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Superimposition effect of sulphur, boron, FYM and Rhizobium on productivity of chickpea (*Cicer arietirum* L.)

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Abstract
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 are analyzed on growth parameters, yield attributes and yield as well as economics 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}) gross income (Rs. 51373.00 and Rs. 70903), Net Income (Rs. 14667.00 and Rs. 32781.00) and B:C ratio (1:1.40 and 1:1.86) 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}), gross income (Rs. 37448 and Rs. 43922) net income (Rs. 6900 and 11600) and B:C ratio (1:1.23 and 1:1.36) during 2014-15 and 2015-16, respectively.

Keywords: Boron, chickpea, FYM, NPK doses, Rhizobium culture and Superimposition effect

Introduction
Together with food security, the concern for nutritional value of it, has attracted attention of the scientist in India and over the world because of a wide spread nutritional deficiency observed among the masses ranging from low to high depending on the territory involved. A greater impetus towards high yielding varieties of cereal crops could perhaps appreciably reduce their nutritive value. It is more so where the practice of regular green manuring and/or organic manure usage is in general disregarded and partly or fully replaced by only NPK fertilizers in persuit of higher yields. In such instances strategy of super imposition doses of micro nutrients, organic manures and microbial supplements appears to enrich grain quality of different crops. Chickpea is an important source of energy, protein, soluble and insoluble fiber. Mature chickpea grains contain 60-65% carbohydrates, 6% fat and 31% protein higher than any other pulse crop. The recommended dietary allowances (RDA) for adult male and female is 60g and 55g pulses per day, respectively. The percapita availability of pulses is 42g per day. The deficiency of protein in humen diet often leads to Protein-Energy Malnutrition (PEM) causing various forms of anemia. A shift in crop preferences by the farmers has been seen since the 1990s. Indo-Gangetic belt farmers who grew pulses erliar have increasingly taken to wheat production where yield range from 3000 to 4000 kg per hactare compared to only about 800 kg in case of pulses. India rank Ist in ana (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 $Kgha^{-1}$. China rank 1st in terms of productivity of 3759 kg ha^{-1} followed by Israel, Republic of Moldova and Bosnia & heizegovina (Anonymous, 2016-17) [1].
During last two decade the practice of reducing inorganic fertilizer doses by 25-50% with complimentary doses of organic manures did not achieve sustainability in yield of crops. The integration of super imposed quantity of micronutrients, organic manures, microbial supplements along with 100% doses of inorganic fertilizers (NPK) catching attention of scientific communities today.

Thus keeping all above facts present investigation was formulated with the objectives to imporve growth and yield potential of chickpea in current location.

Material 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^{-1}) only (control), NPK + Sulphur (25 $kgha^{-1}$), NPK + Boron (1.0 kg ha^{-1}), NPK + Rhizobium (20.0 g kg^{-1} 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^{-1} yield. The soil of the experimental field was sandy loam with 54.30% 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^{-1}), medium in available phosphorus (13.0 kg P_2O_5 ha^{-1}) and Potash (151.0 kg K_2O ha^{-1}).

The meterological observations recorded during the two seasons of study revealed that the maximum temperature averaged of 33.8°C and 15.65°C minimum at 16.45°C and 3.40°C, 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 reduce 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 were subjected to statistical analysis. Valid comparisons between various treatments were drawn using the respective C.D. (critical difference) values.

Results and Discussion

Growth characters

The effect of different treatments on growth characters shown significant impact (Table-1). Application of NPK + Sulphur + Boron + FYM + Rhizobium recorded maximum enhancement in root length (33.64%), fresh weight of root (44.86%), dry weight of root (9.86%) as well as shoot length (16.14%) fresh weight of shoot (34.78%) dry weight of shoot (15.19%) compared to only NPK treatment (control). These findings were supported with the findings of Dixit *et al*., (2014) [4] and Deshmukh *et al.*, (2005) [3].

Table 1: Effect of treatments on growth characters of Chick Pea.

Treatments	Root length (cm)		Root fresh wt.(g)		Root dry wt. (g)		Shoot length (cm.)		Shoot fresh wt. (g)		Shoot dry wt. (g)	
	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16
NPK (20:60:20)	18.52	18.92	2.10	2.27	0.95	0.62	41.60	43.45	25.07	31.25	21.05	29.65
NPK+Sulphur@25 kg ha^{-1}	20.43	22.00	2.26	2.88	1.01	0.83	44.20	46.26	26.03	37.50	22.12	31.05
NPK + Boron@1.0 kg ha^{-1}	20.42	21.83	2.30	2.21	1.10	0.74	44.70	46.71	27.74	33.66	23.68	27.97
NPK + Rhizbium + FYM @ 5 tha^{-1}	20.82	20.08	2.25	2.65	1.05	0.81	44.60	46.75	27.62	35.66	22.36	30.16
NPK + FYM @ 5 tha^{-1}	20.87	21.67	2.15	2.81	0.96	0.80	43.70	46.16	29.78	36.25	21.80	31.04
NPK + S + B	21.60	23.83	2.30	3.05	1.11	0.85	47.80	49.82	31.22	39.25	23015	32.24
NPK + S+B+FYM	22.83	25.00	2.41	3.14	1.17	0.92	48.13	49.95	32.72	40.91	23.72	33.64
NPK + S + B+ FYM + Rhizobium	24.30	25.75	2.45	3.93	1.26	1.16	48.67	50.10	34.56	41.16	24.54	33.75
SE(d) ±	0.924	1.106	0.097	0.246	0.083	0.129	1.172	1.217	2.347	3.153	0.937	1.328
CD (5%)	1.995	2.395	0.209	0.534	1.179	0.279	2.538	2.604	5.034	6.763	2.009	2.848

Yield attributes

The result summarized in Table-2 depicted significant improvement in yield attributes with different treatments. The treatment NPK + S + B+ FYM + Rhizobium recorded significantly maximum improvement in nodules $plant^{-1}$ (31.00 & 36.08) tertiary branches $plant^{-1}$ (26.42 and 37.15), pods $plant^{-1}$ (41.25 and 55.50), seed pod^{-1} (1.93 and 1.67) and 100 grain weight (19.39 and 21.37 g) during 2014-15 and 2015-16, respectively, while only NPK treatment (control) recorded minimum value of yield attributes during both year. The improvement in yield attributes is the resultant of better growth which may only be possible through better nutrition provided to crop plants. The above findings are closely related to the findings of Islam *et al*., (2011) [6] and Dixit *et al.*, (2014) [4].

Table 2: Effect of treatments on yield attributes of Chickpea

Treatments	Nodules $plant^{-1}$		Branches $plant^{-1}$		Pods $plants^{-1}$		Seeds pod^{-1}		100 grain wt (g)	
	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16
NPK (20:60:20)	22.33	21.00	24.16	27.62	35.00	47.52	1.52	1.25	16.94	16.55
NPK+Sulphur@25 kg ha^{-1}	26.33	23.08	25.33	31.10	36.58	54.44	1.61	1.41	17.03	18.77
NPK + Boron@1.0 kg ha^{-1}	26.33	24.75	25.75	32.16	38.25	52.77	1.68	1.16	17.33	17.44
NPK + Rhizbium + FYM @ 5 tha^{-1}	30.33	33.08	25.82	32.97	36.92	52.64	1.64	1.17	17.25	17.22
NPK + FYM @ 5 tha^{-1}	27.33	28.50	24.83	34.04	35.08	57.83	1.72	1.425	17.33	17.33
NPK + S + B	26.33	29.33	28.00	35.64	38.33	55.08	1.77	1.25	17.54	19.22
NPK + S+B+FYM	27.67	31.41	28.25	36.75	40.00	57.58	1.89	1.42	19.22	20.35
NPK + S + B+ FYM + Rhizobium	31.00	36.08	29.42	37.15	41.25	55.50	1.93	1.67	19.39	21.37
SE(d) ±	1.859	2.317	0.605	1.212	1.385	1.771	0.106	0.112	0.478	1.204
CD (5%)	3.987	4.969	1.310	2.593	2.970	3.798	0.229	0.224	1.035	2.607

Yield

Significant improvement was noticed in grain yield and straw yield of chick pea with different treatments (Table -3). Superimposed nutrition provided under treatment NPK + Sulphur + Boron + FYM + Rhizobium recorded significantly maximum improvement in grain yield (34.72% and 62.25%)

and straw yield (63.88% and 51.99%) during 2014-15 and 2015-16, respectively while only NPK treatment (control) recorded minimum grain and straw yield of chickpea. The improvement in yield is the resultant of better growth and yield attributing characters which produces more food material and transportation of food stuff from source to sink. Combined application of sulphur, Boron and Rhizobium showed positive effect on nodulation and yield of chickpea (Das *et al.*, 2016) [2] (Guhey *et al.*, 2008) [5]. The application of FYM @ 5t ha^{-1} with inorganic P_2O_5 @ 40 $kgha^{-1}$ and sulphur @ 20 $kgha^{-1}$ resulted significantly better growth, yield and protein content of chickpea (Shivram and Chandra, 2012) [8].

Economics

Combined application of inorganic fertilizer, micronutrient and microorganism with organic manures showed better response in terms of maximising gross income, net income and B:C ratio (Table-3). Application of NPK+S+B+FYM+Rhizobium recorded improvement in gross income (37.18% and 61.42%), Net income (112.56% and 182.59%) and B:C ratio (13.82% and 36.76%) during 2014-15 and 2015-16, respectively compared to control treatment (NPK only). The findings are in similar order with the findings of Kumar *et al.*, (2006) [7].

Based on the summary of results it may be concluded that super imposition of sulphur, Boron, Rhizobium and FYM over NPK doses recorded better growth, yield attributes yield and economics of chickpea compared to application of only NPK doses.

Table 3: Effect of treatments on yield and economics of Chickpea

Treatments	Grain Yield (kg ha^{-1})		Straw Yield ($kgha^{-1}$)		Gross Income (Rs. ha^{-1})		Net Income (Rs. ha^{-1})		B.C. Ratio (%)	
	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16
NPK (20:60:20)	1000.73	1154.51	1057.67	1171.41	37448	43922	6900	11600	1.23	1.36
NPK+Sulphur@25 kg ha^{-1}	1125.92	1425.82	1348.15	1423.71	42007	54174	8479	18852	1.25	1.53
NPK + Boron@1.0 kg ha^{-1}	1146.65	1373.02	1230.04	1486.23	42962	52514	8594	18032	1.25	1.52
NPK + Rhizbium + FYM @ 5 tha^{-1}	1100.61	1190.61	1073.10	1490.86	40915	46143	10208	13671	1.33	1.42
NPK + FYM @ 5 tha^{-1}	1056.29	1307.42	1423.05	1448.13	40447	50104	7249	14222	1.22	1.40
NPK + S + B	1231.10	1621.21	1494.82	1556.24	46649	61411	12762	25939	1.38	1.73
NPK + S+B+FYM	1293.33	1701.51	1640.00	1728.15	49216	64737	12679	26765	1.35	1.70
NPK + S + B+ FYM + Rhizobium	1348.14	1873.21	1733.34	1780.45	51373	70903	14667	32781	1.40	1.86
SE(d) ±	70.38	85.70	87.86	89.41						
CD (5%)	150.96	183.82	188.45	191.76						

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