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Effect of irrigation and foliar spray of micronutrients and growth hormones on growth and productivity of lentil

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Abstract

The field experiment was conducted during *rabi* season of 2017-18 at the Research cum Instructional Farm, under all India Coordinated Research Project on MULLaRP, Department of Agronomy, College of Agriculture, I.G.K.V. Raipur (CG.) on 'The effect of irrigation and foliar spray of nutrients and growth hormones on nutrient uptake and water use efficiency of lentil' 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) I₁-One irrigation (35 DAS), I₂-Two irrigation (35 and 65 DAS) B. Vertical plot (Foliar Spray-7) F₁-Water Spray, F₂-Nitrobenzene @ 0.3%, F₃-N: P: K:: 19:19:19 @ 1% solution, F₄-Multi micro nutrient (Fe, Mn, Zn, B, Cu, Mo) @ 0.1%, F₅-Plant growth hormones mixture (Cytokinins and Enzymes) @ 0.15%, F₆-N: P: K:: 19:19:19@ 1% + Multi micro nutrient (Fe, Mn, Zn, B, Cu, Mo) @ 0.1%, F₇-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 I₂-Two irrigations followed by I₁-One irrigation. As regards to foliar spray, significantly higher N, P and K uptake in seed, stover and in total was noted under F₇-N: P: K:: 19:19:19 + MMN + PGHM as compared to others, however, it was at par to treatments F₆- N: P: K:: 19:19:19 + MMN, F₃-N: P: K:: 19:19:19 @ 1% and F₄-Multi Micro Nutrients. Between the irrigation levels, significantly higher water use efficiency (86.79 kg ha⁻¹cm) was recorded with I₁-One irrigation as compared to I₂-Two irrigation (66.06 kg ha⁻¹cm). As regards to the foliar spray of micronutrients and growth hormones, maximum water use efficiency (89.56 kg ha⁻¹cm) was recorded with F₇- N: P: K:: 19:19:19 + MMN + PGHM. However, it was at par to treatment F₆-N: P: K:: 19:19:19 + MMN (82.13 kg ha⁻¹). The minimum water use efficiency (58.03 kg ha⁻¹cm) was observed with F₁- Control (water spray).

Keywords: Lentil, irrigation, growth hormones, nutrient uptake, water use efficiency

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) ^[1]. Lentil varieties developing larger and deeper root system are advantageous for sustaining yield in nutrient-poor soils of dry areas. 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) ^[2, 4].

Materials and Methods

The experiment was 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.

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The experiment was laid out in Strip Plot Design having the combination of fourteen treatments and three replications. The treatment was carried out during *rabi* season of 2017-18 at Instructional cum Research Farm, I.G.K.V., Raipur, Chhattisgarh. 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.

Observation recorded

During crop growth period various growth attributing characters of lentil such as plant population (m^{-2}), plant height (cm), number of branches $plant^{-1}$, leaf area $plant^{-1}(cm^2)$, number of nodules $plant^{-1}$ and dry weight of nodules ($g\ plant^{-1}$), yield attributing characters seed yield and stover yield, nutrient uptake, water use efficiency were taken as per schedule and requirement of investigation.

Result and Discussion

Plant population (No. m^{-2})

The observation on plant population was recorded at 30 DAS and at harvest and data are presented in Table 1. Plant

population ranged between 87 to 92.67 plants m^{-2} and 85.5 to 91.2 plants m^{-2} at 30 DAS and at harvest, respectively. The results revealed that there was non-significant variation in plant population at 30 DAS and at harvest due to different irrigation levels and foliar spray of micronutrients and growth hormones in lentil. Similarly, interaction effect was noted to be non-significant at both the stages.

However, between the irrigation levels, I_2 - Two irrigations at 35 and 65 DAS recorded maximum number of plants m^{-2} (90.1) at 30 DAS and (89.1) at harvest. The lowest number of plants m^{-2} was observed under one irrigation (88.6) at 30 DAS and (86.5) at harvest. With respect to foliar sprays of micronutrients and growth hormones, treatment F_7 : N: P: K:: 19:19:19 + MMN + PGHM recorded maximum number of plants m^{-2} (92.7) at 30 DAS and (91.2) at harvest. Whereas, the lowest plant population was observed with treatment F_1 -Control (water sprays) (87.0) at 30 DAS and (85.5) at harvest. The irrigation levels and foliar spray of micronutrients and growth hormones did not cause mortality of plants. The foliar spray of micronutrients is also not expected to cause differences in mortality and ultimately the final plant stand.

Table 1: Plant population of lentil as affected by irrigation levels and foliar spray of micronutrients and growth hormones

Treatment		Plant population (No. m^{-2})	
		30 DAS	At Harvest
Irrigation levels			
I_1 -	One irrigation (35 DAS)	88.57	86.52
I_2 -	Two irrigations (35 and 65 DAS)	90.14	89.14
SEm \pm		1.22	1.25
CD (P=0.05)		NS	NS
Foliar spray			
F_1 -	Water Spray	87.0	85.5
F_2 -	Nitrobenzene @ 0.3%	87.67	86.17
F_3 -	N: P: K:: 19:19:19 @ 1%	90.0	88.5
F_4 -	Multi Micro Nutrients (MMN)	88.5	87.0
F_5 -	Plant Growth Hormones Mixture (PGHM) @ 0.15%	87.17	85.5
F_6 -	N: P: K:: 19:19:19 + MMN	92.5	91.0
F_7 -	N: P: K:: 19:19:19 + MMN + PGHM	92.67	91.17
SEm \pm		2.49	2.47
CD (P=0.05)		NS	NS
Interaction I \times F		NS	NS

Plant height (cm)

Plant height recorded in each plot at different growth stages of lentil (30, 60, 90 DAS and at harvest) were analyzed statistically and presented in the Table 2.

The results showed that the height of the plant was significantly influenced by irrigation levels throughout the growing season except at 30 DAS. The plant height increased gradually up to 60 days. At 60 DAS, the highest plant height (31.4 cm) was recorded with I_2 -Two irrigation level (35 and 65 DAS) whereas, lowest plant height (27.3) was recorded with I_1 - One irrigation (35 DAS). Similarly, at 90 DAS and at harvest, plant height was significantly higher under I_2 - Two irrigation level (35 and 65 DAS) as compared to I_1 - One irrigation (35 DAS).

At 60,90 DAS and at harvest, plant height was constantly increased from 22.0 cm (lowest) under F_1 -water spray to 34.0 cm (highest) under F_7 -(N: P: K:: 19:19:19 + MMN + PGHM). However, treatment F_7 -(N: P: K:: 19:19:19 + MMN + PGHM) was found at par to treatments F_3 -N: P: K:: 19:19:19 @ 1%, F_4 -Multi micro nutrients and F_6 -N: P: K:: 19:19:19 + MMN.

A close inspection of the data reveals that there is uniformity to the effect of different irrigation scheduling on the plant height at all the growth stages of the crop. However, the plant height after 60 DAS onwards was found to respond to irrigation. With the increase in number of irrigation, the plant height was also increased. These findings are closely related with those of Mustafa *et al.* (2008) ^[6].

Table 2: Plant height at different duration of lentil as affected by irrigation levels and foliar spray of micronutrients and growth hormones

Treatment	Plant height (cm)				
	30 DAS	60 DAS	90 DAS	At harvest	
Irrigation levels					
I ₁ -	One irrigation (35 DAS)	10.72	27.34	27.34	27.34
I ₂ -	Two irrigations (35 and 65 DAS)	11.20	31.42	31.40	31.42
SEm±		0.25	0.43	0.47	0.53
CD (P=0.05)		NS	2.59	2.88	3.20
Foliar spray					
F ₁ -	Water Spray	10.28	22.04	22.04	22.04
F ₂ -	Nitrobenzene @ 0.3%	10.58	27.63	27.63	27.63
F ₃ -	N: P: K:: 19:19:19 @ 1%	11.22	31.40	31.40	31.40
F ₄ -	Multi Micro Nutrients (MMN)	10.86	30.19	30.19	30.19
F ₅ -	Plant Growth Hormones Mixture (PGHM) @ 0.15%	10.58	27.44	27.36	27.44
F ₆ -	N: P: K:: 19:19:19 + MMN	11.36	32.96	32.96	32.96
F ₇ -	N: P: K:: 19:19:19 + MMN + PGHM	11.85	34.02	34.02	34.02
SEm±		0.60	1.41	1.59	1.40
CD (P=0.05)		NS	4.34	4.90	4.32
Interaction I×F		NS	NS	NS	NS

The result showed that the height of the plant with foliar spray was significantly higher as compared to control during entire growth period except 30 DAS. At 60, 90 DAS and at harvest, a significant variation was observed in plant height by various application of foliar spray. F₇-N: P: K:: 19:19:19 + MMN + PGHM recorded maximum plant height (34.02 cm) followed F₆-N: P: K:: 19:19:19 + MMN (32.96 cm), F₃-N: P: K:: 19:19:19 @ 1% (31.40cm) and F₄-Multi micro nutrients (30.19 cm).

These results could be best explained through the combine foliar application of nutrients and growth hormones in plants. Nitrobenzene and multi micronutrients helps to increase plant canopy and increase flowering resulted increased in plant height. Similar findings were also reported by Lakpale and Shrivastava (2006) [5] and Prajapta *et al.* (2006) [7].

Interaction effect of irrigation and foliar spray of micronutrients and growth hormones on plant height was found non-significant at entire stage of crop growth.

Number of pods plant⁻¹

Data pertaining to number of pods plant⁻¹ of lentil are presented in Table 3. The results revealed that between the irrigation levels, I₂-Two irrigations produced significantly higher number of pods plant⁻¹ (35.24) as compared to I₁-One irrigation (32.40).

As regards to foliar spray of micronutrients and growth hormones, treatment F₇- N: P: K:: 19:19:19 + MMN + PGHM recorded significantly higher number of pods plant⁻¹ (42.50) as compared to others. The lowest number of pods plant⁻¹ was recorded under F₁-Control (water spray).

The differences in number of pods plant⁻¹ of lentil due to interaction between irrigation levels and foliar spray of micronutrients and growth hormones was found non-

significant.

Maximum number of pods plant⁻¹ was probably attributed to higher number of branches and flowers plant⁻¹ due to adequate supply of soil-moisture and nutrients under optimum plant stand. In almost all the pulses, the extent of flower drop determine the yield and yield attributing characters. Retention of flowers by the plant gives yield more than expected. According to several studies conducted in different crops by different scientists over the world and India revealed that, retention of flowers is possible through foliar application of growth regulators as well as macro nutrients during flower initiation and pod development stages along with soil application of nutrients (Chaurasia *et al.*, 2005) [3].

Number of seeds pod⁻¹

Data pertaining to number of seeds pod⁻¹ of lentil are presented in Table 3. The results revealed that different irrigation levels and foliar spray of micronutrients and growth hormones as well as their interaction failed to give significant impact on number of seeds pod⁻¹. However, between the irrigation levels, I₂-Two irrigations level (35 and 65 DAS) produced maximum number of seeds pod⁻¹ (1.81), whereas, lowest number of seeds pod⁻¹ (1.74) was recorded with I₁-One irrigation (35 DAS).

As regards to foliar spray of micronutrients and growth hormones, treatment F₇- N: P: K:: 19:19:19 + MMN + PGHM gave maximum number of seeds pod⁻¹ (1.86) and lowest number of seeds pod⁻¹ (1.71) was recorded under F₁-Control (water spray).

Maximum number of seeds pod⁻¹ was probably due to adequate supply of soil moisture and nutrients under optimum plant population in above mentioned treatments.

Table 3: Yield attributes of lentil as affected by irrigation levels and foliar spray of micronutrients and growth hormones

Treatment	No. of pods plant ⁻¹	No. of seeds pod ⁻¹	100 seed weight (g)	
Irrigation levels				
I ₁ -	One irrigation (35 DAS)	32.40	1.74	2.99
I ₂ -	Two irrigations(35 and 65 DAS)	35.24	1.81	3.0
SEm±		0.44	0.07	0.11
CD (P=0.05)		2.70	NS	NS
Foliar spray				
F ₁ -	Water Spray	25.07	1.71	2.78
F ₂ -	Nitrobenzene @ 0.3%	28.04	1.73	2.87

F ₃ -	N: P: K:: 19:19:19 @ 1%	36.69	1.80	2.90
F ₄ -	Multi Micro Nutrients (MMN)	34.17	1.75	2.87
F ₅ -	Plant Growth Hormones Mixture (PGHM) @ 0.15%	32.12	1.72	2.80
F ₆ -	N: P: K:: 19:19:19: + MMN	38.16	1.85	3.32
F ₇ -	N: P: K:: 19:19:19 + MMN + PGHM	42.50	1.86	3.42
SEm±		1.09	0.09	0.16
CD (P=0.05)		3.35	NS	NS
Interaction I×F		NS	NS	NS

100-seed weight (g)

Data on 100-seed weight are presented in Table 4. The results revealed that different irrigation levels and foliar spray of micronutrients and growth hormones as well as their interaction failed to give significant impact on 100 seed weight. However, between the irrigation levels, I₂: Two irrigations (35 and 65 DAS) produced maximum 100-seed weight (3.0), whereas, lowest 100-seed weight (2.99) was recorded with I₁: One irrigation (35 DAS).

As regards to foliar spray of micronutrients and growth hormones, treatment F₇- N: P: K:: 19:19:19 + MMN + PGHM recorded maximum 100-seed weight (3.42) and the lowest 100- seed weight (2.78) was recorded with F₁- Control (water spray)

Seed yield (kg ha⁻¹)

Data related to seed yield are presented in Table 4. Irrigation levels significantly influenced the seed yield (kg ha⁻¹) of lentil. Between the irrigation levels, significantly higher seed yield (1189.05 kg ha⁻¹) was observed under the I₂-Two irrigations as compared to I₁-One irrigation due to optimum plant population and superior growth and yield attributes.

As regards to foliar spray of micronutrients and growth hormones, treatment F₇-N: P: K:: 19:19:19 + MMN + PGHM produced significantly higher seed yield (1320.0 kg ha⁻¹) as compared to others. However, it was at par to treatment F₆-N: P: K:: 19:19:19: + MMN (1194.17 kg ha⁻¹). The lowest seed yield (868.33 kg ha⁻¹) was observed with F₁-Control (water spray).

The seed yield is the resultant of growth and yield attributing characters of a crop. The superiority of growth characters *viz.* number of nodules, branches, dry matter accumulation and yield attributes *i.e.* pods plant⁻¹ and seeds pod⁻¹ as discussed earlier could be accounted for the production of higher yield under F₇- N: P: K:: 19:19:19 + MMN + PGHM.

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

Stover yield (kg ha⁻¹)

Data related to stover yield are presented in Table 4. Between the irrigation levels, significantly higher stover yield (1955.52 kg ha⁻¹) was observed under I₂-Two irrigations as compared to I₁-One irrigation (1595.10 kg ha⁻¹) due to optimum plant population and superior growth and yield attributes.

As regards to foliar spray of micronutrients and growth hormones, treatment F₇- N: P: K:: 19:19:19 + MMN + PGHM produced significantly higher stover yield of (2109.17 kg ha⁻¹) as compared to others. However, it was at par to treatment F₆- N: P: K:: 19:19:19: + MMN (1986.50 kg ha⁻¹). The lowest stover yield (1327.83 kg ha⁻¹) was observed with F₁-Control (water spray).

The higher values of growth characteristics *viz.* plant height, branches and dry matter accumulation of F₇-N: P: K:: 19:19:19 + MMN + PGHM gave higher stover yield under

this foliar spray of micronutrients and growth hormones.

The differences in stover yield of lentil due to interaction between irrigation levels and foliar spray of micronutrients and growth hormones was found non- significant.

Table 4: Yield of lentil as affected by irrigation levels and foliar spray of micronutrients and growth hormones

Treatment		Seed yield (kg ha ⁻¹)	Stover yield (kg ha ⁻¹)
Irrigation levels			
I ₁ -	One irrigation (35 DAS)	1041.43	1595.10
I ₂ -	Two irrigations(35 and 65 DAS)	1189.05	1955.52
SEm±		22.44	22.85
CD (P=0.05)		136.55	139.05
Foliar spray			
F ₁ -	Water Spray	868.33	1327.83
F ₂ -	Nitrobenzene @ 0.3%	1056.67	1686.67
F ₃ -	N: P: K:: 19:19:19 @ 1%	1170.83	1883.67
F ₄ -	Multi Micro Nutrients (MMN)	1129.17	1782.50
F ₅ -	Plant Growth Hormones Mixture (PGHM) @ 0.15%	1067.50	1650.83
F ₆ -	N: P: K:: 19:19:19: + MMN	1194.17	1986.50
F ₇ -	N: P: K:: 19:19:19 + MMN + PGHM	1320.0	2109.17
SEm±		47.29	51.31
CD (P=0.05)		145.71	158.11
Interaction I×F		NS	NS

Conclusion

- The plant population at 30 DAS and at harvest remained unaffected due to different irrigation levels and foliar spray of micronutrients and growth hormones. However, treatment I₂- Two irrigations (35 and 65 DAS) recorded higher number of plants m⁻² at 30 DAS and at harvest than I₁-One irrigation (35 DAS). As regards to foliar spray, treatment F₇-N: P: K:: 19:19:19 + MMN + PGHM recorded maximum number of plants m⁻² at 30 DAS and at harvest.
- Plant height at 60, 90 DAS and at harvest was significantly highest with I₂- Two irrigations (35 and 65 DAS) whereas, lowest plant height was recorded with I₁-One irrigation (35 DAS). At 60, 90 DAS and at harvest, plant height was significantly higher under treatment F₇- (N: P: K:: 19:19:19 + MMN + PGHM) as compared to others, but it was at par to treatments F₃-N: P: K:: 19:19:19 @ 1%, F₄-Multi micro nutrients and F₆-N: P: K:: 19:19:19 + MMN.
- Number of pods plant⁻¹ was significantly highest under I₂- Two irrigations (35 and 65 DAS) as well as under F₇- N: P: K:: 19:19:19 + MMN + PGHM as compared to their respective treatments. Whereas, number of seeds pod⁻¹ and 100-seed weight remained unaffected due to different irrigation levels as well as foliar spray of micronutrients and growth hormones.

- Significantly higher seed and stover yields were observed under the I₂-Two irrigations (35 and 65 DAS) compared to the I₁-One irrigation (35 DAS). As regards to foliar spray of micronutrient and growth hormones, treatment F₇-N: P: K:: 19:19:19 + MMN + PGHM produced significantly higher seed and stover yields as compared to others, but it was at par to F₆- N: P: K:: 19:19:19: + MMN. The lowest seed and stover yields were observed with F₁-Control (water spray).

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