International Journal of Statistics and Applied Mathematics

ISSN: 2456-1452
Maths 2023; SP-8(7): 71-73

https://www.mathsjournal.com
Received: 02-08-2023
Accepted: 05-09-2023

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3rd National Conference on Livelihood and Food Security through Agriculture and Applied Sciences (LFSAAS-2023)

Effect of lime, sulphur and boron on the germination of chickpea (*Cicer arietinum* L.) in acidic soil of Jharkhand

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Abstract
This field investigation was carried out with the objective to study the "Effect of lime, boron and sulphur on germination of chickpea in acidic soils of Jharkhand". The experiment was carried out during Rabi season of 2022-23 in the experimental field of Department of Agriculture, Jharkhand Rai University, Ranchi. These were eight treatments with three replications consisting of three components *viz*. lime (@3q/ha), boron (@1kg/ha) and sulphur (@20kg/ha) in different combinations as basal along with the recommended dose of fertilizer (25:50:25 kg/ha). Observations were recorded on three parameters *viz*. germination percentage, vigour index and number of days taken in germination. RDF+Lime @3q/ha + Sulphur@20kg/ha+Boron@1kg/ha recorded higher germination percentage and germination index. Then was no effect of lime, sulphur or boron on days taken in germination. Though the number of days in germination reduced due to NPK application. The maximum number of days taken for germination was observed in control plot.

Keywords: Eight treatments, higher germination percentage, reduced, warm

Introduction
Pulses are a great natural gift that are crucial to the Indian economy and cuisine (Jat *et al*, 2012) [7]. As per Niti Ayog Working Group on Demand and Supply Projections Towards 2033, the demand for pulses is projected to increase from 26.72 million tonnes in 2021-22 to 32.64 million tonnes in 2029-30. The current production of pulses are 29.96 million tonnes. (PIB, Government of India). The most significant ancient pulse crop, chickpea (*Cicer arietinum* L.) traditionally grown in India during October month. It is primarily grown in semi-arid and warm temperate regions of the world where the temperature ranges from 20º to 30 ºC. It is one of the *Rabi* crops that is most widely grown in India. The chickpea holds a prominent position among the pulses in the nation and also important due to its high nutritional value, maximal acreage of cultivation, and high productivity rates.
Because in acidic soils, micronutrients have a limited availability. Micronutrient availability is highest in the very slightly to medium acid range. Due to low availability of micronutrients, the germination, growth and development of chickpea crop affect. Advisely seed germination is a complex physiological process which is mainly depends on environmental signals such as moisture, temperature, humidity, light, nitrate etc. While, poor seed germination is the major limiting factor of some of the important pulse crops including chickpea. The seed germination percentage of many pulse crops is very poor as well as late germination occurs. Rapid germination, maximum germination percentage and healthy seedlings are very much essential to fulfil the growing demands for yield (Dongre, 2007) [5].

Liming of acid soil is a commonly used soil improvement technique for effective use of native soil nutrients and better recovery of applied fertilisers, leading to enhanced production. When several crops are grown in an acidic soil type, with legumes included in the mix, it is highly desirable. As a result, crops that are sensitive to soil acidity like chickpea can be cultivated in limed soil because it enhances base saturation capacity, raises soil pH to nearly neutrality, inactivates Al, Fe, and Mn, inhibits P fixation, lowers exchange acidity, and stimulates microbial activity which causes better germination.

The use of macro and micronutrients will be optimised which increase germination. After N, P, and K, sulphur is regarded as the fourth important nutrient. As a component of vitamins (thiamine and biotin) and other physiologically active compounds like lipoic acid, acetyl coenzyme-A, ferredoxin, and glutathione, it is essential for the synthesis of proteins, especially those containing S-containing amino acids like methionine, cystine, and cysteine (Kala *et al.,* 2017) [8]. Sulphur's advantageous effect as a result of better root development (Lange *et al.* 1994) [9].

In plants, boron (B) is essential for the synthesis of cell walls, the transport of sugar, cell division, differentiation, membrane function, root elongation, control of plant hormone levels, and generative growth which leads to better germination. The soil application of boron is important when the concentration of B in the soil is less than 0.3 mg/kg (Ahlawat *et al.* 2007) [1]. Boron deficiency can be caused by high pH is larger than 6.5-7.0 (Sims, 2000) [11], which occur in highly leached sandy soils or in low organic matter soils and causes harmful effect in germination.

In light of this, the current experiment was conducted to determine the proper dosages of lime, sulphur, boron to apply to chickpea in Chotanagpur Plateau (Jharkhand). Understanding the significance of the aforementioned information, the current study was conducted to assess the impact of boron, sulfur and lime on germination of chickpea.

Materials and Methods

The present investigation was carried out in the experimental field of Department of Agriculture, Jharkhand Rai University, Namkum Campus, Ranchi. The experiment was laid out in 3×2 m^2 plots in a randomized block design (RBD) with three replications and eight treatments including control *viz.,* T_1- Control (No nutrient); T_2- RDF (NPK-25:50:25 kg/ha); T_3- RDF + Lime @3q/ha; T_4- RDF + Boron @ 1kg/ha; T_5- RDF + Sulphur @ 20kg/ha; T_6- RDF + Lime @3q/ha + Boron @ 1kg/ha; T_7- RDF + Lime @3q/ha + Sulphur @ 20kg/ha; T_8- RDF + Lime @3q/ha + Boron @ 1kg/ha + Sulphur @ 20kg/ha. Seeds were treated by *Rhizobium* culture, @10 g/kg before sowing. The treated seeds were kept in shade approximately for 2 hours to get it dry and then sown in the plots as per treatment.

The observations on germination percentage, germination index and number of days taken in germination were recorded in this experiment.

Table 1: Initial physio-chemical properties of experimental soil (Before sowing)

SL. No.	Soil Properties	Values in 2022-23	Natural Value		
			Low	Medium	High
1.	Sand (%)	65.28	-	-	-
	Silt (%)	20.28	-	-	-
3.	Clay (%)	14.44	-	-	-
4.	Textural Class	Sandy loam	-	-	-
5.	Soil pH	5.42	< 6.0 (Acidic)	6.0-8.5 (Saline)	> 9.0 (Alkaline)
6.	Electrical Conductivity (dS/m)	0.05	-	-	-
7.	Organic Carbon (%)	0.16	< 0.5%	0.5-7.5%	> 0.75%
8.	Available N (kg/ha)	74	< 240kg/ha	240-480 kg/ha	> 480kg/ha
9.	Available P (kg/ha)	26.2	< 11.0kg/ha	11-22kg/ha	> 22 kg/ha
10.	Available K (kg/ha)	321.5	< 110kg/ha	110-280kg/ha	> 280kg/ha
11.	Available S (ppm)	10.56	< 10	10-15	>15
12.	Available B (ppm)	0.38	< 0.5	0.5-1.0	>1.0

Results and Discussion

Based on the findings, every trait under investigation was impacted by the treatments, and a significant difference was observed between the control and the plots treated with lime, sulfur, and boron (Tables - 2).

Germination percentage was influenced significantly with application of lime, sulphur and boron. The germination percentage performance ranged from 95 to 98.4, with a mean value of 96.3. The highest germination percentage (98.4%) was reported in the treatment T_8 (RDF + Lime @3q/ha + Boron @ 1kg/ha + Sulphur @ 20kg/ha) which was at par with the treatments T_6 and T_7. The treatment T_1 (Control) exhibited the lowest germination rate of 95%.

Germination index was also influenced significantly with application of lime, sulphur and boron. With an average value of 701.5, mean performance of the germination index varied from 626.3 to 767.2. The higher germination index was obtained by the T_8 **(**RDF + Lime @3q/ha + Boron @ 1kg/ha + Sulphur @ 20kg/ha) (767.2). The treatment T_1 (Control) had the lowest germination index (626.3). Mean performance of number of days taken in germination ranged from 11 to 13 days with the mean value-11.25 days. The latest germination (13 days) was recorded in the treatment T_1 (Control). The earliest germination (11 days) was recorded in rest of all the treatments with fertilizer (T_2 to T_8).

Table 2: Performance of germination attributes in chickpea cv. PUSA-372

Treatments	Germination Percentage (%)	Germination/ Vigour Index	No. of days taken in germination (Days)
T_1	95.0	626.3	13
T_2	95.1	663.3	11
T_3	95.3	694.3	11
T_4	95.2	691.6	11
T_5	95.5	713.3	11
T_6	98.1	731.6	11
T_7	98.1	724.5	11
T_8	98.4	767.2	11
S.Em+	1.01	5.59	-
CD at 5%	3.06	16.96	-

Follow-up investigations found acidic soil negatively impacted germination of pulse crops. In case of pulses, with and without lime application on acid soil showed that liming significantly influenced all the germination parameters.

The germination percentage and vigour index of the seeds under lime application through soil registered a significant increase of 2.4%. Magalhaes *et al.* (1994) [10] also reported increased germination of lime applied plots over lime not applied plots in sorghum.

Lime improves base saturation capacity of soil, increases the soil pH to near neutrality, inactivate Al, Fe and Mn, reduces P fixation, decreases exchange acidity, stimulates microbial activity as a result of which varieties of crops sensitive to soil acidity could be grown in a limed soil. The maximum crop growth rate might be due to the positive effect of lime in an acid soil which not only replaces hydrogen ions, raises soil pH and makes NPK in more available from but also thereby increasing germination percentage of legume crop. Zhao *et al.* (2007) [12] also reported the same trend of effect of lime in acid soil. Azimi *et al.* (2013) [4] reported that the speed of germination was reported to be maximum with the high levels of NPK. The increase in speed of germination with the application of nitrogen can be attributed to the fact the faster initiation of metabolic activities in the seed.

Conclusion

Based on present investigation, it can be concluded that the treatment T_8 (RDF + Lime @3q/ha + Boron @ 1kg/ha + Sulphur @ 20kg/ha) showed superior performance on germination percentage and germination index followed by T_6- RDF + Lime @3q/ha + Boron @ 1kg/ha and T_7- RDF + Lime @3q/ha + Sulphur @ 20kg/ha. When as NPK application was found effective in days taken in germination.

The study demonstrated that improving seed treatment is a straightforward, expensive, and easy way to boost germination performance, which improves agricultural productivity, particularly for farmers that have limited land resources. The demonstrates unequivocally that each micronutrient has a different method of action.

Acknowledgement

Authors are thankful to Dr. R.P Singh 'Ratan', Dean, Department of Agriculture, Jharkhand Rai University, Ranchi and Dr. Shashi Bhushan Kumar, Associate Professor, Department of Soil Science and Agricultural Chemistry, Faculty of Agriculture, Birsa Agricultural University, Ranchi for providing necessary facilities, encouragement and support.

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