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To investigate the interaction effect of irrigation and foliar spray of nutrients and growth hormones on 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 "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) [110]. Insufficient water supply during the growing period may reduce crop production and quality (Debaeke and Aboudrare, 2004) [18], while excess irrigation not only wastes water and increases nutrient leaching (Pang *et al.*, 1997) [66], but can also reduce crop yield (Sezen *et al.*, 2006) [82]. 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.

Result and Discussion

Seed yield (kg ha^{-1})

Data related to seed yield are presented in Table 1. 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 I_2-Two irrigations as compared to I_1-One irrigation due to optimum plant population and superior growth and yield attributes.

As regards to foliar spray of micronutrients and growth hormones, treatmentF7-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 1. Between the irrigation levels, significantly higher stover yield (1955.52 kg ha^{-1}) was observed under I_2-Two irrigations as compared to 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 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 spay of micronutrients and growth hormones was found non- significant.

Table 1: Yield and harvest index 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

Table 2: Interaction table on seed yield of lentil as affected by irrigation and foliar spray of micronutrients and growth hormones

A×B	I_1	I_2	Total	Mean
F_1	705	1032	1737	868
F_2	997	1117	2113	1057
F_3	1172	1170	2342	1171
F_4	1040	1218	2258	1129
F_5	1072	1063	2135	1068
F_6	1137	1252	2388	1194
F_7	1168	1472	2640	1320
Total	7290	8323		
Mean	1041	1189		

Water use efficiency (kg ha^{-1} cm)

The data on water use efficiency are presented in Table 2 and 3. The results revealed that water use efficiency differ significantly with different irrigation levels and foliar spray of micronutrients and growth hormones.

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 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).

Table 3: Water use efficiency of lentil as affected by irrigation levels and foliar spray of micronutrients and growth hormones

Treatment		WUE (kg ha^{-1}cm)
Irrigation levels		
I_1	One irrigation (35 DAS)	86.79
I_2	Two irrigation (35 and 65 DAS)	66.06
SEm±		1.65
CD (P=0.05)		10.02
Foliar spray		
F_1	Water Spray	58.03
F_2	Nitrobenzene @ 0.3%	72.55
F_3	N: P: K:: 19:19:19 @ 1%	81.32
F_4	Multi micro nutrients (MMN)	77.18
F_5	Plant Growth Hormones Mixture (PGHM) @ 0.15%	74.19
F_6	N: P: K:: 19:19:19: + MMN	82.13
F_7	N: P: K:: 19:19:19 + MMN + PGHM	89.56
SEm±		3.60
CD (P=0.05)		11.08
Interaction I×F		NS

Table 4: Interaction table on water use efficiency of lentil as affected by irrigation and foliar spray of micronutrients and growth hormones.

A×B	I_1	I_2	Total	Mean
F_1	58.75	57.31	116.06	58.032
F_2	83.06	62.04	145.09	72.546
F_3	97.64	65.00	162.64	81.319
F_4	86.67	67.69	154.35	77.176
F_5	89.31	59.07	148.38	74.190
F_6	94.72	69.54	164.26	82.130
F_7	97.36	81.76	179.12	89.560
Total	607.50	462.41		
Mean	86.79	66.06		

The differences in water use efficiency of lentil due to interaction effect of irrigation levels and foliar spray of micronutrients and growth hormones was found non-significant. Ray *et al.*, (2001) [74] and Singh *et al.* (2004) [96] also noted similar findings.

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 4, 5, 6 and 7.

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 4.17. 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).

Table 5: 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 6: 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 7: 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		

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 8. 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).

Table 8: 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		

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) [98] and Kumar *et al.* (2017) [46] also noted that foliar spray of nutrients and growth hormones significantly increased the net returns and B: C ratio.

Conclusion

Significantly higher seed and stover yields were observed under the I_2-Two irrigations (35 and 65 DAS) compared to the I_1-One irrigation (35 DAS).As regards to foliar spray of micronutrient and growth hormones, treatment F_7-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 F_6- N: P: K:: 19:19:19: + MMN. The lowest seed and stover yields were observed with F_1-Control (water spray).

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).

Significantly maximum gross return and net return was received under I_2-Two irrigations (35 and 65 DAS) and minimum 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 and net return. But in case of net return, it was at par to treatments F_3-N:P:K::19:19:19 @ 1%, F_4- Multi Micro Nutrients (MMN) and F_6- N:P:K::19:19:19 + MMN.

The return Re^{-1}invested was maximum under I_2-Two irrigations and minimum was received under I_1-One irrigation. As regards to foliar spray of micronutrients and growth hormones, treatment F_7- N: P: K:: 19:19:19 + MMN + PGHM recorded significantly maximum return Re^{-1}invested, however ,it was at par to rest of the treatments except F_1-Control (water spray).

References

1. Abou-El-Nour EAA. Can supplemented potassium foliar feeding reduce the recommended soil potassium. Pak. J Biol. Sci. 2002;5(3):259-26.
2. Abraham T, Thenua OVS, Shjivakumar BG. Impact of levels of irrigation and fertility gradients on dry matter production, nutrient uptake and yield on chickpea (*Cicer arietinium* L.) intercropping system. Legume Research. 2010;33(1):10-16.
3. Anchal D, Kharwara PC, Rana SS. Nutrients uptake by grain (*Cicer arietinum* L.) as influenced by varieties, sowing dates and phosphoruslevels under on farm conditions. Himachal Journal of Agricultural Research. 2001;25(1/2):84-87.
4. Anonymous. Area and production of Chhattisgarh; c2016. http://indiastat.com.
5. Anonymous. Annual report of AICRP on MULLaRP, Indira Gandhi; c2016-17.
6. Arif M, Chohan MA, Ali S, Gul R, Khan S. Response of wheat to foliar application of nutrients. Journal of Agricultural and Biological Science, 2006, 1(4).
7. Ashraf MY, Baig NA, Baig F. Response of wheat (*Triticum aestivum* L.). Treated with cycocel under water

stress conditions. Acta Agron. Hung. 1989;38(3-4):265-269.
8. Bahadur MM, Ashrafuzzaman M, Kabir MA, Chowdhury MF, Majumder DAN. Response of chickpea (*Cicer arietinum* L.) varieties of different levels of phosphorus. Crop Research Hisar. 2002;23(2):293-299.
9. Behra N, Elamathi S. Studies on the time of nitrogen, application of foliar spray of DAP and growth regulator on yield attributes, yield and economics of greengram. Internat. J. Agric. Sci. 2007;3(1):168-169.
10. Black CA, Evans DD. Methods of soil analysis. American Society of Agron., Madison, Wisconsin, USA; c1965. p. 131-137.
11. Chaurasia SNS, Singh KP, Mathura R. Effect of foliar application ofwater soluble fertilizers on growth, yield, and quality of tomato (*Lycopersiconesculentum* L.). Sri. Lankan J. Agric. Sci. 2005;42:6-70.
12. Cheema SS, Chander K, Kundra H, Malhotra OP. Water use efficiency and yield of lentil under irrigation levels. Indian Journal of Ecology. 1985;12:275–280.
13. Choubey SK, Dwivedi VP, Srivastava NK. Effect of different levels of phosphorus and sulphur on growth, yield and quality of lentil (*Lens culinaris* Medk.) Department of Agronomy, National P.G. College, Barhalganj, Gorakhpur, Uttar Pradesh, India. ISSN: 0976-2876 (Print) ISSN: 2250-0138 (Online). Indian J. Sci. Res. 2013;4(2):149-150.
14. Choudhari SB, Chavan DA, Kalegore NK, Shaikh FG. Effect of inorganic and biofertilizers on performance ofsoybean (*Glycine max* L.). Journal of Oilseed Research. 2012;29(2):161-162.
15. Choudhary P, Jhajharia A, Kumar R. Influnence of sulphur and zinc on yield, yield components and quality traits of soybean (*Glycine max* L.). International Quarterly Journal of Life Sciences. 2014;9(1):137-142.
16. Dahiya S, Mehar S. Effect of fertilizer doses and irrigation scheduling on yield and yield attributes of chickpea. Crop Research. 1993;6(3):529-531.
17. Dastan A, Aslam H. Effect of seed inoculation and different N levels on the grain yield of lentil (*Lens culinaris*). Asian J. Plant Sci. 1986;1(4):314-315.
18. Debaeke P, Aboudrare A. Adaptation of crop management to water-limited environments. European Journal of Agronomy. 2004;21:433-446.
19. Dhingra KK, Sekhon HS, Sandhun PS, Bhandari SC. Phosphorus–Rhizobium Interaction Studies on Biological Nitrogen Fixation and Yield of Lentil. Journal of Agricultural Sciences. 1988;110:141-144.
20. Dixit PM, Elamathi S. Effect of foliar application of DAP, micronutrients and NAA on growth and yield of greengram. Legume Res. 2007;30(4):305-307.
21. Doss A, Anand SP, Keerthiga M. Effect of foliar application of di-ammonium phosphate (DAP), potash. K., and naphthalene acetic acid (NAA) on growth, yield and some biochemical constituents of *Vigna mungo* (I.) Hepper. J. Agric. Res. 2013;2(7):206-8.
22. Dubey MP. Grain yield and chemical properties as affected by soybean (*Glycine max* (L.) Merril) genotype and fertility levels. In: Biodiversity and Sustainable Utilization of Biological Resources: Proceeding of a National Conference, Sagar, Madhya Pradesh, India, 2004, 209-214.
23. El-Fouly MM, El-Sayed AA. Foliar fertilizer: An environmentally friendly application of fertilizers. Dahlia Greidinger International symptosium on Fertilizer and Environment 24-27 March, Haifa, Israel, Ed. John, J., 1997, 346357.
24. Fathy MF. Response of lentil to foliar application of potassium phosphate under different irrigation**,** Department of Agronomy, Faculty of Agriculture, Assiut University, Egypt, Assiut J Agric. Sci. 2014;45(5):28-38.
25. Fatima K, Hussain N, Pir FA, Mehdi M. Effect of nitrogen and phosphorus on growth and yield of Lentil (*Lens culnaris*). Sher-E-Kashmir University of Agricultural Science and Technology Kashmir, Jammu & Kashmir, India- 191121. www.elixirpublishers.com (Elixir International Journal) Elixir Appl. Botany. 2013;57:14323-14325.
26. Giriappa JS. Response of green gram to irrigation. Madras Agril. J. 1998;79(5):185-199.
27. Gomez KA, Gomez AA. Statistical procedure for Agricultural Research. John Wiley and Sons Publication, 1984, 84.
28. Growth regulators on growth and yield of lentil (*Lens culinaris* Medik.)
29. Gupta B. Efficacy of growth regulators on nodulation, flowering, pod setting and productivity of chickpea (*Cicer arietinum* L.) in Shrink Swell soils of Chhattisgarh plains. M.Sc. Ag. (Agronomy) Thesis, IGAU, Raipur; c2000.
30. Gupta SC, Sahu S. Response of chickpea to micronutrient and biofertilizers in *vertisol*. Legume Research. 2012;35(3):248-251.
31. Guruswamy T, Desai RS, Weeranguda M. Energy requirement for crop production under dryland agriculture in Karnataka: A Case Study. Karnataka Journal of Agricultural Sciences. 2001;14(1):101-105.
32. Hamayun M, Khan SA, Khan AL, Shinwari ZK, Ahmad N, Kim YH, *et al*. Effect of foliar and soil application of nitrogen, phosphorus and potassium an yield component of lentil. Department of Botany, Abdul Wali Khan University, Mardan, Pakistan, Corresponding author Email: Shinwari 2002 @yahoo.com; ijlee@knu.ac.kr. Pak. J. Bot. 2011;43(1):391-396.
33. Hernandez P. Morphogenesis in sunflower as affected by exogenous application of plant growth regulators. Agriscientia. 1997;13:3-11.
34. Van Hoorn JW, Katerji N, Hamdy A, Mastrorilli M. Effect of salinity on yield and nitrogen uptake of four grain legumes and on biological nitrogen contribution from the soil. Agricultural water management. 2001 Oct 29;51(2):87-98.
35. Husnan E, Hill GD, Field RJ. The effect of plant population and; c1989.
36. Hussain Md, Shah SH, Nazir SM. Differential genotypic response to phosphorus application in lentil (*Lens culinaris Medic*). International Journal of Agriculture and Biology. 2002;4(1):61-63.
37. Jackson ML. Soil Chemical Analysis, Prentice Hall of India, Pvt. Ltd., New Delhi, 1973, 498
38. Kahraman A, Khan MK, Pandey A, Dogan E. Effect of supplemental irrigation on lentil yield and growth in Semi-Arid Environment. Harran University, Faculty of Agriculture, Department of Field Crops, Sanliurfa-63040. Turkeyanamika.biotech@gmail.com ergun, Print ISSN 0255-965X; Electronic 1842-4309 Not Bot Horti Agrobo,

2016;44(1):237-244.
39. Kalpana R, Krishnarajan J. Effects of combined application of nutrients and hormones on soybean yield. Legume Research. 2003;26(2):151-152.
40. Kang S, McKenzie BA, Hill GD. Effect of irrigation on growth and yield of Kabuli chickpea (*Cicer arietinum* L.) and narrow-leafed lupin (*Lupinus angustifolius* L.). Agronomy New Zealand. 2008;38:11-32.
41. Khan H, Ahmad F, Ahmad SQ, Sherin M, Bari A. Effect of phosphorus fertilizer on grain yield of lentil. Sarhad J. Agric. 2006;22(3):433-436.
42. Khutate NG, Mendhe SN, Dongarkar KP, Gudadhe NN, Gavande VH. Effect of nutrient management treatments on growth and yield of soybean. Journal of Soil and Crops. 2005;15(2):411-414.
43. Krishi Viswavidyalaya, Raipur, p. 23.
44. Kumar S, Kumar R. Effect of farm yard manure, phosphorus levels and biofertilizer on productivity of lentil. Crop Research Hisar. 2006;31(3):370-372.
45. Kumar S, Singh V, Solanki VPS. Effect of boron and phosphorus application on yield and uptake of nutrients lentil. Annals of Agricultural Research New Series. 2009;30(3-4):108-110.
46. Kumar P, Vimal SC, Sarvjeet, Gupta JP. Enhancement of yield components and seed quality parameters by growth regulator in lentil (*Lens culinaris* Medik.). N. D. University of Agriculture Technology, Kumarganj-224229, faizabad (U.P.) India. Journal of Pharmacognosy and Phytochemistry, available online at www.phytojournal.com; c2017.
47. Kumawat SM, Dhakar LL, Maliwal PL. Effect of irrigation regimes and nitrogen on yield, oil content and nutrient uptake of soybean (*Glycine max*). Indian Journal of Agronomy. 2000;45(2):361-366.
48. Lakpale R, Shrivastava GK. Effect of integrated nutrient management on yield and economics of soybean. Annuals of Plant and Soil Research. 2006;8(2):138-140.
49. Lakpale R, Srivastava GK, Chaubey NK, Singh AP, Joshi BS, Pandey RL. Response of gram (*Cicer arietinum*) to integrated nutrient management in *Vertisols* of Chhattisgarh plains. Indian Journal of Agricultural Sciences. 2003;73(3):162-3.
50. Leggett ME, Gleddie SC, Prusinkiewicz E, Xie J. Development of Guidelines for the use of PROVIDE™ on Wheat and Canola. In Plant Nutrition: From Genetic Engineering to Field Practice. Dordrecht, Netherlands: Kluwear Academic Publishers, 1993, 375-378.
51. Lone BA, Hassan B, Ansar-ul-haq S, Khan MH. Effect of seed rate, row spacing and fertility levels on relative economics of soybean (*Glycine max* L.) under temperate conditions. African Journal of Agricultural Research. 2010;5(5):322-324.
52. Mallick A, Verma UN, Thakur R, Srivastava VC. Productivity of wheat (*Triticum aestivum*) based intercropping systems under limited irrigation. Indian Journal of Agronomy. 1993;38(2):178-181.
53. Mbah EU, Muoneke CO, Okpara DA. Effect of compound fertilizer on the yield and productivity of soybean and maize in soybean/maize intercrop in southeastern Nigeria. Tropical and Subtropical Agroecosystems. 2007;7:87-95.
54. Meena KL, Singh RK, Gautam RC. Effect of moisture conservation practices, phosphorus levels and bacterial inoculation on growth, yield and economics of chickpea (*Cicer arietinum* L.). Legume Research. 2006;29(1):68-72.
55. Mohsen J, Yousef N, Hamed Z, Mohsen KA, Naser S. Effect of manure and foliar application of growth regulators on lentil (*Lens culinaris*) performance in semi-arid highland environment. Department of Agronomy and Plant Breeding, Agriculture College, University of Maragheh, Iran. E-mail: jmohamad@alumni.ut.ac.ir, ISSN 1392-1665. 2014;20(2):99-108.
56. Morshed RM, Rahman MM, Rahman MA. Effect of nitrogen on seed yield, protein content and nutrient uptake of soybean (*Glycine max* L.). Journal of Agriculture & Rural Development. 2008;6(1):13-7.
57. Mustafa MN, Sagar GK, Chandrika V, Reddy PM. Growth and yield of chickpea as influenced by irrigation and nutrient management. Legume Research-An International Journal. 2008;31(3):221-3.
58. Naeem M, Bhatti IR, Ahmad RH, Ashraf MY. Effect of some growth hormones (GA3, IAA and kinetin) on the morphology and early or delayed initiation of bud of lentil (*Lens culinaris* Medik). Pakistan Journal of Botany. 2004 Dec 1;36(4):801-9.
59. Niri HH, Tobeh A, Gholipouri A, Zakaria RA, Mostafaei H, Jamaati-e-Somarin S. Effect of nitrogen and phosphorous on yield and protein content of lentil in dryland condition. Am Eurasian J Agric Environ Sci. 2010;8(2):185-8. ISSN 1818-6769.
60. Olsen SR, Cole CV, Watanable FS, Dean LA. Estimation of available phosphorus in soils by extraction with sodium carbonate. United State Department of Agriculture Circ. 1954;939:1-9.
61. Oweis T, Hachum A. Reducing peak supplemental irrigation demand by extending sowing dates. Agricultural Water Management. 2001 Sep 3;50(2):109-23.
62. Oweis T, Hachum A, Kijne J. Water harvesting and supplemental irrigation for improved water use efficiency in dry areas. SWIM Paper No. 7, System-Wide Initiative on Water Management. International Water Management Institute (IWMI), Colombo, Sri Lanka; c1999.
63. Oweis T, Hachum A, Pala M. Lentil production under supplemental irrigation in a Mediterranean environment. Natural Resource Management Program, International Center for Agricultural Research in the Dry Areas (ICARDA) Aleppo, Syria, Agricultural Water Management. 2004;68:251-265.
E-mail: t.oweis@cgiar.org
64. Pandey N, Gupta B. The impact of foliar boron sprays on reproductive biology and seed quality of blackgram. Plant Nutrition and Stress Physiology Laboratory, Department of Botany, University of Lucknow; c2012.
65. Panesar BS, Bhatnagar AP. Energy norms for inputs and outputs of Agricultural Sector. (In) Energy management and conservation in agricultural production and food processing. Verma, S.R., Mittal, J.P. and Singh, Surendra (Ed) UGC Publishers and Distributers, Ludhiana; c1994. p. 5-16.
66. Pang XP, Letey J, Wu L. Irrigation quantity and uniformity and nitrogen application effects on crop yield and nitrogen leaching. Soil Science Society of America Journal. 1997 Jan;61(1):257-61.
67. Parmar SK, Patel RA, Saras PI, Chaudhari NN. Effect of

irrigation scheduling (IW/CPE Ratio) and Nitrogen on yield and economics of Rajma (*Phaseolus vulgaris* L.) under Middle Gujarat Conditions. Trends in Biosciences. 2014;7(23):3980-2.
68. Devendra P, Patel JB, Saras PK. Influence of irrigation scheduling based on critical growth stages and different levels of zinc on growth, yield and quality of summer cowpea (*Vigna unguiculata* L. Walp.) under middle Gujarat conditions. Trends in Biosciences. 2015;8(2):358-61.
69. Plant Science Department, Lincoln University, Canterbury, Proceedings Agronomy Society, NZ, 19
70. Prabhakar M, Saraf CS. Dry matter accumulation and distribution in chickpea (*Cicer arietinium* L.) as influenced by genotype, phosphorus source and irrigation level. Indian Journal of Agricultural Sciences. 1990;60(3):204-206.
71. Prajapta MN, Patel JJ, Gediya KM. Influence of different irrigation schedules and growth regulator on summer greengram. Agron. Digest. 2006;6:23-24.
72. Rajeshkumar S, Durairaj SN, Kannan V. Effect of crop geometry and foliar nutrition on growth and yield of irrigated blackgram (*Vigna mungo* L.). Int. J. Curr. Microbiol. App. Sci. 2017;6(11):4084-94.
73. Rathod KS, Pannu RK, Dahiya SS. Effect of nitrogen management on soil fertility and NPK uptake in soybean. Journal of Food Legumes. 2012;25(2):153-5.
74. Ray D, Bandyopadhyay P, Jana PK, Bhowmick MK, Ray D. Influence of irrigation schedules on yield, consumptive use and crop coefficient of chickpea (*Cicer arietinum* L.). J. Interacord. 2001;5:33-8.
75. Richards LA, Fireman M. Pressure-plate apparatus for measuring moisture sorption and transmission by soils. Soil Science. 1943 Dec 1;56(6):395-404.
76. Reddy AA. Pulses Production Technology: Status and Way Forward, Economic & Political Weekly, 26 December. 2009;44(52):73-80.
77. Reddy NRN, Ahlawat IPS. Response of chickpea (*Cicer arietinium* L.) genotypes to irrigation and fertilizers under late-sown conditions. Indian Journal of Agronomy. 1998;43(1):95-101.
78. Roy I, Biswas PK, Md. Ali H, Md. Haque N, Md. Islam S, Khan AK. Effect of supplemental application of nitrogen, irrigation and hormone on the yield and yield components of chickpea. Department of Agronomy, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh, World Journal of Agricultural Sciences. 2016;12(1):70-77. ISSN 1817-3047
79. Satyanarayana V, Vara Prasad PV, Murthy VR, Boote KJ. Influence of integrated use of farmyard manure and inorganic fertilizers on yield and yield components of irrigated lowland rice. Journal of plant nutrition. 2002 Sep 17;25(10):2081-90.
80. Setia N, Setia SRC, Malik CP. Alterations in growth and yield components of lentil in response to foliar application of NAA. Indian J of Plant Physiol. 1993;36(1):47-52.
81. Seyyed MS, Seyyed AN. Evaluation of foliar application effects of Zn and Fe on yield and its components of lentil (*Lens culinaris*, Medik), Iran. Indian Journal of Fundamental and Applied Life Sciences, ISSN: 2231-6345 (Online) An Open Access, Online International Journal Available at http://www.cibtech.org/jls.htm. 2014;4(2):220-225.
82. Sezen SM, Yazar A, Eker S. Effect of drip irrigation regimes on yield and quality of field grown bell pepper. Agricultural Water Management. 2006 Mar 10;81(1-2):115-31.
83. Sharma HO, Nahatkar SB, Yadav RK. Production energy requirement in chickpea. Indian Journal of Pulses Research. 1998;11(2):105-8.
84. Sharma BB, Singh RR. Rooting and Nodulation Patteren in Lentil under Different Rates of Seeding, Seed Inoculation, Nitrogen and Phosphorous Fertilization. Legume Research. 1986;9:69-72.
85. Sharma SN, Prasad R. Effect of soil moisture regime on the yield and water use of lentil (*Lens culinaris* Medic).Water technology centre, Indian Agricultural Research Institute, New Delhi-110012, India, Irrig. Sci. 1984;(5):285-293.
86. Shukla AK, Behera SK. Micronutrient fertilizers for higher productivity. (Speciality fertilisers). Indian Journal of Fertilisers. 2012;8(4):100-117.
87. Singh AK, Meena MK, Bharati RC, Gade RM. Effect of sulphur and zinc management on yield, nutrient uptake, changes in soil fertility and economics in rice (O*ryza sativa*)–lentil (*Lens culinaris*) cropping system. Indian J. Agril. Sci. 2013 Mar 1;83(3):344-8.
88. Singh AK, Srivastava A. Effect of boron application on seed yield and protein content of mungbean (*Vigna radiata* L.). Current Advances in Agricultural Sciences (An International Journal). 2014;6(1):67-8.
89. Singh D, Singh RP. Effect of integrated nutrient management on growth, physiological parameters and productivity of lentil (*Lens culinaris* Medik.), Email: agriandashrath@yahoo.com, Department of Agronomy, Central Institute of Agricultural Engineering, Bhopal (M.P.) India. International Journal of Agricultural Sciences. 2014;10(1):175-178.
90. Singh G, Singh OP. Response of lentil to tillage practices and fertility levels in rice fallows. Indian Journal of Pulses Research. 1993;6(1):49-53.
91. Singh MK, Thakur R, Pal SK, Verma UN, Upasani RR. Plant density and row arrangement of lentil (*Lens culinaris*) and mustard (*Brassica juncea*) intercropping for higher productivity under Bihar plateau. Indian Journal of Agronomy. 2000;45(2):284-287.
92. Singh R, Marok AS. Response of lentil (*Lens culinaris* Med.) to phosphorus application on soils differing in available phosphorus status. Indian Journal of Ecology. 1981;8(2):163-166.
93. Singh R, Chandel AS, Singh R. Economics of weed control methods in *urdbean* (*Vigna mungo* (L.) Hepper). Haryana Journal of Agronomy. 1981;7(2):169-193.
94. Singh S, Malik RK, Punia SS. Performance of late sown chickpea (*Cicer arietinium* L.) and its economic feasibility as affected by irrigation, sulfur and seed inoculation. Haryana Agriculture University Journal Research, 2005;35(2):131-134.
95. Singh N, Singh G, Khanna V. Growth of lentil (*Lens culinaris* Medikus) as influenced by phosphorus, Rhizobium and plant growth promoting rhizobacteria. Indian Journal of Agricultural Research. 2016;50(6):567-72.
96. Singh S, Saini SS, Singh BP. Effect of irrigation, sulphur

and seed inoculation on growth, yield and sulphur uptake of chickpea (*Cicer arietinum*) under late-sown conditions. Indian journal of Agronomy. 2004;49(1):57-9.
97. Singh YP, Chauhan CPS, Gupta RK. Effect of sulphur level, methods of its application and irrigation schedule on growth yield and water use by lentil (*Lens culinaris* Medic). All India Co-ordinated Research Project on use of saline water in agriculture R.B.S. College, Bichpuri, Agra, Uttar Pradesh 283105, Indian Journal of Agriculture Science. 1998;69(8):575.
98. Sitaram T, Sharma SK, Reager ML. Growth attributes and nutrient uptake of green gram as influenced by vermicompost and zinc in arid western Rajasthan. Advance research Journal of crop improvement. 2013;4(1):65-9.
99. Srinivasarao Ch, Benzioni A, Waitziman R, Eshel A, Waisel Y. Effect of phosphorus on root morphology, shoot growth and P uptake by Faba Bean (*Vicia faba* L.) grown in aeroponics. Proceedings of Annual Convention of Indian Society of Soil Science. New Delhi, India; c2000.
100. Srivastava GP, Srivastava VC. Effect of irrigation and foliar spray of nutrients on growth and seed yield of gram (*Cicer arietinium*). Indian Journal of Agricultural sciences. 1994;64(4):219-222.
101. Subbaiah BV, Asija GL. A rapid procedure for the estimation of available nitrogen in soils. Curr. Sci. 1956;25(8):259-260.
102. Sumathi I, Venketeshwarlu B, Rao YH. Effect of FYM and phosphrous on growth and yield of chickpea (*Cicer arietinum* L.). The Andhra Agricultural Research. 2007;53(3-4):111-113.
103. Togay Y, Togay N, Dogan Y. Research on the effect of phosphorus and molybdenum applications on the yield and yield parameters in lentil (*Lens culinaris* Medic.) Yüzüncü Yıl University, Faculty of Agriculture, Department of Field Crops, 65080, Van, Turkey. African Journal of Biotechnology. 2008;7(9):1256-1260. Available online at http://www.academicjournals.org/AJB DOI: 10.5897/AJB07.870 ISSN 1684–5315 © 2008 Academic Journals.
104. Tomar RKS, Raghuwanshi RS. Effect of nutrients on yield of chickpea under irrigated condition. Bhartiya Krishi Anusandhan Patrika, 1995, 10(1/2).
105. Ullah A, Bakht J, Shafi M, Shah WA, Zia-ul-Islam. Effect of various irrigations levels on different chickpea varieties. Asian Journal of Plant Sciences. 2002;1(4):355-357.
106. Venkateswarlu OG, Ahlawat IPS. Effect of soil moisture regimes, seed rate and phosphorus fertilization an growth and yield attributes and yield of late sown lentil (*Lens culinaris*). Indian J. Agronomy. 1993;36(2):236-43.
107. Verma VK. Responce of irrigation chickpea (*Cicer arietinum* L.) to NPK in light soil and its economics. Advance in Plant Sciences. 1994;7(1):138-142.
108. Walkley A, Black CA. Estimation of organic carbon by the chromic acidtitration method. Soil Sci. 1965;47:29-38.
109. Watson DJ. The physiological basis of variation in yield. Adv. Agron. 1952;4(1)**:**101-145.
110. Zayed BA, Salem AK, El Sharkawy HM. Effect of different micronutrient treatments on rice (*Oryza sativa* L.) growth and yield under saline soil conditions. World Journal of Agricultural Sciences. 2011;7(2):179-84. Available online at: http://www.idosi.org/wjas/wjas7(2)/12.pdf
111. Zeidan MS, Hozayn M, Abd El-Salam MEE. Yield and quality of lentil as affected by micronutrient deficiencies in sandy soils. Department of Field Crops Research, National Research Center, Dokki, Giza, Egypt. Journal of Applied Science Research. 2006;2(12):1342-1345.
112. Zeidan MS, Mohamed MF, Hamouda HA. Effect of foliar fertilization of Fe, Mn and Zn on wheat yield and quality in low sandy soils fertility. World J. Agric. Sci. 2010;6(6):696-699. Available online at: http://www.fspublishers.org/ijab/past-ssues/IJABVOL_3_NO_4/11.pdf
113. Zhang H, Pala M, Oweis T, Harris H. Water use and water-use efficiency of chickpea and lentil in a Mediterranean environment. Crop and Pasture Science. 2000;51(2):295-304.