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Effect of irrigation and foliar spray of nutrients and growth hormones on growth, yield attributes and yield 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 "Effect of irrigation and foliar spray of nutrients and growth hormones on growth, yield attributes and yield 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) 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 seed yield (1189.05 kg ha^{-1}) and stover yield (1955.52 kg ha^{-1}) was observed under the I_2-Two irrigation. The minimum seed yield (1041.43 kg ha^{-1}) and stover yield (1595.10 kg ha^{-1}) was observed under the I_1-One irrigation due to optimum plant population and superior growth and yield attributes. As regards to foliar spray of nutrient, F7-N: P: K:: 19:19:19 + MMN + PGHM produced significantly higher seed yield (1320.0 kg ha^{-1}) and stover yield (2109.17 kg ha^{-1}) as compare to other foliar spray of nutrients. However, it was at par to treatment F6- N: P: K:: 19:19:19: + MMN. The lowest seed yield (868.33 kg ha^{-1}) and stover yield (1327.83 kg ha^{-1}) was observed with F1-Control (water spray).

Keywords: lentil, irrigation, growth hormones, yield attributes

Introduction
Lentil (*Lens culinaris* Medikus) is an economically important winter legume crop. It is a self pollinated crop with very low percentage of natural out crossing. It belongs to the family Leguminoceae, sub family Papillionaceae. Lentil, being rich source of protein, carbohydrate, fat, amino acids, vitamins and minerals, is extensively used in various culinary preparations. The young pods are used as green vegetables. Although, lentil is primarily a human food, its leaves and stalks have also a feed value, grown as fodder occasionally. It is a soil building crop which fixes atmospheric nitrogen through symbiotic nitrogen fixation.

Foliar application of micronutrients and growth hormones to the standing crop in the form of spray for quick recovery from the deficiency. It avoids fixation of nutrients in the soil. Therefore it becomes an important aspect of research. Foliar application of micronutrients is more beneficial than soil application. Since application rates are lesser as compared to soil application, same application could be obtained easily and crop reacts to nutrient application immediately (Zayed *et al*., 2011). Insufficient water supply during the growing period may reduce crop production and quality (Debaeke and Aboudrare, 2004) [3], while excess irrigation not only wastes water and increases nutrient leaching (Pang *et al.*, 1997) [4], but can also reduce crop yield (Sezen *et al.*, 2006) [5]. These reasons emphasis on developing methods of irrigation that minimize water use or maximize the water use efficiency. 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.

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. 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 $plant^{-1}(cm^2)$, leaf area index, dry matter accumulation (g $plant^{-1}$),crop growth rate (g day^{-1} $plant^{-1}$), relative growth rate (g g^{-1} day^{-1}), number of nodules $plant^{-1}$ and dry weight of nodules (g $plant^{-1}$), yield attributing characters seed yield and stover yield were taken as per schedule and requirement of investigation.

Results and discussion

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

The observation on plant population was recorded at 30 DAS and at harvest. 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 level and foliar spray of nutrient in lentil. Similarly, interaction effects were 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 nutrient, 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 as compared to other foliar nutrient sprays. 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 level and foliar nutrients spray did not cause of plants. The irrigation level may not differ in mortality rate of plants. The foliar spray of nutrients is also not expected to cause differences in mortality and ultimately the final plant stand.

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 4.1. The result 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%, F4-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].

Crop growth rate ($g^{-1}day^{-1}plant^{-1}$)

The crop growth rates was calculated between 0-30, 30-60, 60-90 DAS and 90 DAS -at harvest as influenced by irrigation and foliar spray of nutrients and growth hormones and data are presented in Fig. 4.2. On examination of growth pattern in general, CGR increased progressively up to physiological maturity of the crop. A quantum jump in CGR has been observed during the period of 60-90 days. It is more likely that new and actively photo-synthesizing tissues of the pods and increasing dry matter and LAI might be responsible for the increase in CGR during this phase (60-90 DAS). It was also observed that the post flowering CGR was higher than pre flowering CGR. Reason for increased CGR could be exploitation of climatic and soil resources at important growth stages by the crop planted early and higher leaf area index which might have provided more photosynthetic area which contributed more dry matter.

On examination of the irrigation levels, I2-Two irrigations recorded maximum CGR as compared to I1-One irrigation. Among the foliar spray, treatment F7-N: P: K:: 19:19:19 + MMN + PGHM recorded highest CGR in between 30-60, 60-90 DAS and 90 DAS- at harvest stage among the various foliar nutrients sprays. However, minimum CGR was ob

Seed yield (kg ha^{-1})

Data related to seed yield are presented in Table 4.8. Irrigation level 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 I_2-Two irrigations as compared to the I_1-One irrigation due to optimum plant population and superior growth and yield attributes. As regards to foliar spray of nutrient, F7-N: P: K:: 19:19:19 + MMN + PGHM produced significantly higher seed yield (1320.0 kg ha^{-1}) as compare to other foliar spray of nutrients. 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 nutrients and growth hormones was found non- significant.

Stover yield (kg ha^{-1})

Data related to stover yield are presented in Table 4.8. Between the irrigation levels significantly higher stover yield (1955.52 kg ha^{-1}) was observed under the I_2-Two irrigations as compared to the I_1-One irrigation (1595.10 kg ha^{-1}) due to optimum plant population and superior growth and yield attributes.

As regards to foliar spray of nutrients, treatment F7- N: P: K:: 19:19:19 + MMN + PGHM produced significantly higher stover yield of (2109.17 kg ha^{-1}) as compared to other foliar spray of nutrients. 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 nutrients. The differences in stover yield of lentil due to interaction of effect of irrigation levels and foliar spay of nutrients and growth hormone was found non-significant.

Conclusion

The growth and yield attributes were produced more that resulted production of high yield with the irrigation level I_2- Two irrigations (35 and 65DAS) as compared to I_1- One irrigation (35 DAS). Between foliar spray of nutrients and growth hormone, treatment F_7-N: P: K:: 19:19:19 + MMN + PGHM was significantly higher growth and yield attributes as compared to other foliar nutrient sprays. The lowest growth and yield attributes was observed with F_1-Control (water spray).

Table 4.1: Plant height at different duration of lentil as affected by irrigation 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

Table 4.2: Yield and harvest index of lentil as affected by irrigation and foliar spray of micronutrients and growth hormones

Treatment		Seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Harvest index (%)
Irrigation levels				
I_1-	One irrigation (35 DAS)	1041.43	1595.10	39.46
I_2-	Two irrigations(35 and 65 DAS)	1189.05	1955.52	38.0
SEm±		22.44	22.85	0.41
CD (P=0.05)		136.55	139.05	NS
Foliar spray				
F_1-	Water Spray	868.33	1327.83	39.14
F_2-	Nitrobenzene @ 0.3%	1056.67	1686.67	39.07
F_3-	N: P: K:: 19:19:19 @ 1%	1170.83	1883.67	38.38
F_4-	Multi Micro Nutrients (MMN)	1129.17	1782.50	39.20
F_5-	Plant Growth Hormones Mixture (PGHM) @ 0.15%	1067.50	1650.83	39.32
F_6-	N: P: K:: 19:19:19: + MMN	1194.17	1986.50	37.67
F_7-	N: P: K:: 19:19:19 + MMN + PGHM	1320.0	2109.17	38.34
SEm±		47.29	51.31	0.98
CD (P=0.05)		145.71	158.11	NS
Interaction I×F		NS	NS	NS

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