10^{-3}$$ha^{-1}$). As regards to the foliar spray of micronutrients and growth hormones, none of the treatments gave significant effect on energy use efficiency.

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