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Manoj Kumar Prajapati
Department of Agricultural Chemistry & Soil Science, Udai Pratap Autonomous Collage, Varanasi, Uttar Pradesh, India

Vimal Kumar
Department of Soil Science & Agricultural Chemistry, IAS, BHU, Varanasi, Uttar Pradesh, India

Shishu Pal Singh
Department of Soil Science & Agricultural Chemistry, IAS, BHU, Varanasi, Uttar Pradesh, India

RP Singh
Department of Agricultural Chemistry & Soil Science, Udai Pratap Autonomous Collage, Varanasi, Uttar Pradesh, India

Correspondence
Vimal Kumar
Department of Soil Science & Agricultural Chemistry, IAS, BHU, Varanasi, Uttar Pradesh, India

Influence of nitrogen levels and micronutrients on growth and quality of gram (*Cicer arietinum* L.) in inceptisol of varanasi

Manoj Kumar Prajapati, Vimal Kumar, Shishu Pal Singh and RP Singh

Abstract
The experiment was conducted during the *rabi* season in randomized block design (RBD) with three replicated and variety K- 468. The application of nitrogen alone and in combination with micronutrients namely B, Mo and Fe significantly increased the grain yield as compared to control. Plots treatment T_5 (20 kg N ha^{-1} + Fe @ 10 kg ha^{-1}) produced significantly higher yield as compared to other treatments and minimum yield was recorded with control. Maximum plant height (30, 45, 60 & 90 DAS) was recorded with treatment T_5 followed by the other treatments in decreasing order $T_5 > T_4 > T_3 > T_1 > T_2 > T_0$. the maximum number of primary branches at 30 DAS was found with the treatment T_5 followed by the other treatments and number of secondary branches per plant recorded at 30 days after sowing showed that the maximum number of branches were found with treatment T_5 (20 kg N ha^{-1} + Fe @ 10 kg ha^{-1}) followed by treatments in decreasing order as T_4, T_3, T_1, T_2, and T_0. The initial soil characteristics in the experimental field of soil reaction (soil pH) were noticed neutral (pH 7.34). The physical and chemical conditions were conducive gram cultivation under nitrogen levels and micronutrients condition of cultivation practice.

Keywords: Nitrogen levels, micronutrients, growth and quality of gram

Introduction

Pulses gram also known as "chickpea" (*Cicer arietinum* L.) occupies 12.0 million hectare with the production of 9.2 million tonne in world and in India gram occupying an area of 6.3 million hectare with production of 7.34 million tonne. Even the India is largest producer and consumer of pulses in the world accounting for 32% of the world area and 25% of world's production. But its productivity is far below that of other agriculture advanced countries.

Among various constraints to low productivity of pulses, inadequate and imbalance plant nutrition assumes great significance as the crops are generally grown in rainfed areas which are impoverished of soil nutrients and the fertilizer use is negligible. Nutrient imbalances in soil system are the major reason for the declined yield and nutritional quality of the pulses. Low yield of pulses are often associated with lack of major as well as micronutrients. It has also been seen that less availability of nutrients in soil adversely affect the protein content and its quality in pulses. Nitrogen, phosphorus and potassium have traditionally been known as the major nutrients. Crop need large amounts of elements and fertilizer programmes are designed to supply them in adequate amounts.

All the pulses are legumes and can assimilate nitrogen directly from the atmosphere by nitrogen fixation or can take up mineral nitrogen from the soil. Nitrogen requirement of pulses depends on the nitrogen content in the soil, the health of the nodules and the crop species. Chickpea requires its own specific *Rhizobium* species. High levels of nitrogen in soil may inhibit the nodulation and N fixation. Nevertheless, application of small amounts of nitrogen at seeding are often recommended for pulse crop. It is thought that this amount of N fertilizer is too low to inhibit nodulation, but is sufficient to stimulate early seedling growth and crop establishment and nodulation. Mo is an essential micro nutrient in the symbiotic N fixation and is an essential component of the N fixing enzyme "nitrogenase". So presence of Mo in adequate amount in soil increases the yield and quality of produce. Boron is recognized as an essential micronutrient for vascular plants and is believed to be involved in nucleic acid metabolism, cell division, sugar biosynthesis and translocation, active nutrient absorption, regulation of rate of photosynthesis and nodulation process.

Boron is associated with the reproductive phase in plants and its deficiency is often found to be associated with sterility and malformation of reproductive organs by Nayyer (1999) [8]. Iron plays essential role in the metabolism of chlorophyll. Application of Fe increased the photosynthesis, net assimilation and relative growth of plant. Plant yield on many soils is limited by poor Fe availability, rather than a low content in soil.

Application of sulphur as K_2SO_4 and molybdenum as Na_2MoO_4 significantly increased the protein, cystine and methionine content of the grains also tend to increase with S application by Kamat *et al.* (1981) [6], while molybdenum had little effect on protein, cystine and methionine contents. The effect of 25 kg $ZnSO_2$ ha^{-1} along with 20 kg N and 40 kg P_2O_5 ha^{-1} was more effective in increasing protein content of soybean by Sharma and Dixit (1987) [12] while increase in seed yield was only marginal. Nitrogen fixation in soil was significant by this soil application. That the response of N, Mo and liming Khirwar and Singh (1991) [7] on yield and uptake of N and Mo by lentil. The lentil crop responded significantly to nitrogen. Addition of Mo significantly increased the grain and straw yield of lentil. Lime addition decreases the grain and straw yield of lentil and uptake of Mo. That the application of phosphorus, sulphur and molybdenum conducted by Chaudhary and Das (1996) [2]. These nutrients had significant effect on number of nodule, grain and straw yield of rainfed black gram. The effect of micronutrient application by Balchandar *et al.* (2003) [1] result revealed that application of all the four micronutrient in combination of Mo 50 ppm, B-0.2%, Co-50 ppm and Fe 0.2% recorded the maximum number of nodule $plant^{-1}$, nodule weight $plant^{-1}$, plant height, biomass production and grain yield.

Materials and Methods

The field experiment was conducted during the *rabi* season of 2008-09 at research plot of Udai Pratap Autonomous College Varanasi, adjoining Department of Agriculture Chemistry and Soil Science. The experiment was conducted in randomized block design (RBD) with three replicated. The seeds were sown variety chickpea, var. - K-468. Treatments of this study, T_0: Control, T_1: 20 kg N ha^{-1}, T_2: 40 kg N ha^{-1}, T_3: 20 kg N ha^{-1} + Mo @ 1 kg ha^{-1}, T_4: 20 kg N ha^{-1} + B @ 5 kg ha^{-1}, T_5: 20 kg N ha^{-1} + Fe @ 10 kg ha^{-1}.

The half dose of nitrogen and full doses of micronutrients (molybdenum, boron and iron) were applied as basal dose before sowing of gram. No input was provided in control plots. Remained half dose of nitrogen was applied accordance with treatment, after 25 days of sowing.

Plant Attributes

Plant Height: The height of five plants in all the plots were measured from ground level to the tips of latest leaf at 30, 45, 60 and 90 DAS (days after sowing) growth stage of gram and mean height per plant was recorded.

Number of Branches: Number of primary and secondary branches were recorded at 30 DAS, there after secondary branches were recorded at 45, 60 and 90 DAS. The datas were expressed as number of primary and secondary branches $plant^{-1}$.

Plant Analysis

Preparation of plant samples and digestion

Plant samples taken at harvesting stage, were dried in shade and chaffed into pieces and then kept in oven at 70^0C for 12 hour to make free from moisture. After that samples were ground in a grinder. For digestion 0.5 g ground plant samples were taken and digested in diacid mixture prepared by mixing sulphuric acid and perchloric acid in the ratio of 9:1. Digested samples were used to determine the nitrogen.

Nitrogen Determination: Total nitrogen in seed and stover was determined by colorimetric method as described by Tandon (1993) [15].

Protein: Crude protein content in grain was calculated by multiplying the nitrogen content into factor 6.25.

Soil Sampling

Soil samples were collected before sowing and dried soil samples were crushed and passed through 2mm sieve.

Soil Analysis

Soil pH and Electrical conductivity (EC): Soil water suspension was prepared in the ratio of 1:2.5 the help of glass electrode digital pH and EC meter by Chopra and Kanwar (1999) [3].

Bulk Density: Bulk density of soil samples was determined using Pycnometer as described by Chopra and Kanwar (1999) [3].

Particle Density: Particle density was determined by using Pycnometer as described by Chopra and Kanwar (1999) [3].

Water Holding Capacity: Water holding capacity of the soil samples was determined Keen Roczkows Box method by Piper (1966) [10].

Porosity: The determination of the total porosity was made with the help of measured value of bulk density and particle density. Porosity was calculated with the help of following formula.

$$\text{Porosity\%} = 1 - \frac{Bulk\ density}{Particle\ density} \times 100$$

Organic carbon: Soil organic carbon content was determined by the Rapid Titraton Method by Walkey and Black's (1934) [16].

Available nitrogen: Available soil nitrogen was determined, using alkaline permanganate method by Subbiah and Asija (1956) [14].

Available phosphorus: The (Olsen's *et al.* (1954) [9] method was used for determination of available phosphorus in soil.

Available potassium: Potassium content in the extract was determined Flamephotometrically by Jackson (1967) [5].

Result and Discussion

Influence of nitrogen levels and micronutrients on growth parameters and yield of gram

Plant height

The plant height at different stages of the crop growth under various treatments (Table 1) consisted of nitrogen levels and micronutrients have been increased continuously with advancement in growth stage under all the treatments. It is evident that plant height at 30 DAS varied from 5.10 cm to 8.33 cm. Maximum plant height was recorded with treatment T_5 followed by the other treatments in decreasing order $T_5 > T_4 > T_3 > T_1 > T_2 > T_0$. The effect of treatments (T_3, T_4 and T_5) on plant height at this stage was found to be statistically significant over control.

The observation recorded at 45 days after sowing showed (Table 1) that plant height varied from 9.88 to 12.88 cm. Application of 20 kg N ha^{-1} + Fe @ 10 kg ha^{-1}(T_5) significantly increased the plant height as compared to control and other treatments. The lowest plant height was recorded with the treatment T_0 (9.88cm). Significantly difference was observed among different treatments.

Table 1: Influence of nitrogen levels and micronutrients treatments on plant height

Treatments	Plant height (cm)			
	30 DAS	**45 DAS**	**60 DAS**	**90 DAS**
T_0	5.10	9.88	14.33	21.77
T_1	6.21	10.88	16.33	22.99
T_2	5.88	10.66	16.44	22.44
T_3	6.88	11.33	15.88	23.32
T_4	7.88	11.99	15.99	23.44
T_5	8.33	12.88	16.66	23.66
SEm$^{\pm}$	0.73	0.56	-	-
CD (P = 0.05)	1.63	1.25	N.S.	N.S.

DAS = Days after sowing, N.S.= Non Significant.

The plant height at 60 days after sowing revealed that the plant height varied from 14.33 to 16.66 cm. The treatment T_5 (20 kg N ha^{-1} + Fe @ 10 kg ha^{-1}) registered maximum increment in plant height as compared to other treatments over control. The difference observed among different treatments was non-significant. Plant height at 90 days after sowing (DAS) revealed that plant height varied from 21.77 to 23.66 cm. The maximum plant height was recorded with treatment T_5 (23.66 cm) and lowest with the treatment T_0 (21.77 cm). The overall treatment effect was found to be non-significant at this stage.

The increase in plant height (Table 1) might be due to both root development with applied nutrients. Applications of graded level of nitrogen along with micronutrient significantly influence the plant height. The effect of nitrogen levels and micronutrients application was significant. But higher level of nitrogen (40 kg ha^{-1}) failed to increase in plant height.

Primary Branching

The observations recorded on average number of primary branches plant^{-1} have been presented in (Table 2). It is clear from the data that the maximum number of primary branches at 30 DAS was found with the treatment T_5 followed by the other treatments in descending order $T_5 > T_4 > T_3 > T_1 > T_2 > T_0$. At this stage number of primary branches varied from 2.99 to 4.44. The effects of various treatments were found statistically significant. T_5 was found to be significantly superior over T_3, T_2, T_1 and T_0.

Secondary Branching

The observations related to number of secondary branches per plant were made at various growth stages and have been presented (Table 2). The data related to the number of secondary branches per plant recorded at 30 days after sowing showed that the maximum number of branches were found with treatment T_5 (20 kg N ha^{-1} + Fe @ 10 kg ha^{-1}) followed by treatments in decreasing order as T_4, T_3,T_1, T_2, and T_0. At this stage number of secondary branches varied from 1.99 to 4.32. The effect of various treatments was found to be statistically significant. T_5 recorded significantly higher number of branches as compared to T_3, T_2, T_1 and T_0.

Table 2: Influence of nitrogen levels and micronutrients treatments on branching

Treatments	Primary Branching	Secondary branching			
	30 DAS	**30 DAS**	**45 DAS**	**60 DAS**	**90 DAS**
T_0	2.99	1.99	2.33	3.10	4.11
T_1	3.21	2.44	3.66	4.11	5.66
T_2	3.10	2.77	2.99	3.77	5.22
T_3	3.44	3.33	3.99	4.66	5.99
T_4	3.99	3.99	4.21	5.55	6.77
T_5	4.44	4.32	5.21	6.44	8.22
SEm$^{\pm}$	0.40	0.38	0.55	0.74	0.93
CD (P = 0.05)	0.89	0.86	1.24	1.65	2.07

DAS = Days after sowing

The second observation related to the number of secondary branches plant^{-1} was recorded at 45 days after sowing application of 20 kg N ha^{-1} + Fe @ 10 kg ha^{-1} significantly increased the number of secondary branches as compared to control. The maximum number of secondary branches plant^{-1} was recorded with treatment T_5 (5.21) and minimum with the treatment T_0 (2.33).

Secondary branches plant^{-1} was recorded at 60 days after sowing showed that the treatment T_4 and T_5 significantly increased the number of branches as compared to control. T_5 registered maximum (6.44) whereas T_0 (3.10) recorded minimum number of secondary branches at this stage. The number varied from 3.10 to 6.44.

At 90 days after sowing, the branching (Table 2) trend was almost similar to that of at 60 DAS. Treatment T_4 and T_5 were found to increase the number of branches significantly as compared to control. The number of branches varied from 4.11 to 8.22. The highest and lowest number was recorded with T_5 and T_0 respectively.

Grain yield and Stover yield

That application of nitrogen alone and in combination with micronutrients namely B, Mo and Fe significantly increased the grain yield as compared to control (Fig. 1). Plots treated with T_5 (20 kg N ha^{-1} + Fe @ 10 kg ha^{-1}) produced significantly higher yield (17.72 q ha^{-1}) as compared to other treatments.

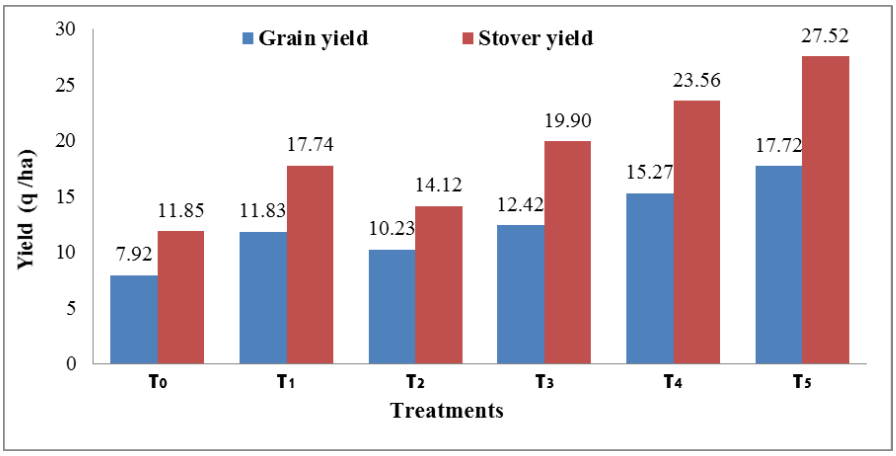

Fig 1: Influence of nitrogen levels and micronutrients treatments on pod number and yield

All the treatments were able to significantly increase the stover yield as compared to control. Stover yield varied from 11.85 to 27.52 q ha^{-1}. Maximum and minimum yield were respectively recorded with T_5 and T_0. Treatment T_5 was found to be significantly superior over other treatments.

Influence of nitrogen levels and micronutrients on quality of gram

Nitrogen content in grain

Nitrogen content (Table 3) all the treatments were able to significantly increased the nitrogen content in grain as compared to control. Nitrogen content varied from 2.98 to 3.92%. Treatments $T_{0,}$ $T_{1,}$ T_2 and T_3 significantly differ from each other. Maximum and minimum nitrogen contents were respectively recorded with T_5 and T_0.

Protein content in grain

Protein content in (Table 3) all the treatments were able to significantly increase the content in grain as compared to control. Protein content in grain varied from 18.63 to 24.50%. Maximum and minimum per cent of protein content were respectively recorded with T_5 and T_0. Treatment T_5 was found to be significantly superior over other treatments.

It is evident from the results of the present study that gram responded significantly due to application of nitrogen and micronutrients (B, Mo and Fe). It was found that growth and yield components like plant height, branching, number of pods plant^{-1} were significantly influenced due to nitrogen, alone and in combination with boron, molybdenum and iron fertilization. Findings revealed that being a leguminous crop chickpea significantly responded to nitrogen at 20 kg N ha^{-1} level and at par with the higher level (40 kg N ha^{-1}). Significant positive response to N addition in soil to bengal gram was reported by Gupta and Singh (1983) [4]. That the effect of applied N upto 30 kg ha^{-1} increased grain yield of cowpea Chaudhary *et al*. (1996) [2].

Application of boron, molybdenum or iron in combination of N at 20 kg ha^{-1} level further increased the growth and yield as compared to nitrogen alone. This might be due to fact that micronutrients play an important role in increasing yield of pulses through their effects on the plant itself and on the nitrogen fixing symbiotic process. Molybdenum is required for the formation of nitrate reductase enzyme and in the legume it plays an additional role in symbiotic nitrogen fixation. Nitrogenase enzyme is composed of molybdenum and iron and without adequate quantities of these elements nitrogen fixation cannot occur. Boron is very important in cell division and in pod and seed formation. Probably all these factors were responsible for the significant response to micronutrient fertilization. That effect of significant improvement in yield of soybean by the application of Mo + B in their study by Shelge *et al.* (2001) [13]. The improve significant increase in yield of mung bean and cowpea respectively due to application of iron upto 6 kg ha^{-1} level. In the present study highest growth and yield were recorded with iron application Yadav *et al.* (2002) [17] and Sharma *et al.* (2002) [11]. This may be due to utilization of iron by crop more easily than the other micronutrients. Furthermore, iron being a constituent of chlorophyll plays more vital role in increasing the growth and yield attributes.

Table 3: Influence of nitrogen levels and micronutrients treatments on nitrogen and protein content in grain of gram

Treatments	Nitrogen content %	Protein content %
T_0	2.98	18.63
T_1	3.34	20.88
T_2	3.57	22.31
T_3	3.79	23.69
T_4	3.85	24.06
T_5	3.92	24.50
SEm$^+$	0.08	0.10
CD (P = 0.05)	0.19	0.23

Initial soil characteristics of the experimental field

The initial soil characteristics (Table 4) in the experimental field of soil reaction (soil pH) were noticed neutral (pH 7.34). The organic matter content, plant available

Table 4: Initial soil characteristics of the experimental field

S. N	Soil properties	Values
1	Bulk density (Mg m^{-3})	1.42
2	Particle density (Mg m^{-3})	2.67
3	Porosity (%)	46.81
4	Water holding capacity (%)	42.98
5	pH	7.34
6	E.C. (dS m^{-1})	0.62
7	Available nitrogen (kg ha^{-1})	196
8	Available potassium (kg ha^{-1})	123
9	Available phosphorus (kg ha^{-1})	19
10	Organic carbon (%)	0.52

nitrogen and potassium were found low range of rating chart for soil test values; whereas plant available phosphorus was in medium range. The water holding capacity porosity in the soil was observed good for gram cultivation. The physical and chemical conditions were conducive gram cultivation under nitrogen Levels and Micronutrients condition of cultivation practice.

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