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Effect of irrigation scheduling and zinc application on chlorophyll content, zinc content, uptake and yield of chickpea (*Cicer arietinum* L.)

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Abstract
A field experiment was conducted during *rabi* season of 2015-16 at Agriculture Farm, Institute of Agriculture, Visva-Bharati, Sriniketan, West Bengal on lateritic soil condition to study the growth and yield of chickpea (*Cicer arietinum* L.) as influenced by irrigation scheduling and zinc application. The experiment was conducted at split plot design having 5 main plot treatments (I_1: irrigation at pre flowering, I_2: irrigation at branching + pod development, I_3: irrigation at branching + pre flowering, I_4: irrigation at branching + pre flowering + pod development, I_5: irrigation at 0.8 bar soil moisture tension) and 3 sub plot treatments viz. Zn_0: control, Zn_1: zinc sulphate @ 0.25%, Zn_2: zinc sulphate @ 0.5%. The results of the experiment revealed that treatment I_4 (i.e. irrigation at branching + pre flowering + pod development) and Zn_2 (0.5% zinc sulphate) recorded highest chlorophyll content (3.14 mg g^{-1}), zinc content on seed (56.97mg kg^{-1}) uptake (151.86 g ha^{-1}), and seed yield (973 kg ha^{-1}), biological yield (2637 kg ha^{-1}) among all the treatments. Interaction effect of I_2, I_4 irrigation scheduling and zinc sulphate @ 0.5% showed significantly chlorophyll content, seed yield and stalk yield.

Keywords: Chickpea, irrigation scheduling, zinc content, chlorophyll, yield

Introduction
Chickpea (*Cicer arietinum*) is an important dry land pulse crop in many parts of the world. During 2015-16, 25.26 million hectares of the chickpea and 16.47 million metric tons production was in India (GOI 2016) [8]. In Madhya Pradesh, it is cultivated in 3.31 million hectares of land with an annual production of 3.81 million metric tons and productivity of 1219 kg ha^{-1} (DOE 2014) [6]. Productivity is often limited by periods of water deficit and in a number of regions, zinc deficiency occur. Osmotic potential was lower and turgor higher in the leaves of zinc-deficient plants, but the ability to adjust osmotically was reduced by zinc deficiency as stress developed. Zinc-deficiency reduced the efficiency with which the water was used for biomass production and compromised the plant's capacity to respond to water stress by osmotic adjustment (Khan *et al*., 2004) [12]. This crop with 17 - 24% protein, 41 - 51% carbohydrates and high percentage of other mineral nutrients and unsaturated linoleic and oleic acids is an important crop for human consumption (Farshadfar and Farshadfar, 2008) [7]. Due to low production cost, wide climate adaptation, use in crop rotation and atmospheric nitrogen fixation ability, chickpea is one of the most important legume plants in sustainable agricultural system (Anonymous, 2002; Farshadfar and Farshadfar, 2008) [2, 7]. Water is essential to plant growth because it provides the medium within which most cellular functions take place (Condon *et al*., 2002) [4]. Zn deficiency is commonly observed in a number of areas where chick-pea is cultivated (Khan *et al*., 2000) [12]. There are difficulties encountered during the development period of the plant due to Zn deficiency and insufficiency of water required for irrigation in a great number of countries where chickpea production is significant (Khan *et al*., 2004) [13]. The chlorophyll content was decreased with decreasing the irrigation water and this decrease was correlated with relative water content in leaves (Munne-Bosch and Alegre, 2000) [15]. Zinc (Zn) is one of the most important micronutrients, which is mainly supplied as Zinc sulphate ($ZnSO_4$). Zn plays an important role in cell division, cell expansion, and protein synthesis and in carbohydrate, nucleic acid and lipid metabolism. It also plays an important role in auxin metabolism (Hossain 1997; Oguchi 2004) [10, 16]. Zinc deficiency cause biochemical changes in membranes and also cause reduction in both growth and yield (Marschner 1995; Cakmak 2004) [14, 3].

Materials and Methods

A field experiments were laid out during 2015-16 at Agriculture Farm, Institute of Agriculture, Visva Bharati, Sriniketan, West Bengal on lateritic soil having acidic pH (6.1), low in nitrogen (167.86 kg ha^{-1}), medium in available phosphorus (29.50 kg ha^{-1}), low potassium (160.50 kg ha^{-1}) and low in zinc (0.4 ppm) of upper 0-30 cm soil depth. A rainfall of 88.9 mm was recorded during the crop growing season in the year.

Treatments and experimental design

The experiment comprising five irrigation treatments, viz. I_1: Irrigation at pre flowering, I_2: Irrigation at branching + pod development, I_3: irrigation at branching + pre flowering, I_4: Irrigation at branching + pre flowering + pod development, I_5: Irrigation at 0.8 bar soil moisture tension and their zinc treatments viz. Zn_0: Control, Zn_1: Zinc sulphate @ 0.25%, Zn_2: Zinc sulphate @ 0.5%. Lime was mixed with the zinc sulphate @ 50% above zinc dose, was arranged in a split plot design keeping different irrigation scheduling in the main plot and zinc application sub plot design with three replication. Zinc sulphate was applied at branching and flowering stage. Sowing was done on 2^{nd} December 2015-16 in lines following the recommended line to line distance of 30 cm and plant to plant distance of 10 cm. The recommended dose of nitrogen 20 kg ha^{-1}, phosphorus 60 kg ha^{-1}, and potassium was 40 kg ha^{-1} through urea, single super phosphate, murate of potash, respectively uniformly applied to each plot as basal dose. As per the treatments, zinc was supplied through zinc sulphate at branching and pre flowering stage. Various intercultural operations such as thinning of plants, weeding and spraying of insecticides were accomplished whenever required to keep the plants healthy and the field weed free. The crop was harvested at maturity on 27^{th} may 2016. The harvested crop of each plot was bundled separately. Ten plants from each plot were selected at random and were tagged for the data collection. Data were collected at harvesting stage

Total chlorophyll estimation

In order to determine the most favorable sampling time for assessing the leaf chlorophyll content, leaf samples were taken from the plants. Leaf material of 50mg was taken from fully emerged leaf and placed in a test tube, and 10ml of DMSO was added. This was kept in an oven at 650C for about 4 hours. After 4 hours the chlorophyll was expressed in the liquid form without any grinding. The extract was taken in a measuring cylinder and final volume was made up to 10ml by using DMSO. The absorbance of the solution was read at 663nm and 645nm using spectrophotometer against the DMSO blank. The chlorophyll content was determine by using the formula given by Arnon (1949) and expressed as mg/g of fresh leaf. Arnon's formula estimate chlorophyll a, chlorophyll b and total chlorophyll as follows.

Results and Discussion

Chlorophyll content

In our observations plants treated with irrigation scheduling and zinc application showed significant increase in total chlorophyll content as compare to control plants Table 1. That the most amount of chlorophyll was recorded at 50 DAS (3.14 mg g^{-1} and 3.06 mg g^{-1}) receiving irrigation at branching + pre flowering + pod development stages (I_4) and application of zinc sulphate @ 0.5 % (Zn_2) respectively. At 90 DAS the total chlorophyll content was decreased due to pod development. Interaction effect between irrigation scheduling and zinc application was found statistically significant Table 2. Irrigation scheduled at irrigation at branching + pod development combine with spraying of zinc @ 0.5% showed the significantly higher total chlorophyll content 1.89 mg g^{-1} and The lowest total chlorophyll content (1.38 mg g^{-1}) was recorded in irrigation at pre flowering with no zinc application these findings are closely related with those of Akey *et al*., (2011) [1].

Zinc content

The present results have indicated that zinc content was significantly affected by irrigation scheduling and application of zinc sulphate in table 1. The highest zinc content was found in seed 56.97 mg kg^{-1} and 48.11 mg kg^{-1} in irrigation at branching + pre flowering + pod development (I4) and Spraying of zinc sulphate @ 0.5% (Zn_2) respectively. Zinc content in stalk 32.28 mg kg^{-1} and 30.92 mg kg^{-1} was found in treatment I4 and treatment Zn_2 respectively. And lowest zinc content (31.1 mg kg^{-1} in seed and 21.131 mg kg^{-1}in stalk) was found in irrigation at 0.8 bar soil moisture tension with without zinc spry.

Zinc uptake

Irrigation scheduling and Zinc application strategy significantly influenced zinc uptake (grain and straw) on chickpea Table 2. The highest (151.86 g ha^{-1} and 133.07g ha^{-1}) zinc uptake was found irrigation at branching + pre flowering + pod development (I_4) and application of zinc sulphate @ 0.5% (Zn_2) respectively and lowest zinc uptake was found in control plot. These findings are closely related with those of Ramaprasad *et al*., (2011) [19].

Yield (Biological yield, seed yield, stalk yield)

Chickpea yields in different treatments as influenced by irrigation scheduling and zinc application are presented in Table 1. The maximum biological yield (2637 kg ha^{-1}), seed yield (973kg ha^{-1}), stalk yield and (1509 kg ha^{-1}) of chickpea was observed in irrigation at branching + pre flowering + pod development (I_4). The irrigation applied all the critical growth stages of the crop might have improved growth and yield components of the crop resulted maximum crop yield under this irrigation treatment similar observations were also reported by Parmar (2014) [17] and Singh (2016) [20]. Spraying of zinc sulphate at branching and pre flowering @ 0.5% probably helped the crop to produce good growth and development of chickpea and hence, it recorded maximum biological yield (2482 kg ha^{-1}), seed yield (840 kg ha^{-1}) and stalk yield (1444 kg ha^{-1}). The results are in the similar trend as observed by Dayanand (2013) [5] and Kayan (2015) [11].

Interaction

The treatment combination of irrigation scheduling and zinc application was found statistically significant Table 2. Irrigation scheduled at irrigation at branching + pre flowering + pod development combine with spraying of zinc @ 0.5% showed the significantly higher biological yield (2977 kg ha^{-1}), seed yield (1166 kg ha^{-1}) and stalk yield (1652 kg ha^{-1}). As compare to other treatment combination. The lowest biological yield, seed yield and stalk yields were found irrigation applied at 0.8 bar soil moisture tension without zinc spray. However, the lowest harvest index was observed under irrigation applied at pre flowering only and no zinc spraying. The results corroborated with the findings of Hadi (2013) [9] and Patidar (2015) [18].

Conclusion

The present study clearly shows that irrigation scheduling and zinc application (I_4: at branching, pre flowering, pod development) and zinc sulphate @ 0.5% (Zn_2) resulting higher chlorophyll content, zinc content in seed and stalk, uptake and yield of chickpea under lateritic condition of West Bengal. Although, irrigation scheduling could decrease effects of water stress on chickpea chlorophyll content, and seed yield. Thus, application of zinc can be helpful in increasing of zinc content, uptake and yield of chickpea.

Table 1: Effect of irrigation scheduling and zinc application on Chlorophyll content, zinc content, uptake and yields of chickpea.

Treatment	Chlorophyll content (mg g^{-1}) 50 DAS	90 DAS	Zinc content (mg kg^{-1}) Seed	Stalk	Zinc uptake (g ha^{-1}) (Seed + Stalk)	Biological yield (kg ha^{-1})	Seed yield (kg ha^{-1})	Stalk yield (kg ha^{-1})
Irrigation scheduling								
I_1	2.88	1.48	33.55	21.92	89.54	2125	592	1283
I_2	3.13	1.81	49.80	31.01	137.49	2345	798	1369
I_3	3.08	1.73	43.36	25.61	112.81	2293	672	1360
I_4	3.14	1.86	56.97	32.28	151.86	2637	973	1509
I_5	2.86	1.47	31.10	21.13	82.54	2060	583	1278
SEm (±)	0.025	0.027	1.832	1.366	4.62	9.51	2.74	5.93
CD at 5%	0.082	0.087	5.975	4.456	15.06	31.00	8.93	19.33
CV (%)	2.62	4.81	12.80	15.53	12.06	1.24	1.13	1.31
Zinc application								
Zn_0	2.96	1.60	37.73	22.56	97.24	2117	596	1291
Zn_1	3.03	1.68	43.03	25.69	114.23	2277	735	1344
Zn_2	3.06	1.73	48.11	30.92	133.07	2482	840	1444
SEm (±)	0.22	0.009	1.375	0.942	3.21	6.81	4.92	4.79
CD at 5%	0.065	0.026	4.055	2.780	9.46	20.09	14.52	14.14
CV (%)	2.73	2.06	12.39	13.83	10.81	1.15	1.18	1.36

I_1: Irrigation at pre flowering, I_2: Irrigation at branching + pod development, I_3: Irrigation at branching + pre flowering, I_4: Irrigation at branching + pre flowering + pod development, I_5: Irrigation at 0.8 bar Soil moisture tension, Zn_1: control, Zn_1: Zinc sulphate @ 0.25%, Zn_2: Zinc sulphate @ 0.5%.

Table 2: Interaction effect of irrigation scheduling and zinc application on Chlorophyll content and yields of chickpea

Treatment	Chlorophyll content (mg g^{-1}) 90DAS			Biological yield (kg ha^{-1})			Seed yield (kg ha^{-1})			Stalk yield (kg ha^{-1})		
Irrigation scheduling	**Zinc application**			**Zinc application**			**Zinc application**			**Zinc application**		
	Zn_0	Zn_1	Zn_2	Zn_0	Zn_1	Zn_2	Zn_0	Zn_1	Zn_2	Zn_0	Zn_1	Zn_2
I_1	1.38	1.49	1.57	2048	2090	2237	533	602	642	1250	1268	1330
I_2	1.72	1.82	1.89	2162	2261	2613	610	791	993	1315	1323	1468
I_3	1.67	1.73	1.8	2167	2227	2484	590	662	765	1307	1327	1445
I_4	1.83	1.85	1.86	2201	2734	2977	715	1037	1166	1337	1540	1652
I_5	1.4	1.47	1.54	2009	2074	2098	532	584	632	1245	1263	1325
I × Zn												
SEm (±)		0.02			15.23			4.92			10.72	
CD at 5%		0.059			44.92			14.52			31.61	
Zn × I												
SEm (±)		0.106			15.65			4.88			10.57	
CD at 5%		0.311			46.03			15.90			31.17	

I_1: Irrigation at pre flowering, I_2: Irrigation at branching + pod development, I_3: Irrigation at branching + pre flowering, I_4: Irrigation at branching + pre flowering + pod development, I_5: Irrigation at 0.8 bar Soil moisture tension, Zn_1: control, Zn_1: Zinc sulphate @ 0.25%, Zn_2: Zinc sulphate @ 0.5%.

References

1. Anonymous. 2002. FAO Web Site.www.fao.org.
2. Akay A. Effect of zinc fertilizer applications on yield and element contents of some registered chickpeas varieties. African Journal of Biotechnology. 2011; 10(61):13090-13096.
3. Cakmak I. Identification and correction of widespread zinc deficiency in Turkey - a success story (a NATO-Science for Stability Project). Proceedings of the International Fertiliser Society. 552, 1-26McNab, A. (Eds.), Application of Physiology in Wheat Breeding. D.F. CIMMYT, pp: 183-199, Mexico, 2004, 183-199.
4. Condon AG, Richards RA, Rebetzke GJ, Farquhar GD. Improving intrinsic water use efficiency and crop yield. Crop Science. 2002; 42:122-131.
5. Dayanand, Mehta SM, Verma RK. Seed yield and economics of chickpea (*Cicer arietinum*) as influenced by foliar application of agrochemicals. Indian journal of agriculture research. 2013; 47(4):359-362.
6. Directorate of Economics and Statistics, Department of Agriculture and Cooperation, Government of India, New Delhi, India, 2014.
7. Farshadfar M, Farshadfar E. Gentic variability and path analysis of chickpea (*Cicer arientinum* L.) landraces and lines. J. Applied Science. 2008; 8:3951-3956.
8. Government of India Ministry of Agriculture & Farmers Welfare Department of Agriculture, Cooperation & Farmers Welfare Directorate of Economics and Statistics Agricultural Statistics at a Glance 2016, 172.
9. Hadi MRHSH, Bazargani P, Darzi MT. Effects of Irrigation Treatment and Zinc Foliar Application on Yield and Yield Components of Chickpea (*Cicer arietinum*). International Journal of Farming and Allied Sciences. 2013; 2(19):720-724.

10. Hossain B, Hirata N, Nagatomo Y, Akashi R, Takaki H. Internal zinc accumulation is correlated with increased growth in rice suspension culture. Journal Plant Growth Regulation. 1997; 16:239-43.
11. Kayan N, Gulmezoglu N, Kaya MD. The optimum foliar zinc source and level for improving Zn content in seed of chickpea. Legume research. 2015; 38(6):826-831.
12. Khan HR, McDonald GK, Rengel. Response of chickpea genotypes to zinc fertilization under filed conditions in South Australia and Pakistan. J Plant Nutrition. 2000; 23(10):1517-1531
13. Khan HR, McDonald GK, Rengel Z. Zinc fertilization and water stress affects plant water relations, stomatal conductance and osmotic adjustment in chickpea (*Cicer arientinum* L.). Plant and Soil. 2004; 267:271-284.
14. Marschner H. Mineral Nutrition of Higher Plants. Academic Press, San Diego, 1995, 889.
15. Munne-Bosch S, Alegre L. Changes in carotenoids, tocopherols and diterpenes during drought and recovery and the biological signicance of chlorophyll loss in *Rosmarinus officinalis* plants. Planta. 2000; 210:925-931.
16. Oguchi K, Tanaka N, Komatsu S, Akao S. Methylmalonate semialdehidedehydrogenase is induced in auxin-stimulated and zinc-stimulated root formation in rice. Plant Cell Rep. 2004; 22:848-58.
17. Parmar SK, Patel RA, Saras P, 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):3980-3982.
18. Patidar D, Patel JB, Saras KS. 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):358-361.
19. Ramaprasad DP, Rao CP, Srinivasulu K. Effect zinc management on yield and nutrient uptake of Kabuli chickpea. The Andhra Agriculture Journal 58(3):258-261.
20. Singh G. Irrigation, seed rate and phosphorus management in vegetable grain chickpea (*Cicer arietinum* L.). Bioinfolet. 2016; 13(1A):26-28.