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Response of chickpea to available nutrients under conservation agriculture practices

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Abstract
A field experiment was conducted at Agriculture Research Station, Kalaburagi, University of Agricultural Sciences, Raichur, conducted during *rabi* 2016-17. To study the "Response of chickpea (*Cicer arietinum* L.) under conservation agriculture practices". The trial was laid out in Split plot design with four replications and six treatments and three main plots and two sub plots. The results concluded that soils are slightly alkaline pH, EC (0.36 dS m^{-1}) and low in soil organic carbon content. Among all the treatments, Zero Tillage with residue retention significantly recorded higher organic carbon, nitrogen, phosphorous, potassium and sulphur also micronutrients like Zn, Fe, Cu and Mn in soil. It is concluded that the among all treatments zero tillage with residue retention was found best combination for higher chickpea crop yields compared to other of treatments.

Keywords: Soil reaction, electrical conductivity, organic carbon and DTPA-extractable micro-nutrient

Introduction
Conservation agriculture is a management system that maintains a soil cover through surface retention of crop residues with no till/zero and reduced tillage. CA is based on optimizing yields and profits, to achieve a balance of agricultural, economic and environmental benefits. As per FAO definition CA is to achieve acceptable profit high and sustained production levels, and conserve the environment. It aims at reversing the process of degradation inherent to the conventional agricultural practices like intensive agriculture, burning/removal of crop residues. Hence, it aims to conserve, improve and make more efficient use of natural resources through integrated management of available soil, water and biological resources combined with external inputs. It can also be referred to as resource efficient or resource effective agriculture.

Chickpea (*Cicer arietinum* L.) is one of the important legume crop and rich in protein content. Its seeds are used as a vegetable and dry bean. In fact, it is a multipurpose crop used in human diets, animal fodder and industrial purposes. Chickpea is the most important pulse crop cultivated during *rabi* season mainly in semi-arid and warm temperate regions of the world. In India, it is cultivated over an area of 9.93 million hectares with an annual production of 9.53 million tonnes and with a productivity of 960 kg ha^{-1} (Anon, 2015) [1]. The area under chickpea in Karnataka is 0.92 million hectares with 0.57 million tonnes of production and with 622 kg ha^{-1} of productivity (Anon, 2015) [1]. In Karnataka, Kalaburagi district, occupies the first position in chickpea area (0.16 million hectares) with a production of 0.11 million tonnes and productivity (0.74 t ha^{-1}) followed by Vijayapura and Bagalakot districts (Anon, 2015) [1].

Chickpea also plays an important role in sustaining soil productivity by improving its physical, chemical and biological properties and trapping atmospheric nitrogen in their root nodules (Ali and Kumar, 2005) [2]. Keeping above facts in consideration a study was conducted on response of chickpea to avaialable nutirents under conservation agriculture practices..

Material and Methods
A field experiment was conducted at Agriculture Research Station, Kalaburagi, University of Agricultural Sciences, Raichur, conducted during *rabi* 2016-17. To study the "Response of chickpea (*Cicer arietinum* L.) under conservation agriculture practices". The trial was laid out in Split plot design with four replications and six treatments and three main plots and two sub plots. The treatment details as fallows.

Treatment details

Main plot:	Main x Sub Plot
M1: Conventional Tillage	M1S1: Conventional Tillage (CT) + with residue
M2: Reduced Tillage	M1S2: Conventional Tillage (CT) + without residue
M3: Zero Tillage	M2S1: Reduced Tillage (RT) + with residue
Sub Plot:	M2S2: Reduced Tillage (RT) + without residue
S1: With residue	M3S1: Zero Tillage (ZT) + with residue
S2: Without residue	M2S2: Zero Tillage (ZT) + without residue

Results

Influence of conservation agriculture practices on available nutrient status in post harvest soil samples.

The data on soil pH, electrical conductivity (dS m^{-1}), organic carbon (%), available nitrogen (kg ha^{-1}), available phosphorus (kg ha^{-1}) and available potassium (kg ha^{-1}) and available sulphur (kg ha^{-1}) as influenced by tillage and residue retention and their interaction after harvest of chickpea are presented in Table 1 and 2.

Soil reaction (pH)

Tillage and residue retention and their interaction of pH in soil were not differed significantly after harvest of chickpea. The pH 1:2.5 (soil: water) did not vary significantly (Table 1). In general, the pH of the soil ranges from 7.54 to 7.80

Electric conductivity of soil

Tillage and nutrient management practices and their interaction of EC in soil were not differed significantly after harvest of chickpea. There is no significant difference in EC of soil was observed among different tillage practices after harvest of chickpea (Table 1). In general EC of soil ranges from 0.30 dS $m^{-1}$to 0.47 dS m^{-1}.

Organic carbon content of soil

The data on Organic carbon in the soil showed significant differences among treatments. The main plot tillage treatments, zero tillage (M3) recorded significantly higher Organic carbon in the soil (0.3%) over conventional tillage (M1) (0.57%). Among sub plot residue treatments, with residue retention (S1) recorded significantly higher Organic carbon in the soil (0.75%**)** over all other treatments (Table 1). However, significantly lower Organic carbon in the soil was recorded in without residue retention (S2) (0.63%). Interaction of tillage and residue treatments on Organic carbon in the soil differed significantly. Significantly higher Organic carbon in the soil (0.91%**)** was observed in zero tillage with residue retention (M3S1) as compared to all other treatments. Conventional tillage without residue retention (M1S2) recorded significantly lower Organic carbon in the soil (0.50%).

Table 1: Chemical properties of soil after harvest of the crop as influenced by Conservation agriculture practices

Treatments	Ph (1 : 2.5)	EC (dSm^{-1})	OC (%)
Main Plot			
M_1:Conventional Tillage	7.54	0.30	0.57
M_2: Reduced Tillage	7.56	0.37	0.67
M_3:Zero Tillage	7.80	0.47	0.83
S.Em±	0.07	0.04	0.05
CD 5%	0.23	0.13	0.18
Sub Plot			
S_1:With Residue	7.70	0.42	0.75
S_2:Without Residue	7.57	0.34	0.63
S.Em±	0.04	0.01	0.03
CD 5%	0.13	0.05	0.08
Main x Sub Plot			
M_1S_1	7.54	0.31	0.65
M_1S_2	7.54	0.29	0.50
M_2S_1	7.57	0.41	0.70
M_2S_2	7.56	0.33	0.65
M_3S_1	7.99	0.55	0.91
M_3S_2	7.61	0.39	0.75
S.Em±	0.07	0.02	0.04
CD 5%	0.23	0.08	0.14

Available nitrogen, phosphorus, potassium and sulphur (kg ha^{-1}) in soil

Among the main plot tillage treatments, zero tillage (M3) recorded significantly higher available nitrogen, phosphorus, potassium and sulphur in soil (222.75, 30.38, 565.63 and 18.38 kg ha^{-1}). Conventional tillage (M1) recorded significantly lower available of nitrogen, phosphorus, potassium and sulphur in soil (188.38, 24.44, 439.25 and 13.25 kg ha^{-1}). Among sub plot residue treatments, with residue retention (S1) recorded significantly higher available nitrogen, phosphorus, potassium and sulphur in soil (212.75, 28.00, 514.33 and 16.58 kg ha^{-1}**)** over all other treatments (Table 2). Without residue retention (S2) recorded significantly lower available nitrogen, phosphorus, potassium and sulphur in soil (193.92, 25.96, 501.17 and 14.92 kg ha^{-1}), respectively.Interaction of tillage and residue treatments on available nitrogen, phosphorus, potassium and sulphur in soil differed significantly. Significantly higher available nitrogen, phosphorus, potassium and sulphur in soil (244.00, 32.50, 574.50 and 19.75 kg ha^{-1}**)** were observed in zero tillage with residue retention (M3S1) compared to all other treatments. Conventional tillage without residue retention (M1S2) recorded significantly lower available nitrogen, phosphorus, potassium and sulphur in soil (189.75, 24.13, 433.25 and 12.25 kg ha^{-1}).

Table 2: Available N, P_2O_5, K_2O and S (kg ha^{-1}) after harvest of the chickpea crop as influenced by Conservation agriculture practices

Treatments	Available nutrient (kg ha^{-1})			
	N	P_2O_5	K_2O	S
Main Plot				
M_1:Conventional Tillage	188.38	24.44	439.25	13.25
M_2: Reduced Tillage	198.88	26.13	518.38	15.63
M_3:Zero Tillage	222.75	30.38	565.63	18.38
S.Em±	11.77	1.22	13.65	1.01
CD 5%	40.73	4.23	47.22	3.49
Sub Plot				
S_1:With Residue	212.75	28.00	514.33	16.58
S_2:Without Residue	193.92	25.96	501.17	14.92
S.Em±	5.30	0.64	2.77	0.49
CD 5%	16.95	2.04	8.87	1.56
Main x Sub Plot				
M_1S_1	187.00	24.75	445.25	14.25
M_1S_2	189.75	24.13	433.25	12.25
M_2S_1	207.25	26.75	523.25	15.75
M_2S_2	190.50	25.50	513.50	15.50
M_3S_1	244.00	32.50	574.50	19.75
M_3S_2	201.50	28.25	556.75	17.00
S.Em±	9.18	1.11	4.80	0.85
CD 5%	29.37	3.54	15.37	2.71

Available micronutrient status in soil

Among the main plot tillage treatments, zero tillage (M3) recorded significantly higher available Zinc, Iron, Copper and Manganese (0.95, 7.14, 2.83 and 6.23 mg kg^{-1}). Conventional tillage (M1) recorded significantly lower available Zinc, Iron, Copper and Manganese in soil (0.81, 6.16, 2.49 and 4.83 mg kg^{-1}). Among sub plot residue treatments, with residue retention (S1) recorded significantly higher Zinc, Iron, Copper and Manganese in soil (0.92, 6.93, 2.73 and 5.77 mg kg^{-1}**)** over all other treatments. Without residue retention (S2) recorded significantly lower available Zinc, Iron, Copper and Manganese in soil (0.85, 6.39, 2.58 and 5.18 mg kg^{-1}). Interaction of tillage and residue treatments on available Zinc, Iron, Copper and Manganese in soil differed significantly. Significantly higher available Zinc, Iron, Copper and Manganese in soil (0.98, 8.13, 2.93 and 6.95 mg kg^{-1}**)** were observed in zero tillage with residue retention (M3S1) compared to all other treatments. Conventional tillage without residue retention (M1S2) recorded significantly lower available Zinc, Iron, Copper and Manganese in soil (0.75, 6.10, 2.40 and 4.78 mg kg^{-1}).

Table 3: Available Micronutrient (mg kg^{-1}) after harvest of the crop as influenced by Conservation agriculture practices

Treatments	Available Micronutrient (mg kg^{-1})			
	Zn	Fe	Cu	Mn
Main Plot				
M_1:Conventional Tillage	0.81	6.16	2.49	4.83
M_2: Reduced Tillage	0.89	6.40	2.66	5.38
M_3:Zero Tillage	0.95	7.41	2.83	6.23
S.Em±	0.05	0.14	0.07	0.17
CD 5%	0.18	0.47	0.25	0.60
Sub Plot				
S_1:With Residue	0.92	6.93	2.73	5.77
S_2:Without Residue	0.85	6.39	2.58	5.18
S.Em±	0.02	0.06	0.03	0.14
CD 5%	0.05	0.18	0.10	0.45
Main x Sub Plot				
M_1S_1	0.88	6.23	2.58	4.88
M_1S_2	0.75	6.10	2.40	4.78
M_2S_1	0.90	6.43	2.70	5.48
M_2S_2	0.89	6.38	2.63	5.28
M_3S_1	0.98	8.13	2.93	6.95
M_3S_2	0.91	6.70	2.73	5.50
S.Em±	0.03	0.10	0.05	0.25
CD 5%	0.09	0.31	0.17	0.78

Discussion

Soil physic-chemical properties *viz*., pH, EC, OC did not differ significantly, whereas available major and micro nutrients in soil after harvest of chickpea was significantly higher in zero tillage + residue retention. However, significantly lower value of major and micro nutrients was recorded in conventional tillage + without residue retention. Neugschwandtner *et al*. (2014) [3] reported that there was no significant difference found in soil pH and EC in 0-15 cm soil depth after continuous cropping of rice-wheat for 3 years with different treatments due to acidifying effect and mineralization of organic matter, nitrification of surface applied N fertilizer and root exudation. Dalal (1989) [4] also reported that lower soil electrical conductivity under no-tillage than under conventional tillage in vertisols of Queensland region.

The Highest SOC content was recorded in zero tillage + with residue treatments as compared to other treatments. This is may be due to less mineralization of stored OC and addition of plant residue under zero tillage increases the SOC content more than conventional tillage without residue, the 11% SOC increased under zero tillage with residue as compared to conventional tillage without residue. The present results corroborated with the findings of Hati *et al*. (2014) [5] and Mc Carty *et al*. (1998) [6]. They reported that conservation tillage particularly no tillage leads to a higher SOC concentration in the top layer of the soil (0-5 cm) and alters its distribution within the soil profile.

Available nitrogen, phosphorous, potassium, and sulpur of chickpea was significantly increased in zero tillage + with residue retention. Significantly lower uptake of nitrogen, phosphorous, potassium, and sulpur of chickpea was recorded in conventional tillage without residue retention. Available phosphorus and potassium content were significantly higher in zero tillage than zero tillage + with residue retention and conventional tillage. In zero tillage, rice straw and fertilizers added on to the soil surface so that nutrients in straw and fertilizer may be accumulated in surface layer of soil. This increase in available phosphorous may be due to higher microbial activity under zero tillage + with residue retention treatment. A significant increase in available potassium content under zero tillage (0-5 and 5-10 cm soil depths) with mulched then the conventional tillage was reported by Du Preez, (2001) [7].

Available micronutrients like Zinc, Iron, Cupper and Manganese of chickpea was significantly increased in zero tillage + with residue retention. However, significantly lower uptake of Zinc, Iron, Cupper, and Manganese of chickpea was recorded in conventional tillage + without residue retention. DTPA-extractable micronutrient cations (Fe, Mn, Zn and Cu) were found significantly higher in zero tillage wheat sown with rice straw as mulch than zero tillage with residue and conventional tillage wheat an average 50-80% of Zn, Mn and Cu are retained in cereals residue so that residue is very important source for augment in micronutrient availability in soil. Similar results also reported by Prasad *et al.* (2010) [8], they found that incorporation of residue both rice and wheat significantly increased DTPA-extractable micronutrient cations (Fe, Mn, Zn and Cu) content in surface (0-15 cm) soil due to build up in organic carbon in soil.

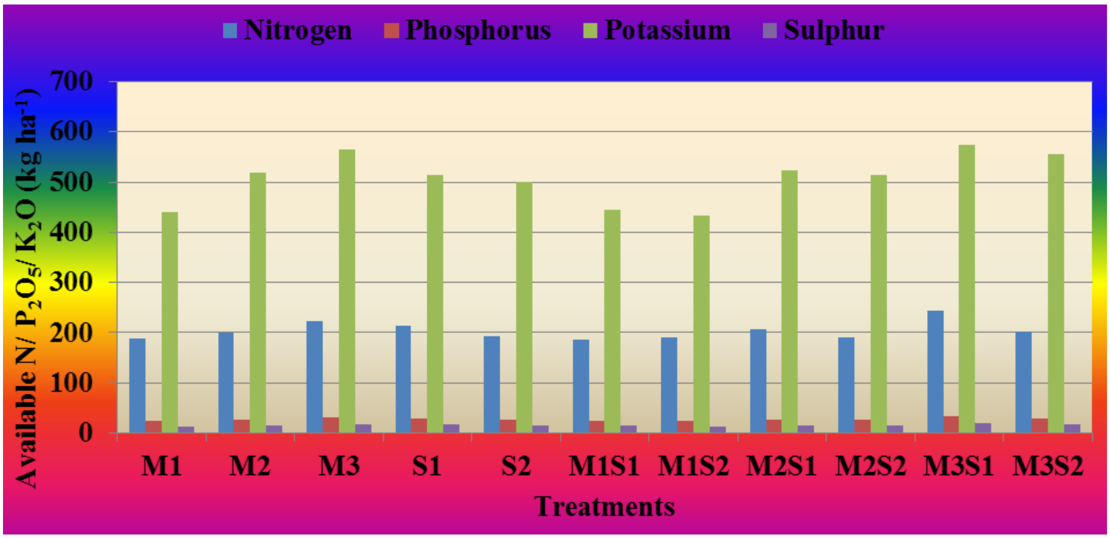

Fig 1: Available nutrients of Nitrogen, Phosphorus, Potassium and Sulphur on soil after the harvest of chickpea as influenced by conservation agriculture practices

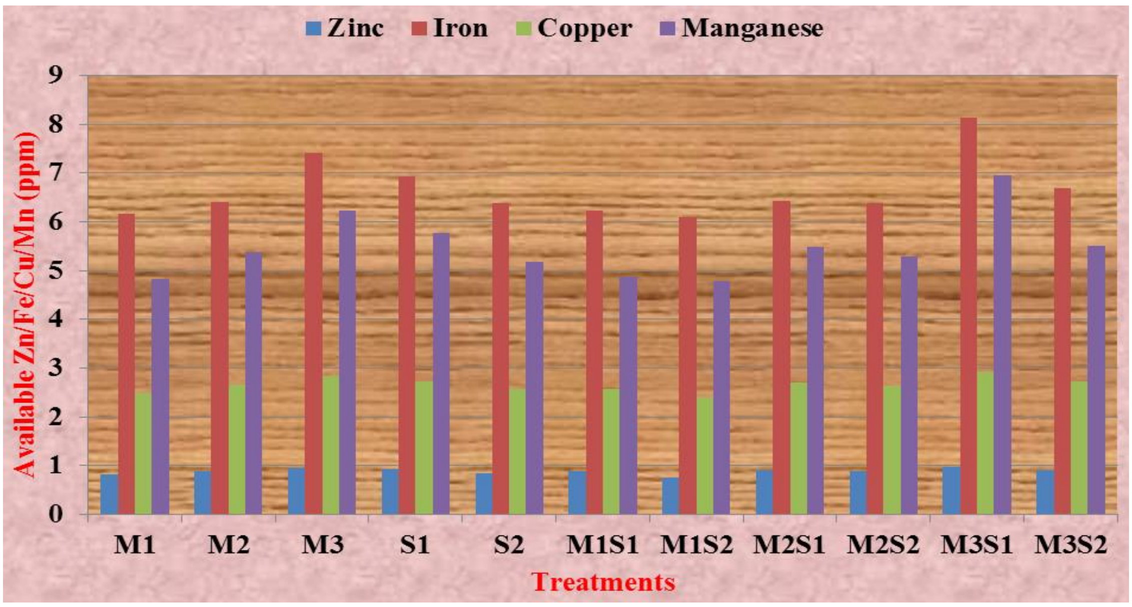

Fig 2: Available micronutrients on soil after the harvest of chickpea as influenced by Conservation agricultural practices.

Conclusions

From the results of the present study, it can be concluded among all treatments zero tillage with residue retention was found best combination for uptake of soil available nutrients in chickpea compared to other of treatments.

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