

Original Research Article

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Effect of Different Tillage Practices on Growth, Yield and Economics of Chickpea (*Cicer arietinum* L.) under Rainfed Condition of Chhattisgarh

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ABSTRACT

A field experiment was conducted at Research-cum Instructional Farm, Indira Gandhi Krishi Vishwavidhyalaya, Raipur to study the Effect of tillage practices on growth, yield and economics of chickpea under rainfed condition of Chhattisgarh. The experiment was laid out in randomized block design with three replications and consisted of four tillage practices viz. T₁- Zero tillage direct drilling of seeds and fertilizers at 2nd days after harvesting of rice, T₂ -Minimum tillage and line sowing of seeds at 3rd days after harvesting of rice, T₃-Minimum tillage at 6th days after harvesting of rice, T₄-Farmer practice broadcasting seeds and fertilizer at 12th days after harvesting of rice. The results revealed that the significantly highest plant stand (32.67 plant m²), plant height (43.08 cm), branches (11.57 plant⁻¹) dry biomass (12.81 g plant⁻¹), pods plant⁻¹ (28.34), seed and stover yield (11.35 and 18.28 q ha⁻¹, respectively) has been superior under minimum tillage and line sowing of seeds at 3rd days after harvesting of rice. However, it was found statistically similar with treatment zero tillage direct drilling of seeds and fertilizers at 2nd days after harvesting of rice but, seed index and harvest index was not significantly varied by tillage practices. Similarly, gross return (Rs 36951 ha⁻¹) was also higher under minimum tillage and line sowing of seeds at 3rd days after harvesting of rice, but net return (Rs 24280 ha⁻¹) and B:C (2.96) ratio were highest under ZT.

Keywords

Chickpea,
Economics,
Rainfed,
Yield,
Yield attributes.

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Introduction

Chickpea (*Cicer arietinum* L.) is an important winter season pulse crop of India and a key source of protein. In Chhattisgarh, chickpea is grown over an area of 393.78 thousand ha with an annual production of 433.158 thousand tonnes and an average productivity of 1100 kg ha⁻¹ (Anonymous, 2013-2014). Sequential cropping after harvesting of winter rice is practiced in medium lands (Kushwana and Ali, 1992). In semiarid region of India, expensive and energy consuming tillage operations, declining soil fertility and soil

moisture limitation are major constraint for agricultural crop production, In rainy (*khari*) season crops are dependent of rainwater while winter (*rabi*) season crops are dependent on conserved soil moisture (Dhar *et al.*, 2008). It is an important winter season pulse crop of India with drought condition as single most important abiotic constraints of higher productivity (Kumar *et al.*, 2006). Chickpea can increase the productivity both in terms of N saving from fertilizer source and build up soil fertility through biological source of N

(Kumar *et al.*, 1998; Kumar and Prasad, 1999). Chickpea can fix up to 140 kg N ha⁻¹ in a growing period (Poonia and Pithia, 2013). Tillage methods affect the sustainable resources through its influence on soil properties, crop growth and the use of excessive and un-necessary tillage operations is often harmful to soil (Nazeer *et al.*, 2012). The yield increase was correlated with increase in water contents in soil due to decrease in evaporation (Chuadhary *et al.*, 1992). The conservation tillage practices, developed mainly for large scale mechanized agriculture need to be adopted for rainfed pulses in India (Kumar *et al.*, 2006), which are systems of managing crop residue on the soil surface with minimum or no tillage (Unger and McCalla, 1980), are crucial in efficiently saving more precipitation for crop production (Halvorson *et al.*, 2000). In cases where soil moisture limits plant growth, no tillage (direct drilling in untilled soil) has been reported to produce crop yields similar to (Carter and Rennie, 1984) or higher than (Tessier *et al.*, 1990) conventional tillage (various combinations of plowing, disking and cultivation operations to control weeds and to prepare a fine seedbed). The present investigation deals with impact of different tillage practices to alleviate the vagaries of drought on growth, productivity and economics of chickpea.

Materials and Methods

The present investigation was conducted at research cum instructional farm IGKV Raipur, Chhattisgarh during winter season of 2014-15. The soil of the experimental field was sandy loam in texture (*Inceptisols*), bulk density 1.48 g m⁻³ (0-15 cm), particle density 2.57 g m⁻³ and porosity 41%. Neutral in soil reaction (6.6 pH) and had medium organic carbon (0.72%), low available nitrogen (219 kg ha⁻¹), medium available phosphorus (16.70 kg ha⁻¹) and medium exchangeable potassium

(322.2 kg ha⁻¹) with normal electrical conductivity. The experiment was laid out in randomized block design with three replications and consisted of four tillage practices *viz.* T₁- Zero tillage direct drilling of seeds and fertilizers at 2nd days after harvesting of rice, T₂ -Minimum tillage and line sowing of seeds at 3rd days after harvesting of rice, T₃-Minimum tillage at 6th days after harvesting of rice, T₄-Farmer practice broadcasting seeds and fertilizer at 12th days after harvesting of rice. The sowing of crop in treatment T₁, T₂, T₃ and T₄ was done on 31st October, 1st, 4th and 10th November 2014, respectively and harvesting of crop done 18 February 2015. All recommended package of practices of chickpea crop were adopted during study period. During crop growth period, the maximum temperature varied between 25^oC to 37.3^oC. The minimum temperature ranged between 8^oC to 21.5^oC. The maximum and minimum relative humidity during the crop period was 94 and 22 percent, respectively. A total of 11.7 mm rainfall was received during the crop period. The data recorded for different characters under investigation were analyzed by following analysis of variance procedure as described by Gomez and Gomez (1984) and Windows-based SPSS program (Version 16.0, SPSS, 2007). The SPSS procedure was used for analysis of variance to determine the statistical significance of treatments effect. The Duncan's multiple-range test was also used to compare treatment means at 5% probability level.

Results and Discussion

Growth and development

Plant population, plant height, number of branches per plant and dry biomass per plant was significantly influenced by different tillage practices (Table 1 and 2). Significantly higher plant population was recorded with

treatment T₂ than other treatments, but both the stages of observation, it was statistically at par with treatment T₁ and lowest plant population was recorded with treatment T₄. The highest plant population under treatment T₂ and T₁ might be due to optimum moisture content in soil during seeding and proper placement of seeds by seed drill. Similarly, lowest plant stand observed in treatment T₄ might be due to loss of soil moisture at the time of sowing and broadcasting of seeds. Rathore *et al.*, (1998) also observed similar plant stand under zero tillage and minimum tillage. Significantly taller plant at all the crop growth stages were recorded with treatment T₂ as compared to rest of the treatments, however, it was found at par with treatment T₁. The higher plant height under treatment T₂ might be owing to better availability of soil moisture and nutrients. These observations are also in agreement with the results given by earlier workers (Rathore *et al.*, 1998 and Kumar *et al.*, 2006). Treatment T₂ registered significantly higher number of branches plant⁻¹ as compared to other tillage practices. Whereas, treatment T₄ recorded significantly minimum branches plant⁻¹ throughout the crop growth period. Similar results were also recorded by Kumar *et al.*, (2006). They observed significantly higher number of branches plant⁻¹ in compact tillage than normal tillage practice. On the contrary, Savu (2007) reported that the conventional tillage produced significantly higher number of branches as compared to zero tillage. Throughout the life span of crop, significantly highest dry biomass was recorded under treatment T₂ but at 30 DAS it was *at par* with treatment T₁. However, significantly lowest dry biomass was recorded with the treatment T₄ throughout the crop growth period. The highest dry biomass under treatment T₁ and T₂ might be due to good availability of moisture which is evidenced by higher plant height and branches plant⁻¹. These results are in line with finding of Rathore *et al.*, (1998)

and Kumar *et al.*, (2006) who also observed the highest dry biomass under zero tillage.

Number of root nodules plant⁻¹ and dry weight of root nodules (mg plant⁻¹)

The number of root nodules plant⁻¹ and dry weight of root nodules (mg plant⁻¹) observed at 30, 45, 60, 75 and 90 DAS and it was significantly influenced by tillage practices (Table 3 and 4). Significantly higher number of root nodules plant⁻¹ was observed with treatment T₂ as compared to others at all the stages of observation. However, it was found at par with treatment T₃ at 30, 45, 60 and 75 DAS. While, significantly lower number of root nodules plant⁻¹ was observed with treatment T₄ at all the period of observation more number of nodules plant⁻¹ may probably be due to better seedbed preparation which facilitated better root growth ultimately more number of nodules plant⁻¹ were registered. The dry weight of root nodules was significantly higher under treatment T₂ as compared to other tillage practices at 30, 45, 60 and 75 DAS. However, at 90 DAS, dry weight of root nodules was significantly higher under above treatment, but it was found statistically at par with the treatment T₃. Higher dry weight of root nodules may be owing to maximum number of nodules plant⁻¹ in treatment T₂.

Yield attributes

Tillage practices brought significant difference on number of pods plant⁻¹. The significantly higher number of pods plant⁻¹ (28.34) was observed with treatment T₂ as compared to rest of the treatments (Table 5). The highest number of pods plant⁻¹ with treatment T₂ which is evidence by more branching. Similar finding have also been recorded by Kumar *et al.*, (2006). However, tillage practices did not bring significant difference on seeds pod⁻¹ and seed index (g).

Table.1 Effect of tillage practices on plant population and growth parameters of chickpea

Treatment	Plant population (m ⁻²)		Plant height (cm)			
	25 DAS	At harvest	30 DAS	60 DAS	90 DAS	At harvest
T ₁	41.52a	31.56 ^{ab}	21.17 ^a	36.02 ^{ab}	38.03 ^{ab}	40.90 ^{ab}
T ₂	43.00 ^a	32.67 ^a	21.53 ^a	37.87 ^a	39.19 ^a	42.08 ^a
T ₃	35.69 ^b	28.78 ^b	19.20 ^b	34.87 ^b	37.04 ^b	38.03 ^{bc}
T ₄	34.41 ^b	24.87 ^c	18.80 ^b	33.25 ^b	35.28 ^c	36.02 ^c

Table.2 Effect of tillage practices on branches plant-1 and dry biomass plant-1 of chickpea

Treatment	Branches plant ⁻¹				Dry biomass plant ⁻¹ (g)			
	30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS	At harvest
T ₁	2.07 ^b	8.74 ^b	9.98 ^{bc}	9.95 ^{bc}	0.45 ^a	5.21 ^b	9.21 ^b	11.30 ^b
T ₂	2.33 ^a	10.99 ^a	11.65 ^a	11.57 ^a	0.46 ^a	5.55 ^a	10.03 ^a	12.81 ^a
T ₃	1.73 ^b	9.54 ^b	10.78 ^{ab}	10.77 ^{ab}	0.41 ^b	5.03 ^b	9.12 ^b	10.93 ^b
T ₄	1.73 ^c	7.82 ^c	9.06 ^c	9.05 ^c	0.36 ^c	4.80 ^c	8.19 ^c	9.45 ^c

T₁ – Zero tillage direct drilling of seeds at 2nd DAH of rice

T₂ – Minimum tillage and line sowing of seeds at 3rd DAH of rice

T₃ – Minimum tillage and line sowing of seeds at 6th DAH of rice

T₄ – Farmer’s practice –seeds and fertilizers broadcasting at 12th DAH of rice

Table.3 Numbers of root nodule plant-1 and dry weight (mg) of root nodules plant-1 as influenced by tillage practices

Treatment	No. of root nodules plant ⁻¹				
	30 DAS	30 DAS	30 DAS	30 DAS	30 DAS
T ₁	9.00 ^b	9.00 ^b	9.00 ^b	9.00 ^b	9.00 ^b
T ₂	9.96 ^a	9.96 ^a	9.96 ^a	9.96 ^a	9.96 ^a
T ₃	9.28 ^{ab}	9.28 ^{ab}	9.28 ^{ab}	9.28 ^{ab}	9.28 ^{ab}
T ₄	8.34 ^c	8.34 ^c	8.34 ^c	8.34 ^c	8.34 ^c

Table.4 Numbers of root nodule plant-1 and dry weight (mg) of root nodules plant-1 as influenced by tillage practices

Treatment	Dry weight (mg) of root nodules plant ⁻¹				
	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS
T ₁	8.36 ^b	28.10 ^b	50.67 ^b	48.23 ^b	6.50 ^b
T ₂	10.57 ^a	33.70 ^a	60.33 ^a	56.00 ^a	7.67 ^a
T ₃	9.43 ^b	29.45 ^b	54.70 ^b	50.23 ^b	7.28 ^b
T ₄	8.64 ^c	28.74 ^c	52.34 ^b	48.32 ^b	6.10 ^c

Table.5 Yield attributes and yields of chickpea as influenced by tillage practices

Treatment	No. of pods plant ⁻¹	No. of seeds pod ⁻¹	Seed index (g)	Seed yield (q ha ⁻¹)	Stover yield (q ha ⁻¹)	HI (%)
T ₁	23.45 ^b	1.27	22.43	11.09 ^a	15.53 ^b	39.70
T ₂	28.34 ^a	1.27	22.47	11.35 ^a	18.28 ^a	38.30
T ₃	22.64 ^b	1.20	22.47	9.30 ^b	14.46 ^b	39.13
T ₄	18.26 ^c	1.20	22.32	7.15 ^c	11.37 ^c	38.66

Table.6 Economics of chickpea as influenced by tillage practices

Treatment	Cost of cultivation (Rs. ha ⁻¹)	Gross return (Rs. ha ⁻¹)	Net return (Rs. ha ⁻¹)	B:C ratio
T ₁	12337	36545 ^a	24208 ^a	2.96 ^a
T ₂	14237	36951 ^a	22713 ^a	2.60 ^b
T ₃	14237	30631 ^b	16394 ^b	2.15 ^c
T ₄	15237	23661 ^c	8424 ^c	1.55 ^d

Seeds pod⁻¹ was varied from 1.13 - 1.27. The highest number of seeds pod⁻¹ (1.27) was noted under both the treatment T₁ and T₂. Whereas, the lowest number of seeds plant⁻¹ (1.13) was noted with treatment T₄.

Yield

The perusal of data given in table 5 reveal that the significantly highest seed yield and stover yield (11.35 and 18.28 q ha⁻¹) was obtained under treatment T₂, but seed yield was found *at par* to treatment T₁. The lowest seed yield and stover yield (7.15 and 11.37 q ha⁻¹) was obtained under treatment T₄. The significantly higher seed yield and stover yield was recorded in treatment T₂ and T₁ as compared to treatment T₄, which is evident by more number of branches plant⁻¹, higher dry weight plant⁻¹ and more number of pods plant⁻¹. Similar results have also been reported by Rathore *et al.*, (1998) and Hemmat and Eskandari (2004) and Kumar *et al.*, (2006) and Yau *et al.*, (2010). Harvest index (%) did not show any variation by different tillage practices. But, highest harvest index (39.70 %) was recorded under treatment T₁ followed

by T₃ and the lowest harvest index (38.30 %) was recorded in treatment T₂.

Economics

Cost of cultivation, gross return, net return and B: C ratio varied due to tillage practices (Table 6) The highest cost of cultivation (Rs. 15237 ha⁻¹) was involved in treatment T₄ followed by T₂ and T₃. Treatment T₂ gave the highest gross return (Rs. 36951 ha⁻¹) but, net return (Rs. 24208 ha⁻¹) and B: C ratio (2.96) were highest recorded under treatment T₁ followed by T₂ and T₃ due to reduction in cost of cultivation in conservation tillage. Dhar *et al.*, (2008) also recorded highest yield under zero tillage practice.

In conclusion, on the basis of experiment results, it is concluded that minimum tillage and line sowing of seeds at 3rd days after harvesting of rice may be the better tillage practice for growing of the chickpea in midland rainfed condition of Chhattisgarh region as minimum tillage treatment recorded higher grain yield and economics comparison to the rest of the tillage practices studied.

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