Original Research Article, Review Article or Short Communication

Influence of zypmite on productivity and nutrient uptake of chickpea (*Cicer arietinum* l.) Crop under rainfed condition Chhattisgarh plain region

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ABSTRACT

A field experiment was conducted to evaluate the effect of Zypmite fertilizer along with di-ammonium phosphate (DAP) in study. The application of Zypmite exhibited in growth, yield, nutrients uptake and availability of nutrient in soil. Zypmite response, the maximum number of branches (25.8 p^{-1}), test weight (18.5 gm) and grain yield (17.10 q ha^{-1}) was observed with 50 kg P_2O_5 through DAP + 40 kg S through Zypmite (T_6). The nitrogen (69.52 kg ha^{-1}) and phosphorous (7.89 kg ha^{-1}) uptake was also found maximum under T_6 and minimum in control (T_1). The potassium (39.27 kg ha^{-1}) and sulphur (7.85 kg ha^{-1}) uptake was observed maximum under 50 kg P_2O_5 through DAP + 20 kg S through Zypmite (T_5). After harvesting of crop, available nutrient status was observed higher available nitrogen (243.0 kg ha^{-1}) under T_6 and available phosphorous was significantly higher in T_2 and T_9 (18.0 kg ha^{-1}) as compared to control. Availability of potassium in all treatments was significantly not influenced during both years. The sulphur availability in soil was significantly influenced among treatment and found maximum (23.0 kg ha^{-1}) under 40 kg sulphur through Zypmite (T_7). It was observed that Zypmite and chemical fertilizers, enhanced yield and higher uptake of nutrient as well as improved soil fertility.

Key Words- Zypmite, Sulpher, Productivity, Chickpea, Yield

INTRODUCTION

Chickpea (*Cicer arietinum* L.) is a most important pulse crop grown in India. Pulses can be grown on a varied soil series and climatic environments, and play important role in crop rotation, mixed and inter-cropping and maintain soil fertility through nitrogen (N) fixation in soil. Pulse crops are major source of protein among the all vegetarian in India, and having essential amino acids, vitamins and minerals Pingoliya *et al*. (2013). They contain 22 to 24 percent protein, which is just about double in wheat and thrice in rice Shukla *et al*. (2013). It is an integral part of the cropping system of the farmers all over the country, because this crop fits well in the crop rotation

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and mixed cropping. It has multipurpose use and ability to grow under the condition of low fertility and varying conditions of soil and climate. Kumbhare *et al.* (2014) concluded that good agronomic management practices, awareness campaign of integrated pest management (IPM) and use of high yielding verities (HYV), pulses are more economic as compared to cereals. Dry land areas comprise virtually 64% of the total cultivated area and recorded 42% of total food grain production in the Indian agriculture (Anonymous, 2011). In Chhattisgarh state about 803.03 ha area under chickpea cultivation (ICRISAT- Annual progress report 2011-12).

Sulphur is now recognized as major plant nutrient, along with nitrogen (N), phosphorus (P), and potassium (K). Poor nutrient management is vital rationale of low productivity of chickpea. Phosphorus is an important fertilizer in chickpea production (Dotaniya *et al.,* 2014; Dotaniya *et al*., 2013; Dutaniya and Datta, 2013). Phosphorus has a positive effect on nodule formation and nitrogen fixation in legume crops (Deo and Khaldelwal, 2009). Sulphur constitutes the main element of amino acids such as cysteine and methionine, which are of essential nutrient value. In addition to these functions, ferro-sulphur proteins play an important role in nitrogen fixation. This element positively affects nodulation in legume crops in particular. It is essential for the growth and development of all crops, without exception. Most of the plants requirement of Sulphur is absorbed through the roots in the form of sulphate (SO_4^{-2}). Sulphur deficiency is becoming more critical with each passing year which is severely restricting crop yield, produce quality, nutrient use efficiency and economic returns on millions of farms. Like any essential nutrient, sulphur also has certain specific functions to perform in the plant. Thus, sulphur deficiencies can only be corrected by the application of sulphur fertilizer (Tandon and Messick, 2007).

Due to continuous cropping and imbalanced use of fertilizers, the deficiencies of secondary nutrients are also coming up. The continuous use of S- free fertilizers has also created the problem of S deficiency. Zypmite is a new source of S which contains 15% S and can be a beneficial to different crops. In present study, Zypmite product was tested with combinations of different fertilizer sources in different quantities to study the effect of Zypmite on chickpea crop. The experiment was under taken during Rabi season 2010-11 and 2011-12 with chickpea as a test crop in *Vertisols* of the instructional cum research farm of IGKV Raipur, with the objectives to study the effect of Zypmite on the productivity of chickpea crop and nutrient uptake.

MATERIALS AND METHODS

The experiment was conducted rabi session of 2010-11 and 2011-12 at the research cum instructional farm of Indira Gandhi Krishi Vishwavidyalaya, Raipur Chhattisgarh. The soil of the experimental field comes under the soil order of *Vertisols*. This soil is locally known as *Kanhar* and identified as Arang II series. It is clayey in texture, dark brown to black in color, neutral to alkaline in soil reaction (pH 7.6) due to presence of lime concretion in lower horizon. The soil is 1-1.5 meter deep. Soil is represented as typical fine *montmorillonitic, hyperthermic, udic chromustert.* The ten treatments were selected with three replicates and each consisted of a Control (T_1), 50 kg P_2O_5 through DAP (T_2), 50 kg P_2O_5 through DAP+ Ca through $CaCO_3$+ Zn (5 kg) through EDTA (T_3) , 50 kg P_2O_5 through DAP+ Ca through $CaCO_3$ (T_4), 50 kg P_2O_5 through DAP+ 20 kg S through Zypmite (T_5) 50 kg P_2O_5 through DAP+ 40 kg S through Zypmite (T_6), 40 kg S through Zypmite (T_7), 50 Kg P_2O_5 through DAP+ 0.5 % S spray through Zypmite (T_8), 50 kg P_2O_5 through DAP+ 1 % S spray through Zypmite (T_9) and Soil test based fertilizer recommendation (T_{10}) with chickpea (JG -226) crop having a plot size 5x5 m. The treatments were replicated thrice and laid out under randomized block design (RBD). After thorough field preparation initial soil samples were taken to analyze the initial soil properties. The initial soil sample was analyzed for available major nutrients; nitrogen (N), phosphorous (P), potassium (K) and sulphur (S), organic carbon (OC), pH and soluble salts. The pH of the experimental field was 7.6, EC 0.42 dSm^{-1}, CEC (c mol (p^+) kg^{-1}) 39.38 and organic carbon was 0.56%. The N status of the experimental field was low (218 kg ha^{-1}), medium in available P (16.40 kg ha^{-1}) and S (18.20 kg ha^{-1}) while available K status was in higher range (432.0 kg ha^{-1}). Phosphorus and sulphur were applied through DAP and Zypmite, respectively. At harvest, seed and straw yields were recorded. Plant samples were collected for chemical analysis of phosphorus, sulphur and nitrogen in seed and straw samples. In ground seed and straw samples, N was estimated by micro Kjeldahal method (Piper 1966). For P and S, plant samples were digested (ratio 9:3) in a diacid (HNO_3:$HClO_4$) mixture and P in the extract was determined by vanadomolybdate yellow colour method (Jackson 1973). Sulphur content in the same extract was determined according to method outlined by Tabatabai and Bremner (1970). Surface soil samples (0-15 cm depth) were collected for chemical analysis after harvesting the crop each year from all plots. For available P, soil samples were extracted with 0.5 *M* $NaHCO_3$ (pH = 8.5) (Olsen *et al.* 1954) and P content in the extracts was determined as described by Jackson (1973). Available S was determined by extracting soil samples with 0.15% $CaCl_2$ (Williams and Steinbergs 1959), and S in the extract was estimated by turbidimetric method (Chesnin and Yien 1951).

The observations on plant height, No. of branches $plant^{-1}$ were recorded manually on five randomly selected representative plants from each plot of each replication separately as well as yield and yield attributing character were recorded as per the standard method. Yield attributes were also recorded at physiological maturity stage. The seed and straw yield was recorded from net plot area of each treatment. The data obtained from various characters under study were analyzed by the method of analysis of variance as described by (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Yield and Yield Attributes: The data can be recorded and analyzed for yield attributing characters of chickpea (Table 1). Among the different treatment maximum number of branches (25.80 per plant) was observed under treatment T_6, and which was found to be at par with T_2, T_3, T_4, T_5, T_8, T_9 th and T_{10}. The maximum test weight (18.50 gm) was also observed under T_6. The grain and stover yield data was significantly influenced by different nutrient treatment. The maximum grain yield 17.10 (q ha^{-1}) was observed under T_6 and stover yield (15.89 q ha^{-1}) in T_5. Similar finding was reported Lal *et al*. (2014) and Lakpale *et al.* (2003).

Data in Table 1 show that treatments had significant effect on grain and straw yields of chickpea. Srividya *et al.* (2009) reported that the P at 50 kg P_2O_5 ha^{-1} was supplied through SSP, rock phosphate (20% wt/wt) and DAP produced maximum yield of chickpea over control. Although the significant differences were not observed between control and application of P through DAP. It indicates that P response to the test crop did not have a remarkable effect. Similar results were finding by Singh and Rana (2006). Verma and Singh (2008) reported that seed and straw yield of moong bean significantly increased with the application of 75 kg P_2O_5 ha^{-1} with Rhizobium treated. Similar result was reported by Pingoliya *et al.* (2014). Other treatments were also not statistically significant, however; Zypmite application and soil test based fertilizer application had significant effect over control treatment. Nawange *et. al*. (2011) also reported that application 40 kg S increase the seed yield of chickpea. The straw yield also showed identical results to that of yields. The data on phenology like number of branches, plant heights and test weight showed supporting results of grain and straw yield.

Nutrient Uptake: The data analyzed on two year mean basis data of Nutrient uptake was tabulated in (Table 2). The N uptake was found maximum (69.52 kg ha^{-1}) under T_6, and which was significantly higher over all other treatment. In contrast to the application of 20 kg ha^{-1} N and 25 kg P_2O_5 ha^{-1} significantly increased number of branches and nutrients over the control. The P uptake is important in pulses for maximum production, the uptake of P was found maximum (7.87 kg ha^{-1}) under T_6, while treatment T_2, T_3, T_4, T_5, T_8, T_9 and T_{10} found to be at par. Krishna and Yadav (1997) conducted a field experiment with different levels of P and S and micronutrients concentration on chickpea and we concluded that significantly higher yield with cupper content decreased with increasing dose of P and minimum cupper content was found in grain and straw and higher uptake of P and S. Similar results were reported by Singh and Singh (2004) in black gram; Deo and Khaldelwal, (2009) and Ammal *et al*. (2001) in chickpea. The formation of acids by soil microorganism and root exudates enhanced nutrients mobilization in soil Ammal *et al.* (2001). The uptake of potassium and sulphur in chickpea crop was observed higher (39.27 and 7.85 kg ha^{-1}) under T_5. The S uptake of treatment T_2, T_3, T_6, T_9 and T_{10} found at par with it. Chaudhary and Goswami (2005) reported that P and S application in chickpea significantly increased the yield and yield attributes over the control. Similar results were found Sharma and Jat (2003).

Available Soil Nutrients: After harvesting of crop, soil was analyzed for available soil nutrient and data was analyzed and tabulated in (Table 3). The available soil N was found maximum (243.0 kg ha^{-1}) under T_6. Khoja *et al.* (2002) reported that application of nitrogen with phosphatic fertilizers improve soil fertility levels in chickpea over the control. The available P in soil was maximum (18.0 kg ha^{-1}) under treatment T_2 and T_9. There was no significant change in available K in soil in due to treatments. The S availability in soil was significantly influenced among treatment and was found maximum (23.0 kg ha^{-1}) under treatment T_7. Kothari and Jethra (2002); Chandra Dev and Khaldelwal, (2009) also reported that the available sulphur increased with increasing levels of sulphur application. Phosphorus application had no effect on the sulphur content of soil.

The data showed that post-harvest soil test status in relation to different treatments application. The results show that the changes in soil test values with respect to available N did not have remarkable effect in relation to the different treatments application. Since the test crop is a leguminous crop and initial starter dose of fertilizer N was given, hence control and Zypmite application resulted low available N level after the crop harvest. Available P and S level slightly increased in comparison to other treatments application. The levels of these nutrients were low in control treatment which was expected due to uptake of nutrient from the soil source only. The level of available K did not show any significant variation due to the application of deferent treatments.

CONCLUSION

The explosions of Indian population enhance the demand of pulses. The high human population needs higher pulse production for satisfying the nutritive protein requirements. We are celebrating international pulse years 2016 and we will produce more amounts of pulses in upcoming centuries. Experiment results revealed that chickpea responds to P and S fertilization and improves the productivity of the seeds. Therefore, 50 kg P_2O_5 ha^{-1} along with 40 kg S ha^{-1} through Zypmite should be applied in heavy textured soils for chickpea production. Application of Zypmite along with phosphatic fertilizers in chickpea production, improved soil fertility in long run. The continuous use of suphur containing fertilizer has also reduced the problem of S deficiency in Indian soils and protect to plant by fungal infestation. Sulfur had better for included in nutrient management to get maximum yield of chickpea.We have a duty to develop new HYV with resistance to insect-pest and disease and making a new combination of fertilizer to enhanced higher use efficiency.

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TABLE 1: Yield and yield attributing parameters for chickpea crop in relation to different treatments application

Treatment	No. of branches plant $^{-1}$			Test wt. (gm^{-1}100 seed)			Grain Yield (q ha^{-1})			Straw Yield (q ha^{-1})		
	2011	2012	Mean	2011	2012	Mean	2011	2012	Mean	2011	2012	Mean
T_1:Control	21.40	20.40	20.90	17.90	17.60	17.75	14.37	12.35	13.36	13.37	11.57	12.47
T_2:50 kg P_2O_5 through DAP	24.60	24.80	24.70	18.20	18.40	18.30	16.31	16.42	16.36	15.21	15.75	15.48
T_3: 50 kg P_2O_5 through DAP+ Ca through $CaCO_3$+ Zn (5 kg) through EDTA	25.10	25.00	25.05	18.30	18.50	18.40	16.92	15.97	16.45	15.93	15.30	15.61
T_4: 50 kg P_2O_5 through DAP+ Ca through $CaCO_3$	24.60	24.50	24.55	18.20	18.10	18.15	16.41	16.30	16.35	15.06	15.32	15.19
T_5: 50 kg P_2O_5 through DAP+ 20 kg S through Zypmite	25.20	24.60	24.90	18.30	18.40	18.35	17.13	16.98	17.06	15.83	15.95	15.89
T_6: 50 kg P_2O_5 through DAP+ 40 kg S through Zypmite	26.00	25.60	25.80	18.30	18.10	18.50	17.43	16.78	17.10	16.08	15.30	15.69
T_7: 40 kg S through Zypmite	23.60	24.10	23.85	18.10	18.20	18.15	15.18	15.18	15.18	14.27	14.53	14.40
T_8: 50 kg P_2O_5 through DAP+ 0.5 % S spray through Zypmite	24.90	24.80	24.85	18.20	18.10	18.15	16.68	16.22	16.45	15.56	15.42	15.49
T_9: 50 kg P_2O_5 through DAP+ 1 % S spray through Zypmite	25.40	25.00	25.20	18.20	18.50	18.35	16.87	16.31	16.59	15.78	15.63	15.71
T_{10}: Soil test based fertilizer recommendation	25.20	24.6	24.90	18.00	17.80	17.90	16.76	16.58	16.67	15.77	14.50	15.13
SEm±	0.69	0.53	0.48	0.65	0.75	0.45	0.57	0.28	0.32	0.53	0.67	0.44
CD ($P \leq 0.05$)	2.07	1.59	1.44*	NS	NS	NS	1.70	0.84	0.97*	1.59	1.99	1.32*

DAP- Di-ammonium phosphate; Ca- Calcium; EDTA- Ethylene diamine tetraacitic acid; Zypmite- As a source of sulphur fertilizer; *Significant at $P \leq 0.05$; NS- Non Significant at $P > 0.05$

TABLE 2: Nutrient uptake by chickpea crop in relation to different treatment application

Treatment	Total nutrient uptake by gram crop (kg ha^{-1})											
	Nitrogen			Phosphorous			Potassium			Sulphur		
	2011	2012	Mean	2011	2012	Mean	2011	2012	Mean	2011	2012	Mean
T_1:Control	55.19	53.65	54.42	6.41	6.11	6.26	32.05	31.53	31.79	6.66	6.39	6.53
T_2:50 kg P_2O_5 through DAP	63.37	65.32	64.35	7.33	7.40	7.37	37.22	37.60	37.41	7.26	7.33	7.30
T_3: 50 kg P_2O_5 through DAP+ Ca through $CaCO_3$+ Zn (5 kg) through EDTA	67.27	64.36	65.82	7.59	7.26	7.43	39.35	38.64	39.00	7.83	7.49	7.66
T_4: 50 kg P_2O_5 through DAP+ Ca through $CaCO_3$	63.36	63.14	63.25	7.22	7.19	7.21	37.20	37.07	37.14	7.37	7.29	7.33
T_5: 50 kg P_2O_5 through DAP+ 20 kg S through Zypmite	68.01	66.48	67.25	7.65	7.48	7.57	39.71	38.82	39.27	7.94	7.76	7.85
T_6: 50 kg P_2O_5 through DAP+ 40 kg S through Zypmite	70.09	68.95	69.52	7.93	7.80	7.87	38.33	37.70	38.02	7.79	7.66	7.73
T_7: 40 kg S through Zypmite	60.97	62.3	61.64	6.80	6.95	6.88	35.15	35.92	35.54	6.77	6.92	6.85
T_8: 50 kg P_2O_5 through DAP+ 0.5 % S spray through Zypmite	65.76	65.51	65.64	7.50	7.47	7.49	38.46	38.32	38.39	7.26	7.18	7.22
T_9: 50 kg P_2O_5 through DAP+ 1 % S spray through Zypmite	67.83	66.37	67.10	7.53	7.26	7.40	39.33	37.91	38.62	7.96	7.67	7.82
T_{10}: Soil test based fertilizer recommendation	66.8	65.68	66.24	7.55	7.31	7.43	39.23	37.98	38.61	7.57	7.38	7.48
SEm±	0.79	0.76	0.48	0.27	0.44	0.25	0.99	1.10	0.73	0.27	0.23	0.16
CD ($P \leq 0.05$)	2.37	2.26	1.44*	0.82	NS	0.75*	2.94	3.28	2.18*	0.81	0.69	0.50*

DAP- Di-ammonium phosphate; Ca- Calcium; EDTA- Ethylene diamine tetraacitic acid; Zypmite- As a source of sulphur fertilizer; *Significant at $P \leq 0.05$; NS- Non Significant at $P > 0.05$

TABLE 3: Soil available nutrients status after harvesting of crop

Treatment	Available nutrients (kg ha^{-1})											
	N			P			K			S		
	2011	2012	Mean	2011	2012	Mean	2011	2012	Mean	2011	2012	Mean
T_1:Control	222.0	219.0	220.5	14.6	13.2	13.9	424.0	419.0	421.5	16.4	15.4	15.9
T_2:50 kg P_2O_5 through DAP	232.0	234.0	233.0	17.4	18.6	18.0	428.0	424.0	426.0	16.2	15.8	16.0
T_3: 50 kg P_2O_5 through DAP+ Ca through $CaCO_3$+ Zn (5 kg) through EDTA	238.0	237.0	237.5	15.8	17.2	16.5	432.0	427.0	429.5	19.6	18.8	19.2
T_4: 50 kg P_2O_5 through DAP+ Ca through $CaCO_3$	238.0	239.0	238.5	15.8	17.6	16.7	430.0	426.0	428.0	19.7	18.7	19.2
T_5: 50 kg P_2O_5 through DAP+ 20 kg S through Zypmite	244.0	241.0	242.5	16.3	17.6	17.0	428.0	433.0	431.0	19.6	20.8	20.2
T_6: 50 kg P_2O_5 through DAP+ 40 kg S through Zypmite	242.0	244.0	243.0	16.6	18.4	17.5	426.0	431.0	429.0	20.4	22.2	21.3
T_7: 40 kg S through Zypmite	228.0	230.0	229.0	17.6	15.6	16.6	432.0	428.0	430.0	22.2	23.8	23.0
T_8: 50 kg P_2O_5 through DAP+ 0.5 % S spray through Zypmite	238.0	236.0	237.0	16.8	18.2	17.5	430.0	431.0	431.0	19.4	18.6	19.0
T_9: 50 kg P_2O_5 through DAP+ 1 % S spray through Zypmite	234.0	236.0	235.0	17.2	18.8	18.0	434.0	429.0	432.0	19.6	19.0	19.3
T_{10}: Soil test based fertilizer recommendation	234.0	232.0	233.0	17.4	18.2	17.8	432.0	437.0	435.0	19.6	18.4	19.0
SEm±	1.12	1.34	0.72	0.42	0.28	0.28	6.89	5.66	5.95	0.57	0.35	0.27
CD ($P \leq 0.05$)	3.32	4.00	2.15*	1.26	0.84	0.84*	NS	NS	NS	1.53	1.06	0.81*

DAP- Di-ammonium phosphate; Ca- Calcium; EDTA- Ethylene diamine tetraacitic acid; Zypmite- As a source of sulphur fertilizer; *Significant at $P \leq 0.05$; NS- Non Significant at $P > 0.05$