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Conservation agricultural practices for enhancing productivity of chickpea (*Cicer arietinum* L.) in rainfed areas

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Abstract
A field experiment was undertaken at Regional Agriculture Research Station, Nandyal, Andhra Pradesh during rabi 2017-18 on vertisols to enhance the productivity of chickpea in rainfed areas through conservation agricultural practices involving tillage and crop residues retention. The present investigation was carried out with three tillage methods **(**Conventional tillage - two harrowing + planking; Reduced tillage -one harrowing + planking and Zero tillage) and two types of crop residue retention (@2.5 t/ha) **(**with **c**rop residue retention @2.5 t/ha and without crop residue retention) sown at plant geometry of 30 x 10 cm in split plot design replicated four times. Conservation tillage has recorded higher grain yield (1699 kg/ha) and Net returns (Rs 44,275/ha) and was at par with reduced tillage (1592 kg/ ha). Significantly higher soil moisture (24.4 and 13.2%) was observed with crop residue retention at 30 and 60 DAS respectively. Higher net returns (Rs 42,927/ha) and BCR of 2.46 was observed with crop residue retention (@2.5 t/ha).

Keywords: Chickpea, conservation tillage, reduced tillage, zero tillage, seed yield

Introduction
It is hypothesized that conservation agriculture (CA), which consists of zero/ minimum tillage, crop residue retention/ growing cover crops and adoption of suitable cropping systems, leads to reversal of process of land degradation when practiced continuously through significant reduction in runoff and soil loss (Castro *et al.,* 1991) [1] as well as improvement in soil physical, chemical and biological properties (Lal, 2010) [2]. Conservation tillage (CT) has been used to address global food security challenges, and holds much promise in managing agro ecosystems for improved and sustained productivity, increased profits while preserving/enhancing the resource base and environment(Hobbs *et al.,* 2008; Friedrich *et al.,* 2012) [3, 4]. These positive effects, particularly improving crop yields are significant in dryland farming areas. For example, no-till in combination with residue retention and crop rotation significantly increases crop productivity in dry climates, suggesting it might become an important strategy for adapting to climate-change in regions around the world as they become drier (Cameron *et al.,* 2015) [5]. Chickpea (*Cicer arietinum* L.) is an important pulse legume cultivated and consumed across the world. India is the largest producer and consumer of chickpea in the world. It is the major pulse crops of the subcontinent grown on an area of about 9.54 mha with a production of 9.08 mt and productivity of 951 kg ha^{-1} (Agricultural Statistics at a Glance, 2016) [6]. In the present investigation, effect of conservation agricultural practices involving tillage and crop residues retention was studied for enhancing the productivity of chickpea in rainfed areas.

Material and methods
The present investigation was carried out with three tillage methods **(**Conventional tillage - two harrowing + planking; Reduced tillage -one harrowing + planking and Zero tillage) applied in main plots and two types of crop residue retention (@2.5 t/ha) **(**with **c**rop residue retention @2.5 t/ha and without crop residue retention) were applied to sub plots and sown at plant geometry of 30 x 10 cm in split plot design replicated four times during *Rabi* 2017-18 at Regional Agriculture Research Station, Nandyal (ANGRAU), Andhra Pradesh. All the recommended package of practices was adopted to raise the crop. Five randomly selected plants from each cultivar in each replication were used for recording the observations to estimate the genetic parameters among cultivars. The data were recorded on soil moisture and quantitative traits such as plant height (cm), number of branches, Days to 50% flowering,

number of pods per plant, test weight (g), grain yield(kg/ha) and harvest index (%). The mean values of all the parameters and quantitative characters were subjected to statistical analysis by adopting Fisher's method of analysis of variance as outlined by Gomez and Gomez (1984) [7]. The level of significance used in 'F' test was at 5 per cent.

Result and discussion

The analysis of variance was significant for soil moisture and quantitative traits due to tillage and crop residue retention (Table 1). Tillage methods did not influenced the soil moisture at 30 and 90 DAS. Significantly higher soil moisture (14.1%) was observed in zero tillage and was at par with reduced tillage (12.9%). Significantly lower soil moisture (10.9%) was observed in conservation tillage. Tillage methods did not significantly influence plant height, number of branches/plant, days to 50% flowering, test weight and harvest index. Significantly higher pods/plant (36.1) and seed yield (1699 kg/ha) was observed in conservation tillage and is at par with reduced tillage (32.2 and 1592 kg/ha respectively). Significantly lower pods/plant (30.4) and seed yield (1493 kg/ha) was observed in zero tillage. Higher net returns (Rs 44,275/ha) was observed in conservation tillage and higher benefit cost ration (BCR) of 2.46 was observed in reduced tillage. Recent studies indicated that CT was effective in increasing soil water content and water use efficiency, and this positive effect was particularly evident in dryland areas or in drought years when compared to traditional tillage (TT). This can be attributed to improved soil capacity for conserving water, increased water infiltration, and reduced run off and evaporation. Fan et al.2014 [8] found that no-tillage soil contained between 2.5% (vol/vol) more water in the top 0–30 cm than when using a moldboard plough. Chen et al.2014 [9] found that no-till with stubble retained had more water stable aggregation. Crop residue retention (@2.5 t/ha) influenced the soil moisture at 30 and 60 DAS. Significantly higher soil moisture (24.4 and 13.2%) was observed with crop residue retention at 30 and 60 DAS respectively. Crop residue retention (@2.5 t/ha) did not influence significantly number of branches/plant, days to 50% flowering, pods/plant, test weight, seed yield and harvest index. Higher net returns (Rs 42,927/ha) and BCR of 2.46 was observed with crop residue retention(@2.5 t/ha). Interaction effects of tillage methods and crop residue retention on soil soil moisture and quantitative traits are insignificant.The management of crop residues can have direct and indirect effects on crop yield (Pittelkow *et al.,* 2015) [10]. Crop residues that cover the soil act as physical barriers, making it less susceptible to the erosive action of raindrops and wind (Johnson *et al.,* 2016) [11]. Moreover, the maintenance of crop residues favors infiltration (Valim *et al.,* 2016) [12] and storage of water in the soil (Tormena *et al.,* 2017) [13]. In a climate change scenario, the maintenance of crop residues on the soil might decrease the effects of droughts, as well as prevent soil losses by erosion due to the occurrence of more frequent heavy rains.

Table 1: Growth and yield parameters of chickpea as influenced by planting geometry and cultivar

Treatments	Soil moisture (%)			Plant height (cm)	No of branches /plant	Days to 50% flowering	Pods/ plant	Test weight (gm)	Seed yield (kg/ha)	Harvest Index (%)	Net returns (Rs)	BCR
	30 DAS	60 DAS	90 DAS									
I) Tillage methods												
Conservation tillage	22.2	10.9	10.4	37.9	16.2	41.4	36.1	29.5	1699	47.7	44275	2.45
Reduced tillage	23.2	12.9	11.5	37.0	14.8	41.1	32.2	29.8	1592	48.4	41539	2.46
Zero tillage	24.4	14.1	11.7	36.5	13.2	39.0	30.4	29.1	1493	49.2	38184	2.39
S.Em±	0.72	0.70	0.35	0.72	0.83	0.61	1.2	0.32	38.3	1.0		
CD (P=0.05)	NS	2.4	NS	NS	NS	NS	4.1	NS	132	NS		
II) Crop residue retention												
With Crop residue retention	24.4	13.2	11.6	37.8	15.5	40.6	34.2	29.8	1642	48.8	42927	2.46
Without crop residue retention	22.2	12.1	10.8	36.5	14.0	40.4	31.6	29.2	1547	48.1	39738	2.40
S.Em±	0.55	0.16	0.30	0.29	0.62	0.25	1.0	0.44	49	0.97		
CD (P=0.05)	1.7	0.5	NS	0.9	NS	NS	NS	NS	NS	NS		
Interactions	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS		

Conclusion

It can be inferred that Conservation tillage with crop residue retention (@2.5 t/ha) could be effective for soil moisture retention and higher seed yield and net returns. Improved soil properties and increased soil moisture are necessary for the improvement of agricultural productivity in mature conservation tillage systems as compared to traditional tillage systems.

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