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Response of Chickpea (*Cicer arietinum* L.) to Iron and Zinc Nutrition on Protein and Chlorophyll Content

Kuldeep, P. D. Kumawat, Mahendra Choudhary, Kuldeep

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Abstract An experiment was conducted to assess the effect of iron and zinc nutrition on protein and chlorophyll content of chickpea (*Cicer arietinum* L.) during *rabi* 2014-15. The results of experiment indicated that protein and chlorophyll content (SPAD value) of chickpea increased significantly with the increase in iron levels up to 4.0 kg Fe ha^{-1} whereas maximum protein content in seed (22.94%) and chlorophyll content in leaf was recorded with the application of 6.0 kg Fe ha^{-1} which was significantly higher over control and 2.0 kg Fe ha^{-1} but remained at par with 4.0 kg Fe ha^{-1}. Application of 5.0 kg Zn ha^{-1} significantly increased the protein content over control and 1.25 kg Zn ha^{-1} and remained at par with 2.5 kg Zn ha^{-1}. Chlorophyll content (SPAD value) of chickpea leaves significantly increased with the increasing levels of zinc at 60 DAS. Application of 5.0 kg Zn ha^{-1} significantly increased the chlorophyll content (SPAD value) in leaf to the extent of 11.63, 6.91 and 5.75% respectively over control, 1.25 and 2.5 kg Zn ha^{-1}.

Keywords Chickpea, Iron, Zinc, Protein, Chlorophyll.

Kuldeep*, M. Choudhary
Department of Agronomy, College of Agriculture, Junagadh Agricultural University, Junagadh 362001, Gujarat, India

P. D. Kumawat
Main Sugarcane Research Station, JAU, Kodinar 362725, India

Kuldeep
Department of Agronomy, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur 313001, Rajasthan, India
e-mail: kasniya99@gmail.com
*Correspondence

Introduction

India is one of the major pulses growing country of the world. Pulses occupy a key position in Indian diet and meet about 30% of the daily protein requirement. Among the food crops, pulses are an important group which occupies a unique position in the world of agriculture by virtue of their high protein content. Importance of pulses is relatively more in our country as its contribution in nutrient supply is far more in Indian diet than that in Asia and world as a whole. Among the pulses, chickpea is a most important *rabi* crop with high acceptability and wider use [1].

Chickpea (*Cicer arietinum* L.) belongs to the genus *Cicer,* tribe *Cicereae,* family Fabaceae and subfamily Papilionaceae. It has 2n=16 chromosome number. The origin of the crop is considered in Western Asia from where it spread in India and other part of the world. There are two distinct types of chickpea, "Kabuli" (also known as *macrosperma*) and "Desi"(also known as *microsperma*). "Desi" (*Cicer arietinum* L.) type chickpea's color ranges from brown to yellow. Seeds are normally small in size. It is widely grown group of chickpea "Kabuli" *(Cicer kabulium)* chickpeas are usually white in color. Seeds are bold and attractive. Chickpea also known by different names in various countries, such as gram, bengal gram, chana, pois, hoos, hommos, grao-de-beco and garbanzo. Chickpea is mostly consumed in the form of processed whole seed (boiled, roasted, parched, fried, steamed, sprouted) or dal or as dal flour (besan). It is used in preparing a variety of snacks, sweets and condiments.

Chickpea is a rich source of Ca, Fe, niacin, vitamin B and C. It is mostly consumed in the form of processed whole seed (boiled, roasted, parched, fried, steamed, sprouted) or dal or as dal flour (besan). It is used in preparing a variety of snacks, sweets and condiments. It is mixed with wheat flour for "chapati" making. Fresh green seeds are consumed as green vegetable. Green leaves are used as vegetable. Grains are also used as vegetable (chhole). Chickpea is the third most important pulse crop in the world after beans and field peas. In India, it is the premier pulse crop occupying 10.2 million hectares area and contributing 9.9 million tonnes to the national pulse basket with the productivity of 967 kg ha^{-1} [2]. In Gujarat, chickpea occupied an area of 2.47 lakh hectares with a production of 3.10 lakh tonnes with the average yield of 1,251 kg ha^{-1} [2].

Recently, prices of pulses in the country have increased significantly as compared to other food grains, pushing pulses out of the reach of poor masses. Declining per capita availability of pulses indicates the pace of technological development could not commensurate with the rising demand. Pulse production of country touched the magic figure of 18.09 million tonnes, but this is still not sufficient. According to an estimate country has to produc 30.0 million tonnes of pulses during the span 2020-30.

Iron is the most important micronutrient for chickpea crop. Fe is present at high quantities in soils but its availability to plants is usually low and therefore Fe deficiency is common problem [3]. Iron plays an important role in synthesis and maintenance of chlorophyll in plant. It helps in the formation of chlorophyll and is an important constituent of the enzyme nitrogenase, which is essential for nitrogen fixation.It has an essential role in nucleic acid metabolism. It activates number of enzymes, including aminolevolinic acid synthetase and coproporphyrinagen oxidase and a structural component of hemes, hematin and leg hemoglobin [4]. Iron is a constituent of two groups of protein viz., (a) Heme protein contain Fe porphyrin complex as a prosthetic group : cytochrome oxidase, catalase, peroxidase, leg hemoglobin and (b) Fe-S protein in which Fe is coordinated to the thiol group of cysteine or to inorganic ferrodoxin. Iron helps in electron transport coupled with oxidative phosphorylation during respiration. The iron, being a constituent of ferredoxin cytochromes is involved in respiration-linked active uptake of irons. It being a constituent of ferrodoxin also plays a key role in nitrogen fixation by diverse group of micro-organisms-aerobic and anaerobic bacteria and blue green algae. It helps in absorption of other nutrients. A deficiency of iron causes chlorosis between the veins of leaves. A little amount of Fe enhanced the chickpea yield and quality. Application of Fe fertilizer for crop production also reduces the malnourishment in human and animals. Iron deficiency is one of the major limiting factors affecting crop yields.

Among all agronomic factors, adequate and balanced fertilization stands first and it is considered as one of the most productive inputs in agriculture. In modern agriculture micronutrients are becoming deficient day by day due to intensive cultivation with high yielding varieties of crops using high analysis fertilizers, which not only reduce the crop productivity but also deteriorates the quality of produce. Micronutrients are essential for the normal growth of plants. Deficiencies of micronutrient drastically affected the growth, metabolism and reproductive phase in plants, animals and human beings. Fe and Zn deficiency in human nutrition are wide-spread in developing Asian countries including India. Iron plays an important role in chlorophyll synthesis, being a structural component of hemes, hematin and leg hemoglobin. It is also an important part of the enzyme nitrogenase, which is essential for the N_2 fixation in legumes. Zinc plays an important role in formation of chlorophyll and growth hormones. Zinc is also an essential plant nutrient for plant growth and development. Zn is recognized as essential component of several enzyme systems having vital roles in the plant metabolism, e.g. carbonic anhydrase for reversible hydration of CO_2 to form HCO_3^- for transport and utilization of CO_2 in photosynthesis. It is also responsible for resisting pH changes in cytoplasm. Zn is involved in auxin metabolism like, tryptophan synthesis, tryptamine metabolism. Therefore, the present investigation was carried out to study the effect of Fe and Zn nutrition on growth and quality parameter of chickpea.

Materials and Methods

The field experiment on effect of iron and zinc nutrition on protein and chlorophyll content of chickpea (*Cicer arietinum* L.) was conducted during *rabi* 2014-15 at Instructional Farm, Department of Agronomy, Junagadh Agricultural University, Junagadh, which is situated in South Saurashtra Agro-climatic region of Gujarat state and enjoys a typically subtropical climate characterized by fairly cold and dry winter, hot and dry summer as well as warm and moderately humid monsoon. It is situated at 21.5^0 N latitude and 70.5^0 E longitudes with an altitude of 60 m above the mean sea level. The soil was clayey in texture and slightly alkaline in reaction with pH 7.8 and EC 0.33 dS m^{-1}. The soil of the experimental site was medium in available iron (5.23 mg kg^{-1}) and zinc (0.75 mg kg^{-1}) and low in sulfur (17.02 kg ha^{-1}). Total sixteen treatment combinations involving four levels of iron (0, 2.00, 4.00 and 6.00 kg ha^{-1}) and four levels of zinc (0, 1.25, 2.50 and 5.00 kg ha^{-1}) were set out in a factorial randomized block design (FRBD) with three repetitions. The crop was sown in 45 cm × 10 cm spacing with seed rate of 60 kg ha^{-1}. The variety GG-1 was sown on 16^{th} November and recommended dose of fertilizer was 20-40-0 N-P-K kg ha^{-1} and all other recommended practices were adopted as perneed of crop. Statistical analysis of the individual data of various characters studied in the experiment was carried out using standard statistical procedures as described by Panse and Sukhatme [5]. Standard error of mean, critical difference (CD) at 5% level of probability and coefficient of variance were worked out for the interpretation of the results.

Table 1. Effect of iron and zinc levels on protein and chlorophyll content of chickpea.

Treatments	Protein content (%)	SPAD value (60 DAS)
Iron (kg ha^{-1})		
0.00	20.88	47.66
2.00	21.67	49.81
4.00	22.57	52.81
6.00	22.94	53.78
SEm ±	0.26	0.95
CD (p = 0.05)	0.76	2.75
Zinc (kg ha^{-1})		
0.00	20.57	48.40
1.25	21.33	50.54
2.50	22.85	51.09
5.00	23.31	54.03
SEm ±	0.26	0.95
CD (p = 0.05)	0.76	2.75
CV (%)	4.15	6.47

Results and Discussion

Protein content in seed

Iron

The data presented in Table 1 indicated that the increasing levels of iron up to 4.0 kg ha^{-1} significantly increased the protein content in chickpea seed. Maximum protein in seed (22.94%) was recorded with the application of 6.0 kg Fe ha^{-1} which was significantly higher over control and 2.0 kg Fe ha^{-1} but remained at par with 4.0 kg Fe ha^{-1}. The application of 2.0, 4.0 and 6.0 kg Fe ha^{-1} increased the protein content to the tune of 3.78, 8.09 and 9.87%, respectively over control. Similar findings were also reported by Sharma et al. [6] in pigeon peacrop.

Zinc

It is explicit from the data presented in the Table 1 that application of 5.0 kg Zn ha^{-1} significantly increased the protein content over control and 1.25 kg Zn ha^{-1} and was at par with 2.5 kg Zn ha^{-1}. The increase in protein content with the application 5.0 kg Zn ha^{-1} was 13.32, 9.28 and 2.01% over control, 1.25 and 2.5 kg Zn ha^{-1}, respectively. Similar results were also reported earlier [7, 8].

Chlorophyll content

Iron

Table 1 explained that the increasing levels of iron up to 4.0 kg ha^{-1} significantly increased the leaf chlorophyll content (SPAD value) at 60 DAS. Highest chlorophyll content was recorded with the application of 6.0 kg Fe ha^{-1} which was significantly higher over control and 2.0 kg Fe ha^{-1} but found statistically at par with 4.0 kg Fe ha^{-1}. The application of 4.0 and 6.0 kg Fe ha^{-1} increased the chlorophyll content by 10.81 and 12.84%, respectively over control. These findings are in confirmation to the earlier reported by Kumawat et al. [9].

Zinc

Further perusal of data shown in Table 1 revealed that chlorophyll content (SPAD value) in leaf of chickpea significantly increased with the increasing levels of zinc at 60 DAS. Application of 5.0 kg Zn ha^{-1} significantly increased the chlorophyll content (SPAD value) in leaf to the extent of 11.63, 6.91 and 5.75%, respectively over control, 1.25 and 2.5 kg Zn ha^{-1}. Sinilar results were also reported by Yadav et al. [8].

Conclusion

On the basis of one year experimental data, it may be concluded that soil application of 4.0 kg Fe ha^{-1} and 2.5 kg Zn ha^{-1} were found effective in improving the protein content and chlorophyll content (SPAD value) at 60 DAS of chickpea under irrigated conditions of South Saurashtra Agro-climatic zone.

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