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Superimposition of Sulphur and Boron on Production and Quality of Chickpea (*Cicer arietirum* L.)

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A B S T R A C T

The present study was conducted during the *Rabi* seasons of 2014-15 and 2015-16 at SIF Farm of Chandra Shekhar Azad University of Agriculture & Technology, Kanpur, Uttar Pradesh, India to find out suitable superimposed nutritional doses for increase in production, productivity and economics of chickpea in Central Plain Zone. The treatments consisted seven (7) superimposed doses of sulphur (25 kg ha^{-1}), Boron (1.0 kg ha^{-1}), FYM (5.0 t ha^{-1}) used a individually, Rhizobium culture + FYM, Sulphur+ Boron, Sulphur + Boron + FYM, Sulphur + Boron + FYM + Rhizobium in combination along with NPK (20:60:20 kg ha^{-1}) doses compared with only NPK (20:60:20 kg ha^{-1}) dose (control treatment). The experiments were laid out in Randomized Block Design, replicated three times. The response of above treatments is analyzed on growth parameters, yield attributes and yield as well as quality of chickpea, variety KWR-108. The superimposition effect of sulphur, Boron, FYM and Rhizobium species along with NPK doses in different treatment exhibited significant response is terms of increasing grain yield to the tune of 23 percent to 62 percent compared to control treatment. Among different treatments superimposed doses of NPK (20:60:20 kg ha^{-1}) + Sulphur (25 kg ha^{-1}) + Boron (1.0 kg ha^{-1}) + FYM (5.0 t ha^{-1}) + Rhizobium inoculation treatment recorded maximum grain yield (1348.14 kg ha^{-1} and 1873.21 kg ha^{-1}), Nitrogen content (3.34% and 3.37%), Phosphorus content (1.46% and 1.47%), Potash content (0.65% and 0.67%), Sulphur content (0.61% and 0.63%) and Boron content (57 ppm and 58 ppm) in grain during 2014-15 and 2015-16, respectively compared to NPK only (control) treatment, which recorded lowest grain yield (1000.73 kg ha^{-1}) and 1154.54 kg ha^{-1}), Nitrogen content (3.18% and 3.20%), Phosphorus content (1.23% and 1.25%), Potash content (0.47% and 0.49%), Sulphur content (0.43% and 0.45%) and Boron content (41 ppm and 42 ppm) in grain during 2014-15 and 2015-16, respectively.

Keywords

Boron, Chickpea, NPK doses, Superimposition effect, Sulphur

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Introduction

Pulses have been the main stay of the agriculture and nutrition of the people in the developing world especially for vegetarian. Among the pulses chickpea (*Cicer arietinum* L.) is the third most important crop after drybean (*Phasealus vulgaris* L.) and dry peas (*Pisum asativum* L.) chickpea is an important source of energy, protein and soluble and insoluble fibre. Mature chickpea grains contain 60-65% carbohydrate, 6% fat and between 12% to 31% protein higher than any other pulse crop.

India rank 1st in area (71%) and production (71.95%) in chickpea at global level followed by Pakistan, Iran and Australia but productivity is very low i.e. only 995 kg ha^{-1}. China rank 1st in terms of productivity of 3759 kg ha^{-1} followed by Israel, Republic of Moldova and Bosnia & Heizegovina (Anonymous, 2016-17).

The low productivity of chickpea is corelated with improper nutrition and moisture stress condition as well as heavy infestation of diseases and pest. Chickpea are usually grown under stored residual soil moisture with the moisture receding to deeper soil layers with the age of the plants experiencing terminal drought stress.

The intensity and timing of the stress, of course, can vary depending on rainfall, soil type, crop duration and crop growth. The deficiency major and micro nutrients have been very pronounced under multiple cropping system and hence their exogenous supplies an urgently required. Except that during one to two decades the practice of reducing inorganic fertilizer doses by 25 to 50% with complementary doses of organic manures did not achieved sustainability in crop production. The integration of super imposed quantity of micronutrients, organic manures, microbial supplements along with 100% dose of NPK catching attention of scientific communities, now days.

Thus keeping above facts in view the present investigation was formulated and conducted with the objective that assess impact of super imposed doses of nutrients on growth, yield and quality of chickpea in irrigated condition of Central Uttar Pradesh (India).

Materials and Methods

Field experiments were conducted during two consecutive rabi seasons of 2014-15 and 2015-16 at students' Instructional Farm of C.S. Azad University of Agriculture & Technology, Kanpur, Uttar Pradesh, India situated at 125.9 meter altitude, 26.4148 north latitude and 80.2321 East longitude. Treatments involved in the study viz. NPK (20:60:20 kg/ha) only (control), NPK + Sulphur (25 $kgha^{-1}$), NPK + Boron (1.0 kg ha^{-1}), NPK + Rhizobium (20.0 kg/ha seed), NPK + FYM and NPK + S + B+FYM + Rhizobium laid out in Randomized Block Design replicated three times. The variety KWR 108 (matures in 130-135 days) was used in study having ability to produce 18-20 q/ha yield. The soil of the experimental field was sandy loam with 54.30 per cent sand, 27.20% silt and 18.50% clay and pH of 7.92. It was moderately fertile being low in carbon (0.34%) available N (172 kg/ha), medium in available P_2O_5 (13.0 kg/ha) and available K_2O (151.0 kg/ha).

The meterological observations recorded during the two seasons of study revealed that the maximum temperature averaged of 33.8ºC and 15.65ºC minimum at 16.45ºC and 3.40ºC, relative humidity at 97% and 53.5% and cumulative rainfall at 212.0 mm and 49.3 mm, respectively during the year 2014-15 and 2015-16. A higher rain fall of 71.5 mm and 95 mm in the 9th SMW and 11th SMW (26 Feb to 4 March and 12-18 march) during 2014-15 at flowering and fruiting stage affected badly to crop condition. It reduces crop productivity in the same year. Crop responses to the treatments were measured in terms of predetermined quantitative indices. The year wise observation so recorded was subjected to statistical analysis. Valid comparisons between various treatments were drawn using the respective C.D. (critical difference) values.

Results and Discussion

Growth characteristics (Table 1)

Integration of major and micronutrients, organic manure and Rhizobium species depicted significant improvement in growth characters over individual application of major and micronutrients, FYM and Rhizobium inoculation. Combined application of NPK + sulphur + Boron + FYM + Rhizobium inoculation increased 15.91% plant height, 34.78% plant fresh weight, 15.19% plant dry weight, 55.13% nodules plant^{-1} and 28.13% branches plant^{-1} during both years compared to NPK only treatment (control). The improvement in growth may be due to sulphur application because sulphur induced the process of photo synthesis and production of protein. It also pomotes the nodulation process in legumes. Boron promotes cell multiplication specially growing tips, xylem and phloem and enhances uptake of other nutrients and nutrient use efficiency (Prasad *et al.,* 2014). Similar findings are reported by Dixit *et al.,* (2014) and Desh Mukh *et al.,* (2015).

Yield attributes and yield

The data representing yield attributes and yield are summarised in Table 2, exhibited that superimposition of sulphur, boron, FYM and Rhizobium culture significantly increase yield attributes and yield of chickpea. The increment in yield attributes recorded 17.32% pods plant^{-1}, 30% 28 seeds pod^{-1} and 21.79% 100 grain weight compared to NPK only treatment (control). The grain yield of Chickpea increased significantly to tune of 37.71% and 62.25% during 2014-15 and 2015-16, respectively compared to only NPK treatment (control). The enhancement in yield attributes and yield of chickpea may be due to application of sulphur and boron along with FYM and Rhizobium culture. Sulphur promotes formation of seed and their yield because it is the constituent of nitrogenase, an enzyme involved in biological nitrogen fixation and nitrate reductase which calalyzes the synthesis of plant proteins. Boron promotes flowering, development of pollen tubes and germination and growth of pollen grains. FYM is well known to enhance nutrient use efficiency which ultimately increase the development of yield attributes and yield of crops (Prasad *et al.,* 2015). The findings are coroborated with the findings of Islam *et al.,* (2011), Dixit *et al.,* (2014) and Shivram and Chandra (2012).

Quality of chickpea

The data regarding grain quality of chickpea are summarised in Table 3, exhibited significant response in increasing nitrogen, phosphorus, potash, sulphur and boron content in grain. Combined application of NPK + Sulphur+Boron+ FYM Rhizobium culture recorded significantly maximum improvement viz. 5.17% nitrogen, 18.14% phosphorus, 37.51% potash, 43.43% sulphur and 38.55% boron content in chickpea grain compared to NPK only (control) treatment.

The improvement in quality of grain is positively correlated with the application of sulphur and boron. Sulphur interacts positively with other nutrients (Boron and Nitrogen) and improves protein content in grain. Sulphur is the constituent of 3 inter-related sulphur bearing amino acids (cysteine, cystine and methionine) which helps in stabilizing protein structure.

Boron enhances flowering and fruiting of legumes crops. FYM is considered as resorvior of different nutrients which enrich grain quality of crops (Prasad *et al.,* 2014). Similar findings are reported by Katiyar *et al.,* (2015) and Das *et al.,* (2016).

Table.1 Growth characters of chickpea as influenced by major and minor nutrients, FYM and Rhizobium culture

Treatments	Plant height (cm)		Plant fresh wt.(g)		Plant dry wt. (g)		Nodules/Plant		Branches/Plant	
	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16
NPK (20:60:20)	41.60	43.45	25.07	31.25	21.05	29.65	22.33	21.00	24.16	27.62
NPK+Sulphur@25 kg ha^{-1}	44.20	46.26	26.03	37.50	22.12	31.05	26.33	23.08	25.33	31.10
NPK + Boron@1.0 kg ha^{-1}	44.70	46.71	27.74	33.66	23.68	27.97	26.33	24.75	25.75	32.16
NPK + Rhizbium + FYM @ 5 tha^{-1}	44.60	46.75	27.62	35.66	22.36	30.16	30.33	33.08	25.82	32.97
NPK + FYM @ 5 tha^{-1}	43.70	46.16	29.78	36.25	21.80	31.04	27.33	28.50	24.83	34.04
NPK + S + B	47.80	49.82	31.22	39.25	23.15	32.24	26.33	29.33	28.00	35.64
NPK + S+B+FYM	48.13	49.95	32.72	40.91	23.72	33.64	27.67	31.41	28.25	36.75
NPK + S + B+ FYM + Rhizobium	48.67	50.10	34.56	41.16	24.54	33.75	31.00	36.08	29.42	37.15
SE(d) ±	**1.172**	**1.217**	**2.347**	**3.153**	**0.937**	**1.328**	**1.859**	**2.317**	**0.605**	**1.212**
CD (5%)	**2.538**	**2.604**	**5.034**	**6.763**	**2.009**	**2.848**	**3.987**	**4.969**	**1.297**	**2.593**

Table.2 Yield attributes and yield of chickpea as influenced by major and minor nutrients, FYM and Rhizobium culture

Treatments	Pods/plants		Seeds/Pod		100 grain wt. (g)		Grain Yield (k ha-1)		Straw Yield (kg ha^{-1})	
	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16
NPK (20:60:20)	35.00	47.52	1.52	1.25	16.94	16.55	1000.73	1154.51	1057.67	1171.41
NPK+Sulphur@25 kg ha^{-1}	36.58	54.44	1.61	1.41	17.03	18.77	1125.92	1425.82	1348.15	1423.71
NPK + Boron@1.0 kg ha^{-1}	38.25	52.77	1.68	1.16	17.32	17.44	1146.65	1373.02	1230.04	1486.23
NPK + Rhizbium + FYM @ 5 tha^{-1}	36.92	52.64	1.64	1.17	17.25	17.22	1100.61	1390.61	1273.10	1490.86
NPK + FYM @ 5 tha^{-1}	35.08	57.83	1.72	1.42	17.33	17.33	1056.29	1307.42	1423.05	1448.13
NPK + S + B	38.33	55.08	1.77	1.25	17.54	19.22	1231.10	1621.21	1494.82	1556.24
NPK + S+B+FYM	40.00	57.58	1.89	1.42	19.22	20.35	1293.33	1701.51	1640.00	1728.15
NPK + S + B+ FYM + Rhizobium	41.25	55.50	1.93	1.67	19.39	21.37	1348.14	1873.21	1733.34	1780.45
SE(d) ±	**1.385**	**1.771**	**0.106**	**0.112**	**0.478**	**1.204**	**70.38**	**85.70**	**87.86**	**89.41**
CD (5%)	**2.970**	**3.798**	**0.229**	**0.224**	**1.035**	**2.607**	**150.96**	**183.82**	**188.45**	**191.76**

Table.3 Quality of chickpea influenced by major and minor nutrients, FYM and Rhizobium culture

Treatments	Nitrogen (%)		Phosphorous (%)		Potash (%)		Sulphur (%)		Boron (ppm)	
	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16
NPK (20:60:20)	3.18	3.20	1.23	1.25	0.47	0.49	0.43	0.45	41	42
NPK+Sulphur@25 kg ha^{-1}	3.28	3.31	1.35	1.37	0.49	0.58	0.54	0.57	45	47
NPK + Boron@1.0 kg ha^{-1}	3.22	3.25	1.26	1.29	0.50	0.51	0.46	0.48	51	53
NPK + Rhizbium + FYM @ 5 tha^{-1}	3.26	3.28	1.32	1.33	0.55	0.56	0.51	0.54	49	51
NPK + FYM @ 5 tha^{-1}	3.24	3.27	1.29	1.31	0.53	0.54	0.49	0.51	47	49
NPK + S + B	3.30	3.33	1.39	1.41	0.59	0.61	0.56	0.59	53	54
NPK + S+B+FYM	3.32	3.34	1.42	1.45	0.62	0.65	0.59	0.61	55	57
NPK + S + B+ FYM + Rhizobium	3.34	3.37	1.46	1.47	0.65	0.67	0.61	0.63	57	58
SE(d) ±	**0.02**	**0.01**	**0.009**	**0.009**	**0.004**	**0.005**	**0.003**	**0.004**	**0.75**	**0.78**
CD (5%)	**0.07**	**0.05**	**0.030**	**0.030**	**0.01**	**0.01**	**0.01**	**0.01**	**1.608**	**1.672**

Based on above findings of results it may be concluded that superimposition of Sulphur and Boron recorded improvement in growth characters, yield attributes, yield as well as quality of Chickpea in the present location.

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