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Effect of different complex fertilizers on growth, quality and yield of chickpea

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Abstract
Chickpea (*Cicer arietinum* L.) is widely cultivated in world in all tropic and semitropic regions of world. It is most important pulse crop in India. It is sown in *Rabi* season. Chickpea occupies an important position due to its nutritious value (17-23% protein) in large vegetarian population of the country. The present study was carried out to get information about the effect of different complex fertilizers on growth, quality and yield of chickpea. Chickpea BDNG-797 (Akash) was used as test crop. The research was carried out during *Rabi* 2020-21 with nine treatments and three replications in RBD experimental design. The results indicated that growth parameters like plant height, number of branches, number of pods, number of nodules, fresh and dry weight of nodules per plant showed significantly maximum with 25% more of treatment T_3 through complex fertilizer grade (11.30.14+Sec+ MN) + Urea (T_8) at respective growth stages The highest seed and straw yield were obtained with application of 25% more of treatment T_3 through complex fertilizer grade (11.30.14+Sec+ MN) + Urea (T_8). The lowest seed (1033.33 kg ha^{-1}) and straw yield (1976 kg ha^{-1}) was registered in farmer practice. The maximum test weight (24.06 g 100 $seed^{-1}$) and seed protein content (22.73%) was recorded with application of fertilizer 25% more than T_3 through complex grade (11:30:14+ Sec+MN) + Urea (T_8). It was concluded that application of 25% more of treatment T_3 through complex fertilizer grade (11.30.14+Sec+ MN) + Urea were more effective than rest of the treatments.

Keywords: complex fertilizers, chickpea, growth parameter, quality, yield

Introduction
Chickpea (*Cicer arietinum*) is widely cultivated in world in all tropic and semitropic regions of world. In India, chickpea is grown in about 106.00 lakh hectares with the production of 111.00 lakh ton at the ever-highest productivity level of 1056 kg ha^{-1}. The current per capita availability of pulses of 80 gm^{-1} $capita^{-1}$ day^{-1} as recommended by FAO is very low which could not meet per capita requirement; therefore, it is necessary that agricultural scientists should keep the strategy for increasing the production of pulses to meet the protein requirement of increasing population of the country (Subbulakshmi *et al.*, 2009) [22]. It is the most important leguminous crop of rainfed agriculture. Chickpea is multipurpose plant, grains are eaten as *dal*; green pods are used as vegetable; Plants need nutrients for their growth and development. Nitrogen plays an imperative role in synthesis of chlorophyll, amino acid and other organic compounds which add to the building units of proteins in the plant system. When protein-rich grains are harvested much of nitrogen is removed from soil hence crucial amount of nitrogen can remain in soil for future crops Kumar *et al.* (2014) [8]. Phosphorus has central role in energy transfer and protein metabolism and also associated with increased root growth and early maturity of crops (Siag, 1995) [17]. Potassium has been described as the "quality element" for crop production (Usherwood, 1985) [24]; (Pettigrew, 2000) [14]. Potassium increases the protein content of plants. As compared to primary macronutrient, secondary macronutrient [Calcium (Ca), Magnesium (Mg) and Sulphur (S)] are also utilized in large quantities but sufficiently supplied and are readily available. Sulphur fertilizer are known as enhance crop yield and uptake of macronutrient especially nitrogen (Das *et al.*, 2006) [5]. Sulphur has a great role in N- fixation by influencing active nodulation in legume. Low productivity of chickpea in India is mainly attributed to improper and inadequate nutritional supply to plant. Use of fertilizers in appropriate quantities and in balanced proportion is absolutely essential for good productivity of crop. Therefore there is needed to take much more attention to the fertilizer recombination practices for pulse crops and particular in chickpea. Primary and secondary nutrient along with micronutrient is essential for chickpea production beneficial to legume. It fixes nitrogen in rhizosphere, increases number of pods per plant and crop yield (Das *et al.*, 2006) [5].

Materials and Methods

Field experiment was conducted during *Rabi* seasons of 2020-21, at Research Farm of Department of Soil Science and Agricultural Chemistry, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani (M.S.). Research farm is located at 74^0 65' E longitude and 19^0 38' N latitude. Soils of Parbhani series belongs to *Typic Haplusterts*, on the basis of morphology, soil depth and texture (Malewar, 1976) [11]. Soil was having soil pH 7.73, available N (198 kg ha^{-1}), available P (14.61 kg ha^{-1}) and available K (629.60 kg ha^{-1}). This experiment was conducted in RBD design along with three replications and nine treatment combinations with RDF 25: 50: 25 kg ha^{-1} N, P_2O_5 and K_2O. The treatments comprised of T_1: Farmer practice (22:58:00 kg ha^{-1}), T_2: RDF (25:50:25 kg ha^{-1}), T_3: RDF +20 Kg S +5.25 kg Zn, T_4: RDF equivalent to T_2 through complex fertilizer grade (11.30.14+Sec+MN) + Urea, T_5: RDF equivalent to T_3 through complex fertilizer grade (11.30.14+Sec+MN) + Urea + Bensulf, T_6 :10% less of treatment T_3 through complex fertilizer grade (11.30.14+Sec +MN) + Urea, T_7: 10% more of treatment T_3 through complex fertilizer grade (11.30.14+Sec +MN) + Urea, T_8: 25% more of treatment T_3 through complex fertilizer grade (11.30.14+Sec+ MN) + Urea, T_9: 25% less of treatment T_3 through complex fertilizer grade **(**11.30.14+Sec +MN) + Urea. Seeds were dibbled @ 60 Kg ha^{-1} with 30 cm row spacing. Crop was not much affected by the incidence of pest and disease. The plant growth observations were recorded during plant growth period. The soil samples were collected before sowing and after harvest of chickpea. The soil samples were analyzed for macro and micro nutrients by using standard methods of analysis (Jackson, 1973; Walkley and Black, 1934; Subbiah and Asija, 1956; Olsen *et al.* 1954; Piper, 1966; Chopra and Kanwar, 1977; Lindsay and Norvell, 1977) [6, 27, 21, 12, 15, 4, 10]. The plant samples were collected at harvest of chickpea and processed as per standard protocol. The plant samples were analyzed by method suggested by Piper (1966) [15], A.O.A.C (1975) [1], Jackson (1973) [6], Tabatabai and Bremner, (1970) [23] and Lindsay and Norvell (1978) [10]. Statistical analysis was done by using method suggested by Panse and Sukhatme (1985) [13].

Results and Discussion

Plant height

Chickpea plants exhibited significant responses to different complex fertilizers in respect to growth, yield and yield attributes. The plant height at 30 DAS, 60 DAS and 80 DAS of chickpea was varied from 20.00 to 28.53 cm, 36.35 to 48.32 cm and 38.00 to 48.46 cm with an average value of 23.84, 42.79 and 43.92cm, respectively (Table 1). Significantly maximum height (48.46 cm) at harvest of chickpea was recorded in treatment with application of 25% more of treatment T_3 through complex fertilizer grade (11:30:14+Sec+ MN) + urea (T_8). Application of complex fertilizers were found significantly superior in improving the growth parameters like plant height, number of branches, fresh and dry weight of nodule. The significant increase in plant height due to combination of nutrients like N, P, K and micronutrient through complex fertilizer grade which helped in acceleration of various metabolic processes in plants resulting greater apical growth Verma *et al.* (2015) [26].

Number of branches

The results on mean number of branches per plant are presented in Table 2. The number of branches per plant was influenced by application of different complex fertilizer grade on chickpea. Number of branches per plant at flowering and pod development stage was varied from 5.60 to 7.25 and 5.93 to 8.01 with an average of 6.54 and 6.84, respectively. The increase in number of branches in complex fertilizer applied treatment with micronutrients could be due to cell and internodal elongation, increased plant metabolism, there by promoting vegetative growth which is positively correlated with to productivity of plant. The increase in number of branches due to combination of nutrients N, P, K and micronutrient through complex fertilizer grade observed in present investigation was in accordance with the findings reported by Buriro *et al.* (2015) [3] and Sohu *et al.* (2015) [20].

Nodule count

The number of root nodules per plant was significantly increased with increased levels of complex fertilizers application in conjunction with urea (Table 3). They provide the micronutrients along with all other essential elements which might have acted as co-enzyme for formation of root nodules. These results are in with the findings of Balai *et al.* (2005) [2]. Number of nodules per plant, the nodule fresh and dry weight at 60 DAS showed increase in number of nodules, nodule weight significantly due to application of complex fertilizers compared to the farmer practice. The number of nodules per plant was recorded from 16.33 to 41.00 with an average 29.48, respectively at 60 DAS. Significantly highest number of nodules per plant, fresh and dry weight of nodules per plant (41.00, 800.00 mg and 390.00 mg) were recorded in 25% more of treatment T3 through complex fertilizer grade (11.30.14 + Sec + MN) + Urea treatment (T_8) at 60 DAS. The lowest was recorded in Farmer practice (22:58:00 kg/ha) - T_1. The root nodules per plant were significantly increased with increased levels of complex fertilizers application in conjunction with urea. It provides the micronutrients along with all other essential elements which might have acted as co-enzyme for formation of root nodules. These results are in conformity of with Balai *et al.* (2005) [2].

Number of pods

The number of pods per plant is an important yield parameter and it gives rough estimate of crop yield. The result on number of pods per plant as influenced by different treatments is presented in Table 3. It was observed that number of pods at pod development and harvesting stage were influenced significantly due to treatments administrated. Number of pods per plant at pod development stage and harvesting stage was varied from 42.17 to 70.27 and 48.71 to 80.94 with an average of 54.84 and 66.27, respectively. The highest number of pods (70.27 and 80.94) were observed in the treatment receiving 25% more of treatment T_3 through complex fertilizer grade (11.30.14+Sec+ MN) + Urea (T_8) at 60 DAS and 80 DAS, respectively and it was followed by treatment T_5, T_7, T_3, T_6, T_9 and T_4 and lowest number of pods was recorded in treatment Farmer practice (T_1). These results are in agreement with Sohu *et al.* (2015) [20].

Yield

Seed

There was a significant increase in the seed yield of chickpea as a result of application of complex fertilizers as compared to farmer practice (Table 4). The chickpea seed yield was increased from 1033.33 - 1832.10 kg ha^{-1} with an average yield of 1322.40 kg ha^{-1}. Significantly highest chickpea seed

yield (1832.10 kg ha^{-1}) was recorded in the treatment 25% more of treatment T_3 through complex fertilizer grade (11:30:14+Sec+ MN) + urea (T_8). It was followed by the seed yield (1623.23 kg ha^{-1}) recorded in the treatment T_5 receiving RDF equivalent to T_3 through complex fertilizer grade (11.30.14+Sec+MN) +Urea+ Bensulf and lowest seed yield (1033.33 kg ha^{-1}) was found in Farmer practice (22:58:00 kg ha^{-1}) treatment (T_1). However, the magnitude of increase in seed yield under treatment T_8 receiving 25% more of treatment T3 through complex fertilizer grade (11.30.14 + Sec + MN) + Urea was 43.59% over farmer practice.

Significantly highest seed yield was observed in 25% more of treatment T_3 through complex fertilizer grade (11.30.14+Sec+ MN) + Urea (T_8) due to adequate supply of required nutrients at all plant growth stages during plant growth. The better nutrient availability and nutrient uptake increased the growth and yield of soybean. Singh and Prasad (1997) [18] reported the application of 15 kg N +30 kg P2O5 enhanced grain yield by 26.89% and 21.27%, respectively while the combined used 15 kg N + 30 kg P2O5 ha^{-1} resulted in higher grain yield by 48.15% over control. These results are in corroborated with the findings of Singh *et al.* (2001) [19].

Straw

The straw yield of chickpea was increased with the application of different complex fertilizers over farmer practice and the results are narrated in Table 4. The straw yield of chickpea was varied from 1976.00 to 3123.33 kg ha^{-1} in various treatments. The highest straw yield (3123.33 kg ha^{-1}) was recorded with the treatment 25% more of treatment T3 through complex fertilizer grade (11.30.14+Sec+ MN) + Urea (T_8). The lowest straw yield (1976 kg ha^{-1}) was recorded in Farmer practice treatment (T_1). The magnitude of increase in straw yield under treatment T_8 was 36.73% over farmer practice (T_1). Treatment 25% more of treatment T_3 through complex fertilizer grade (11.30.14 + Sec + MN) + Urea might (T_8) have resulted in the better availability of nutrients throughout the growth of chickpea. Sharma and Singh (2014) [16] also reported that chickpea recorded significantly higher seed and biological yield with the application of 100 kg DAP ha^{-1}. The considerable increase in stover yield was recorded with the combined application of N, P, K and micronutrient also through chemical fertilizers. Our results are also in agreement with the findings of Kale *et al.* (2020) [7].

Quality

Test weight

The test weight of chickpea was significantly influenced with different complex fertilizers are presented in Table 5. The test weight of chickpea varied from 20.71 to 24.06 g/100 seed. The highest test weight (24.06 g) of chickpea seed was registered in treatment T8 (25% more of treatment T3 through complex fertilizer grade (11.30.14+Sec+ MN) + Urea and lowest was noted in farmer practice. Landge *et al.* (2020) [9] also reported the higher test weight of black gram with the application of phosphorus and sulphur (60 kg P2O5 ha^{-1}, 40 kg S ha^{-1}).

Protein content

The results of protein content in seeds of chickpea as influenced by complex fertilizers are narrated in Table 5. The protein content in seeds of chickpea varied from 20.46 to 24.06% with mean value of 21.45%. The increase in protein content of seeds of chickpea due to application of complex fertilizers was recorded. The results are in similar line with Venkatesh *et al.* (2011) [25].

Table 1: Effect of different complex fertilizers on plant height at various growth stages of chickpea

Treatment details	Plant height (cm)		
	30 DAS	60 DAS	80 DAS
T_1: Farmer practice (22:58:00 kg/ha)	20.00	36.35	38.00
T_2: RDF (25:50:25 kg/ha)	21.93	39.66	41.51
T_3: RDF +20 Kg S +5.25 kg Zn	24.57	43.93	45.62
T_4: RDF equivalent to T_2 through complex fertilizer grade (11.30.14+Sec+MN) + urea	22.46	42.29	43.18
T_5: RDF equivalent to T_3 through complex fertilizer grade (11:30:14+Sec+MN) +urea+ bensulf	26.34	45.59	47.51
T_6: 10% less of treatment T_3 through complex fertilizer grade (11:30:14+Sec +MN) + urea	22.85	41.66	42.98
T_7: 10% more of treatment T_3 through complex fertilizer grade (11:30:14+Sec +MN) + urea	25.33	43.12	44.56
T_8: 25% more of treatment T_3 through complex fertilizer grade (11:30:14+Sec+ MN) + urea	28.53	48.32	48.46
T_9: 25% less of treatment T_3 through complex fertilizer grade (11:30:14+Sec +MN) + urea	22.58	44.24	43.53
S.Em±	0.76	1.98	1.58
CD at 5%	2.29	5.95	4.75
Grand mean	23.84	42.79	43.92

Table 2: Effect of different complex fertilizers on number of branches plant^{-1} at various growth stages of chickpea

Treatment	Number of branches plant^{-1}		Number of pods plant^{-1}	
	30 DAS	60 DAS	60 DAS	80 DAS
T_1: Farmer practice (22:58:00 kg/ha)	5.60	5.93	42.17	48.71
T_2: RDF (25:50:25 kg/ha)	6.30	6.44	45.18	55.24
T_3: RDF +20 Kg S +5.25 kg Zn	6.57	7.50	58.19	70.07
T_4: RDF equivalent to T_2 through complex fertilizer grade (11:30:14+Sec+MN) + urea	6.52	6.86	50.58	61.92
T_5: RDF equivalent to T_3 through complex fertilizer grade (11:30:14+Sec+MN) +urea+ bensulf	6.95	7.75	65.88	73.95
T_6: 10% less of treatment T_3 through complex fertilizer grade (11:30:14+Sec +MN) + urea	6.39	6.81	51.05	65.70
T_7: 10% more of treatment T_3 through complex fertilizer grade (11:30:14+Sec +MN) + urea	6.82	6.22	56.93	72.51
T_8: 25% more of treatment T_3 through complex fertilizer grade (11:30:14+Sec+ MN) + urea	7.25	8.01	70.27	80.94
T_9: 25% less of treatment T_3 through complex fertilizer grade (11:30:14+Sec +MN) + urea	6.55	6.12	53.38	67.39
S.Em±	0.24	0.23	3.03	1.44
CD at 5%	0.72	0.69	9.10	4.32
Grand mean	6.54	6.84	54.84	66.27

Table 3: Effect of different complex fertilizers on number of root nodules, fresh and dry weight of nodules plant^{-1} (60 DAS) in chickpea

Treatment details	No of nodules	Fresh weight (mg)	Dry weight (mg)
T_1: Farmer practice (22:58:00 kg/ha)	16.33	660.00	310.00
T_2: RDF (25:50:25 kg/ha)	20.00	690.00	340.00
T_3: RDF +20 Kg S +5.25 kg Zn	32.67	720.00	320.00
T_4: RDF equivalent to T_2 through complex fertilizer grade (11:30:14+Sec+MN) + urea	25.67	730.00	340.00
T_5: RDF equivalent to T_3 through complex fertilizer grade (11:30:14+Sec+MN) +urea+ bensulf	37.00	790.00	380.00
T_6: 10% less of treatment T_3 through complex fertilizer grade (11:30:14+Sec +MN) + urea	28.67	710.00	310.00
T_7: 10% more of treatment T_3 through complex fertilizer grade (11:30:14+Sec +MN) + urea	32.67	750.00	330.00
T_8: 25% more of treatment T_3 through complex fertilizer grade (11:30:14+Sec+ MN) + urea	41.00	800.00	390.00
T_9: 25% less of treatment T_3 through complex fertilizer grade (11:30:14+Sec +MN) + urea	31.33	740.00	320.00
S.Em±	1.16	0.025	0.008
CD at 5%	3.47	0.075	0.026
Grand mean	29.48	730.00	330.0

Table 4: Effect of different complex fertilizers on seed and straw yield of chickpea

Treatment	Seed yield (kg ha^{-1})	% Increase over farmers practice	Straw yield (kg ha^{-1})	% Increase over farmer practice
T_1: Farmer practice (22:58:00 kg/ha)	1033.33	--	1976.00	--
T_2: RDF (25:50:25 kg/ha)	1100.40	6.09	2201.67	10.24
T_3: RDF +20 Kg S +5.25 kg Zn	1234.91	16.32	2636.00	25.03
T_4: RDF equivalent to T_2 through complex fertilizer grade (11.30.14+Sec+MN) + urea	1178.95	12.35	2211.00	10.62
T_5: RDF equivalent to T_3 through complex fertilizer grade (11:30:14+Sec+MN) +urea+ bensulf	1623.23	36.34	3039.00	34.97
T_6: 10% less of treatment T_3 through complex fertilizer grade (11:30:14+Sec +MN) + urea	1191.26	13.25	2468.00	19.93
T_7: 10% more of treatment T_3 through complex fertilizer grade (11:30:14+Sec +MN) + urea	1486.41	30.48	2736.67	27.80
T_8: 25% more of treatment T_3 through complex fertilizer grade (11:30:14+Sec+ MN) + urea	1832.10	43.59	3123.33	36.73
T_9: 25% less of treatment T_3 through complex fertilizer grade (11:30:14+Sec +MN) + urea	1221.04	15.37	2562.33	22.88
S.Em±	29.85	--	66.43	--
CD at 5.*et al.*%	89.51	--	199.19	--
Grand mean	1322.40	--	2550.44	--

Table-5: Effect of different complex fertilizers on test weight and protein content of chickpea

Treatment	Test wt. (g/100 seed)	Protein content (%)
T_1: Farmer practice (22:58:00 kg/ha)	20.71	20.46
T_2: RDF (25:50:25 kg/ha)	21.82	20.73
T_3: RDF +20 Kg S +5.25 kg Zn	23.83	21.75
T_4: RDF equivalent to T_2 through complex fertilizer grade (11:30:14+Sec+MN) + urea	22.42	21.05
T_5: RDF equivalent to T_3 through complex fertilizer grade (11:30:14+Sec+MN) +urea+ bensulf	22.38	21.25
T_6: 10% less of treatment T_3 through complex fertilizer grade (11:30:14+Sec +MN) + urea	22.06	21.40
T_7: 10% more of treatment T_3 through complex fertilizer grade (11:30:14+Sec +MN) + urea	22.08	21.67
T_8: 25% more of treatment T_3 through complex fertilizer grade (11:30:14+Sec+ MN) + urea	24.06	22.73
T_9: 25% less of treatment T_3 through complex fertilizer grade (11:30:14+Sec +MN) + urea	21.35	21.10
S.Em±	0.62	0.58
CD at 5%	1.88	1.76
Grand mean	22.30	21.45

Conclusion

Application of fertilizer 25% more than T_3 (RDF +20 Kg S +5.25 kg Zn) through complex grade (11:30:14+Sec+MN) +Urea has significantly enhanced growth, yield and quality parameter of chickpea.

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