Effect of foliar application of iron on clusterbean \([Cyamopsis tetragonoloba (L.) TAUB]\) varieties

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Abstract: A field experiment was conducted to work out optimum dose of foliar application of iron and to evaluate production potential of clusterbean \([Cyamopsis tetragonoloba (L.) Taub]\) varieties. The treatment consisted of combinations of five clusterbean varieties (RGC-986, RGC-1003, RGC-1033, RGC-1055 and RGC-1066) and four foliar sprays treatment of 0.5 % FeSO\(_4\) (control, branching, flowering and branching +flowering) were tested in randomized block design with three replications. Results revealed that the highest total N, P, K and Fe uptake (110.8, 13.0, 51.5 kg/ha and 1143 g/ha), seed yield (1816 kg/ha), stover yield (3787 kg/ha), net returns (Rs. 53651/ha) and B:C ratio (2.25), ‘RGC-1033’ proved best and economically profitable compared to rest of varieties. Application of 0.5 % FeSO\(_4\) at branching + flowering stage significantly increased quality of seed and stover, seed yield (1550 kg/ha) and stover yield (3624 kg/ha) and proved economically beneficial compared to over control. However, application of 0.5 % FeSO\(_4\) at branching recorded at par net returns with spray at branching +flowering stage.

Key words: Clusterbean, Varieties, Foliar spray, Iron, Nutrient uptake

Introduction

Clusterbean, also known as guar, is an arid legume crop that is cultivated mostly in the arid and semi arid areas as it is drought resistant. The word “guar” represents its derivation from sanskrit word “Gauaahar” which means cow fodder or otherwise fodder of the livestock. There is no other legume crop so hardy and drought tolerant as clusterbean, which is especially suited for soils and climate of Rajasthan. The popular guar gum (28 to 32%), which is used in mining, petroleum drilling and textile manufacturing sectors, is obtained from the endosperm of the seed of the plant. The India’s contribution is around 75-80 % in world’s total production. India is earning crores from the endosperm of the seed of the plant. The India’s contribution of traditional low yielding varieties without or with little fertilization and lack of other improved agronomic practices. Thus, it offers a great scope for increasing its productivity through selection of suitable varieties and sound crop husbandry practices. Use of recently released high yielding varieties is imperative to meet our increasing industrial demand. However, a number of high yielding varieties of clusterbean have been developed by plant breeders at various research stations. These varieties vary yielding potential under varied climatic conditions, but a variety performing better is selected for the region.

Reinbott and Blevins (1995) reported that micronutrients have played vital roles in the improved of growth, yield and quality of legumes crops. Hallock (1978) observed that foliar application of micronutrient is better than soil application for increasing yield. Legume crops required not only adequate macronutrient but also micronutrients for increasing the bacterial activity of nodule. Therefore, an optimum supply of micronutrients under balanced condition is very important for achieving higher productivity. Iron being an essential micronutrient takes active part in the metabolic activities of the plant. It acts as an activator of dehydrogenase, proteolase and peptidases enzymes and involved directly or indirectly in the synthesis of carbohydrates and proteins. Iron being a structural component of porphyrin molecules, cytochromes, heams, hematin, ferrichrome and leg–heamoglobin is involved in oxidation-reduction reactions. Iron in chloroplast reflects the presence of cytochromes for performing various photosynthetic reduction processes. The ferrodoxins are Fe-S protein and are the first stable redox compound of the photosynthetic electron transport chain (Haviln et al., 1997). Rao and Rao (1994) also showed that Fe deficiency due to high pH caused tissue necrosis and necrotic patches of leaf lamina of \(vigna mungo\) and \(vigna radiata\). Therefore, the present investigation was carried out to identify response foliar application of iron in different of clusterbean.

Materials and Methods

The experiment was conducted at the Agronomy farm, Sri Karan Narendra Agriculture University, Jobner in Agroclimatic zone III A (Semi-arid Eastern Plain Zone) of Rajasthan. The soil was...
loamy sand in texture, alkaline in reaction (pH value 8.2), poor in organic carbon (0.14%) with low available nitrogen (130 kg/ha) and medium in phosphorus and nitrogen content (18.9 & 175.6 kg/ha) respectively. The rainfall received during the period (June to October) was 251 mm. The Twenty treatment combinations consisting of five clusterbean varieties (RGC-986, RGC-1003, RGC-1033, RGC-1055 and RGC-1066) and four foliar spray treatment of 0.5 % FeSO₄ (control, branching, flowering and branching + flowering) were tested in randomized block design with three replications. The seed was sown manually on 10 July 2014 maintaining spacing of 30 cm x 10 cm, with 20 kg/ha seed rate. Each plot consisted gross dimension of 4.0 m x 3.0 m and net area 3.0 m x 1.8 m. Phosphorus as per treatments was applied basal, whereas nitrogen was applied as starter dose only due to a leguminous crop. In order to all three operations viz, thinning, hoeing and weeding were done after 20 days of sowing to maintain recommended spacing, proper aeration and weed free field. Net return and profit: cost ratios were calculated on the basis of prevailing market prices of seed of clusterbean varieties. Leaf-area index, crop-growth rate (CGR) and relative growth rate (RGR) were worked out by using standard method for analysis and formula.

**Growth indices:**

**Leaf area index (LAI):** Five plants were randomly selected for measurement of leaf area at Harvest. The leaf area was measured with the help of portable leaf area meter at the experimental site. LAI was calculated by the following relationship (Watson, 1958).

\[
\text{Leaf area index} = \frac{\text{leaf area (cm}^2\text{)}}{\text{Ground area (cm}^2\text{)}}
\]

**Crop growth rate (CGR):** The CGR of a plant for a time ‘t’ is defined as the increase in dry weight of plant material from a unit area per unit of time. It was calculated with following formula (Radford, 1967) from periodic dry matter recorded at different stages.

\[
\text{CGR (g / m row length / day)} = \frac{(W_2 - W_1)}{(t_2 - t_1)}
\]

Where: \(W_1 = \text{Total dry weight of plant at time} \ t_1\); \(W_2 = \text{Total dry weight of plant at time} \ t_2\); \(t_1 = \text{Time at first observation}\); \(t_2 = \text{Time at second observation}\)

**Relative growth rate (RGR):** The RGR of a plant at an instant in time (t) is defined as the increase in dry weight of plant material per unit of material already present per unit of time. The RGR of the crop was calculated by the following formula (Radford, 1967).

\[
\text{RGR (g / g / day)} = \frac{(log_{10} W_2 - log_{10} W_1)}{(t_2 - t_1)}
\]

Where: \(W_1\) and \(W_2\) are total dry matter at time \(t_1\) and \(t_2\), respectively.

**Nutrient content, uptake and quality parameters estimation:**

**Nitrogen concentration and its uptake:** The seed and straw samples were analyzed separately for nitrogen concentration (%) by standard (Nessler's reagent) colorimetric method (Snell and Snell, 1949). The uptake of nitrogen by crop was calculated using following formula:

\[
\text{N uptake (kg/ha)} = (\text{N conc. in seed (%) x Seed yield (kg /ha)} + \text{N conc. in straw (%) x Straw yield (kg/ha)}) / 100
\]

**Potassium concentration and its uptake:** Potassium concentration in seed and straw was estimated by flame photometry method (Jackson, 1973). The Uptake of potassium by crop was calculated using following formula:

\[
\text{K uptake (kg/ha)} = (\text{K conc. in seed (%) x Seed yield (kg /ha)} + \text{K conc. in straw (%) x Straw yield (kg/ha)}) / 100
\]

**Iron content:** Iron was estimated using wet digestion of plant sample with diacid (HNO₃ and HClO₄ in ratio of 9:4) and was analysed with the help of AAS (Elwell and Grindley 1967).

**Protein content in grain:** Protein content in grain was calculated by multiplying nitrogen concentration in grain (%) with a factor of 6.25 (A.O.C., 1960).

**Results and Discussion**

**Growth parameter and yield attributes:** Results indicated that variety of RGC-1066 recorded significantly increase plant height and remained at par with variety of RGC-1055 over rest of varieties (Table 1). The variety RGC -1033 have more branching and dry matter at all the crop growth stages as compared to other varieties. This variety also recorded higher growth indices i.e. LAI, CGR and RGR over RGC-1066, RGC-1003, RGC-986 and RGC-1055. The variety of RGC-1033 and RGC-1055 recorded significantly increases the dry matter of 48.4 and 39.6% at harvest, respectively, over variety RGC-1066. The maximum leaf area index was obtained with RGC-1033 (5.24) which was significantly higher over RGC-1066, RGC-1003 and remained at par with RGC-986 and RGC-1055 (Table 1). Number of seeds per pod and test weight of RGC-1033 remained at par with the variety of RGC-1055. The differential behaviour among the varieties could be explained solely by the variation in their genetic make up and their differential behavior under different climatic conditions Pathak et al. (2010), Kalyani and Lakshmi (2012), and Rawat et al. (2015). Kumar and Kaushik (2014) observed that clusterbean variety RGC-936 recorded significantly higher plant height and dry matter as compared to RGC-1003 and RGC-1002. However, variety of RGC-1033 recorded highest number of pods per plant, seeds per pod over rest of varieties and test weight remained at par with RGC-1055 over rest of varieties.

**Effect of foliar application of FeSO₄:** Result indicated that application of FeSO₄ @ 0.5 % at branching + flowering stage significantly increase the plant height 10.4 and 8.4 per cent at 60 DAS and at harvest stages. Similarly, Dry matter and growth indices: LAI, CGR, and RGR were significantly increased at branching + flowering stage over control, flowering and branching. Number of pods per plant and remained at par with the application of FeSO₄ @ 0.5% at branching stage over control (Table 1). Similar result was found in case of number of seeds per pod and test weight but remained at par with the application of FeSO₄ @ 0.5% at flowering stage over rest of stages. Among foliar spray, 0.5 % FeSO₄ foliar spray at branching and at branching + flowering stage recorded highest value of growth parameters. The overall growth of plant increased in terms of plant height and leaf area which contributed for higher dry matter production (Mondal et al., 2011). A significantly increased growth with both 25 kg FeSO₄/ha as basal dose and foliar spray of 0.5% FeSO₄ at 25 and 40 DAS in comparison to control in mungbean (Meena et al., 2013). This might be due to readily available Fe at early and the critical stage of plant growth.
Solanki et al. growth that facilitated maximum plant growth (Eleyan et al., 2014).
The favourable effect of foliar application of fertilizers might be due to
on account of improved photosynthetic efficiency and chlorophyll formation.

Yield, economics and nutrient uptake: Result revealed that
variety of RGC-1033 significantly increases seed yield, stover yield
and total Fe uptake and remained at par with the variety of RGC-
1055 over other variety (Table 2). However, this variety significantly
increase protein content and remained at par with the variety of
RGC-986, RGC-1003, RGC-1055 and RGC-1066. Thus, as a
consequence of marked improvement in both these regulative
processes as evidenced from higher accumulation of biomass and
nutrients as well as yield components under variety RGC-1033 led
to significant increase in seed yield due to its genetic potential when
grown under semi-arid conditions and improved growth at
successive stages Ayub et al. (2010), Kalyani and Sunitha (2011),
Kumar et al. (2012) and Kalyani and Lakshmi, 2012). Kalyani and
sunitha (2011) observed that variety Durgarapura safed recorded
significantly more gum and protein content in seed as compared to
local varieties of clusterbean. Further, Sharma and Ratnou (2014)
observed that variety RGC-1033 produced significantly higher yield
(18.22q/ha) as compared to rest of varieties. The variety of RGC-
1033 significantly higher the net returns, B:C ratio, Total N, P and K
uptake over rest of varieties. Since the uptake of a nutrient is a
product of yield and its concentration in plant, the significant increase
in total uptake of nitrogen, phosphorus, potassium and iron of variety
RGC-1033 might be the result of cumulative effect of higher content
of these nutrients in seed and stover along with its higher yield. The
results of the present investigation regarding differential behaviour
of clusterbean varieties with respect to nutrient concentration and
their uptake are in close conformity with findings of other workers
like Kalyani and Sunitha (2011) and Kumar et al. (2012).

Effect of foliar application of FeSO₄: Further result indicate
that application of FeSO₄ @ 0.5 % at branching + flowering stage
significantly increase the yield attributes, yield and protein content,
net returns, B:C ratio, total K and Fe uptake and remained at par with the application of FeSO4 @ 0.5% at branching stage over other stages (Table 2). Generally, crops requires a favourable nutrient balance at reproductive stage for favourable development of pod and seed, whereas the soil applied nutrient does not meet the demand of crop for optimum nutrition. So foliar application of nutrient is a good way for supplying optimum nutrition for crop to complete its reproductive phases for obtaining higher productivity from crop plants. Zeidan et al. (2010) also observed in wheat remarkable improvement in yield attributes and yields due to application 0.1% FeSO4. Sadeghi and Noorhosseini (2014) found that application of Fe + Zn combination increased the number of pods/plant, number of seed/pod (2.28) and test weight. A significantly increased growth with both 25 kg FeSO4/ha as basal dose and foliar spray of 0.5% FeSO4 at 25 and 40 DAS in comparison to control in mungbean (Meena et al., 2013). The results of present investigation are in conformity with those of Qing et al. (2011), Radhika et al. (2013), Singh et al. (2013). Similar result was found in total N and P uptake over rest of stages. The beneficial role of iron in chlorophyll content and involved in large number of metabolically active compounds like cytochromes and other functional metallo proteins is well understand. Iron is related to vitamins and certain enzymes which helps in micronutrients metabolic process of plant. Salih (2013) reported that foliar application of Fe, B and Zn at two concentrations (1 and 2 ppm) sprayed at every 15 days. The results of Iron treatment has a greater effect on the nutrient uptake (P, K, Ca, Mg, Na and Cl) and protein percentage of seed than other treatment. This result is consistent with that earlier report (Choudhary et al., 2013 and Singh et al., 2013).

It was concluded that under prevailing conditions, clusterbean varieties ‘RGC-1033’ appear suitable for cultivation in semi-arid Rajasthan. However, foliar application of 0.5% FeSO4 at branching stage could be useful for improving highest seed yield, nutrient status, quality and uptake. Interaction between varieties and foliar application of 0.5% FeSO4 was non significant. The farmers of the Indian sub-continent are not habituated to use micronutrients as foliar spray on field crop.

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References