Tillage practices influence on growth, yield and economics of Toria (*Brassica rapa* var. Toria) under rainfed condition of Chhattisgarh

TR Banjara[1*], GP Pali[2], Bhujendra Kumar[2] and Sunil Kumar[1]

[1]*Department of Agronomy, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi 221005 (Uttar Pradesh), India*
[2]*Department of Agronomy, Indira Gandhi Krishi Vishwavidyalaya, Raipur (Chhattisgarh) 492012, India*
corresponding author: tejrambanjara@gmail.com

Abstract

An experiment was conducted to study the effect of tillage practices on growth and productivity of toria, with 4 tillage practices *viz.* T_1- Zero tillage direct drilling of seeds and fertilizers at 2nd days after harvesting of rice, T_2-Minimum tillage and line sowing of seeds at 3rd days after harvesting of rice, T_3-Minimum tillage at 6th days after harvesting of rice, T_4-Farmer practice broadcasting seeds and fertilizer at 12th days after harvesting of rice. The plant population m^2 (47.4), plant height (99.44 cm), branches $plant^{-1}$ (1.6), dry biomass (2.8 g $plant^{-1}$), number of siliqua $plant^{-1}$ (28.4), number of seeds $siliqua^{-1}$ (9.7), pod length (4.7 cm), seed yield (4.3 q ha^{-1}) and stover yield (12.2 q ha^{-1}) was recorded significantly higher under T_2 (Minimum tillage and line sowing of seed at 3rd DAH of rice), but these are found statistically similar with T_1 (Zero tillage direct drilling of seeds at 2nd DAH of rice). Whereas, test weight (g) and harvest index (%) did not vary significantly by different tillage practices. The gross returns (Rs. 13330 ha^{-1}) was highest in treatment T_2, but net return (Rs. 3908 ha^{-1}) and B:C (1.42) ratio were higher in the T_1. In conclusion the minimum tillage and line sowing of seeds at 3rd days after harvesting of rice and/or Zero tillage direct drilling of seeds and fertilizers at 2nd days after harvesting of rice were the better tillage practice as it performed well over the remaining treatments with respect to all growth, yield and economics of toria grown under rainfed conditions of Chhattisgarh.

Key words: economics, Rainfed, tillage practices, yield attributes

Introduction

Toria (*Brassica rapa* var. Toria) is a short duration crop cultivated largely in Assam, Bihar, Orissa and West Bengal in the east mainly as winter crop and also in limited areas of eastern Uttar Pradesh. In Haryana, Himachal Pradesh, Madhya Pradesh, Punjab, Uttaranchal and western Uttar Pradesh, it is grown as a catch crop during September-December. The human induced degradation of natural resources, including soils, represents a major concern for sustainability and is imposing the adoption of conservation cropping systems (i.e. minimum, conservative or no-tillage) to mitigate its effects. Among the cultural operations used for raising the agricultural crops, tillage is an important cultural operation for changing soil physical-chemical characteristics and it also reportedly increases total crop output (Zhongqing *et al*. 1995). Many research findings conducted across the globe and published in different journals have reported that an adopting modified tillage practice not only reduce the cost of cultivation but also improves the soil physical, chemical and biological properties of soil which may ultimately improves crop productivity, ecological and environmental sustainability. Therefore, the research study on toria crop with four tillage practices was conducted in *Inceptisols* under rainfed condition of Chhattisgarh region with the hypothesis that the conservation tillage may enhance the overall crop productivity of toria with reducing the input cost.

Materials and Methods

The field experiment of toria under rainfed condition after winter rice was undertaken at research cum

instructional farm Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh during winter season of 2014-15. The field experiment was laid-out in randomized block design with three replications. The treatments consisting of four tillage practices *viz.* T_1 (Zero tillage direct drilling of seeds and fertilizers at 2nd days after harvesting of rice), T_2 (Minimum tillage and line sowing of seeds at 3rd days after harvesting of rice), T_3 (Minimum tillage and line sowing of seeds at 6th days after harvesting of rice), T_4 (Farmer practice broadcasting seeds and fertilizer at 12th days after harvesting of rice) were investigated. Geographically, Raipur is situated in the centre of Chhattisgarh and lies between $21^0\ 16^{'}$ N latitude and $81^0\ 36^{'}$ E longitudes with an altitude of 298 m above the mean sea level. The climatic condition of Raipur is sub-humid to semi-arid and the average rainfall of locality is about 1325 mm $year^{-1}$. The variation in maximum and minimum temperature 25^0 to 37.3^0C and 8^0 to 21.5^0C, respectively with 3 to 9.8 day^{-1} bright sunshine hour were observed during crop growth period. The maximum and minimum relative humidity 94 and 22 %, respectively were also recorded during the crop growing period. A total of 11.7 mm rainfall was received at study area during the cropping period. Soil sampling from the experiment field were taken with the help of a tube auger from 10 different points of the plots before starting of field experiment and were subsequently processed for further analysis for soil quality parameters. The soil sampling for soil bulk density measurement were undertaken from

desired depths with the help of core samplers and were calculated by Soil Core method (Blake and Hartge, 1986). The oven dry soil samples (<2 mm) were analyzed for pH (Piper, 1967), organic carbon (Walkley and Black's rapid titration method, 1934), available N (alkaline $KMnO_4$ method by Subbiah and Asija, 1956), 0.5 M $NaHCO_3$ (pH 8.5) extractable P (Olsen *et al*., 1984) and 1N NH_4OAc extractable K by Flame photometric method (Jackson, 1967). The physico-chemical properties of the field soil are depicted in Table1.

The sowing of crop in treatment T_1 was done on 31 October however treatment T_2, T_3 and T_4 was sown on November 1st, 4th and 10th, 2014, respectively but harvesting of all treatments was done on February 20, 2015. The recommended package and practices were followed properly for growing crop in the field condition. The five random points in each plot were selected for recording the plant population and plant population was recorded with the help of 1 square meter quadrate. The five plant in each plot were randomly selected and tagged for recording growth parameters and observations namely plant height, number of branches $plant^{-1}$, dry weight (g $plant^{-1}$) were recorded at 30, 60, 90 day after sowing (DAS) and harvest. However, plant population was studied at 25 DAS and at harvest. 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,

Table 1: Physico-chemical properties of the experimental soil

Particulars	Analysis Values	Group/Class
A. Physical properties		
Bulk density (g cm^{-3})(0-15 cm, soil depth)	1.48	Sandy loam*(Inceptisol)*
Particle density (g cm^{-3})	2.57	
Porosity %	41	
B. Chemical properties		
Organic carbon (%)	0.72	Medium
Available N (kg ha^{-1})	219.14	Low
Available P (kg ha^{-1})	16.70	Medium
Available K (kg ha^{-1})	322	Medium
pH (1: 2.5 soil : water)	6.6	Neutral
EC (dSm^{-1} 25ºC)	0.43	Normal

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
Plant population and Growth characters

The plant population was recorded at 25 DAS and at harvest and data are presented in Table 2. Significantly highest plant population (75 and 47.44 plants m^{-2} at 25 and at harvest, respectively) was recorded in T_2 (Minimum tillage and line sowing of seeds at 3rd DAH of rice), however, it was found *at par* with T_1 (Zero tillage direct drilling of seeds and at 2nd DAH of rice) at both the stage of crop growth. The highest plant stand under treatment T_2 followed by treatment T_1 might be due to sufficient availability of moisture and better placement of seeds. Present study is in agreement with the finding of Rathore *et al.* (1998). They reported that the minimum tillage, with or without straw, enhanced soil moisture conservation and moisture availability at initial stage which resulted in better plant stand.

Plant height (cm)

Plant height and number of branches $plant^{-1}$ was measured at 30, 60, 90 DAS and at harvest (Table 2). At 30 DAS, significantly tallest plant was recorded in T_2 (Minimum tillage and line sowing of seeds at 3rd DAH of rice). While, at rest of the stages, plant height and also number of branches $plant^{-1}$ in above mentioned treatment performed significantly superior over other but it was *at par* with T_1 (Zero tillage direct drilling of seeds at 2nd DAH of rice). Tallest plants and higher branches were recorded in T_2 (Minimum tillage and line sowing of seeds 3rd DAH of rice) in present investigation is similar to the reports of Rathore *et al.* (1998). They reported that the minimum tillage, with or without straw, enhanced soil moisture conservation and moisture availability during crop growth which resulted in inward plant height and branches.

Dry biomass of plant (g $plant^{-1}$)

Dry biomass $plant^{-1}$ was recorded at 30, 60, 90 DAS and at harvest (Table 3). Throughout the life span of crop, significantly higher dry biomass (0.30, 1.13, 2.34 and 2.79 g $plant^{-1}$ at 30, 60, 90 DAS and at harvest, respectively) was recorded under treatment T_2 in comparison to other treatments. However, it was found *at par* with T_1 at all the stages except at 60 DAS where, it was significantly highest in comparison to all treatments. However, lowest dry biomass was recorded under the treatment T_4. At all the stages the higher dry biomass might be owing

Table 2: Effect of tillage practices on plant population and plant height

Treatment	Plant population (No. m^2)		Plant height (cm)			
	25 DAS	At harvest	30 DAS	60 DAS	90 DAS	At harvest
T_1	71.7[a]	46.8[ab]	14.5[a]	90.9[a]	96.3[a]	98.6[a]
T_2	75.0[a]	47.4[a]	17.2[a]	93.0[a]	98.5[a]	99.4[a]
T_3	66.5[ab]	43.1[bc]	14.3[b]	81.3[b]	84.0[b]	85.4[b]
T_4	62.0[c]	41.3[c]	13.4[c]	78.5[c]	82.6[c]	83.2[b]

Table 3: Tillage practices influence of branches and dry biomass of Toria

Treatment	Branches $plant^{-1}$				Dry biomass $plant^{-1}$			
	30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS	At harvest
T_1	0.33[a]	1.07[a]	1.49[a]	1.49[a]	0.29[a]	1.07[a]	2.23[ab]	2.77[a]
T_2	0.36[a]	1.67[a]	1.60[a]	1.60[a]	0.30[a]	1.13[a]	2.34[a]	2.79[a]
T_3	0.27[b]	0.93[b]	0.95[b]	0.95[b]	0.20[b]	0.98[b]	2.07[b]	2.29[b]
T_4	0.20[c]	0.73[c]	0.91[b]	0.91[b]	0.18[b]	0.91[b]	1.77[c]	2.03[c]

to higher number of branches and higher plant growth as observed in treatment T_2 than treatment T_1.

Yield attributes and yield

The data on number of siliqua plant^{-1} and number of seeds siliqua $^{-1}$ and siliqua length (cm) are presented in Table 4. Significantly maximum number of siliqua plant^{-1} (28.4), number of seeds siliqua $^{-1}$ (10.0) and siliqua length (4.7 cm) was recorded in T_2 (Minimum tillage and line sowing of seeds at 3rd day after harvesting of rice). However, it was found *at par* with T_1 (Zero tillage and line sowing of seeds at 2nd DAH of rice). Treatment T_2 and T_1 performed better which might be due higher number of branches plant^{-1} recorded in this treatment. Similarly, higher number of seeds siliqua^{-1} in above treatment might be due to larger size of siliqua in these treatments. Test weight (g) did not differ significantly due to tillage practices.

Yield

The perusal of data given in Table 4 reveal that the significantly highest seed yield (4.3 q ha^{-1}) and stover yield (12.2 q ha^{-1}) was recorded under minimum tillage and line sowing of seeds at 3rd DAH of rice, which was statistically *at par* with zero tillage direct drilling of seeds at 2nd DAH of rice. However, the lowest seed yield (3.6 q ha^{-1}) and stover yield (9.7 q ha^{-1}) was obtained under farmer's practice - seeds and fertilizers broadcasting at 12th DAH of rice. The

higher number of branches and higher number of siliqua plant^{-1}, more number of seeds siliqua^{-1} and higher test weight recorded in T_2 resulted in to higher seed and stover yield. Similarly, the lowest yield under treatment T_4 might be due to poor plant stand as well as poor growth and yield characters. These observations are in agreement with the finding of Rathore *et al.* (1998). They reported that the Zero tillage was superior to the other tillage practices for mustard. Chiriac *et al.* (2013) also reported that the ranking of treatment was minimum tillage than conventional tillage than deep tillage in both years in term of mean yield. Similarly tillage by MB ploughing twice and rototilling twice increased the yield of toria significantly over farmer's practice Barua *et al.*, (2007). Different tillage practices did not significantly influence the harvest index (%).

Economics

Cost of cultivation, gross return, net return and B:C ratio varied among tillage practices and presented in Table 5.The highest cost of cultivation Rs. 12187 ha^{-1} was incurred for the treatment T_4 followed by T_2 and T_3. The significantly highest gross return (Rs. 13329 ha^{-1}) observed in treatment T_2 which were found statistically similar with treatment T_1. However, net return (Rs. 3908 ha^{-1}) and B:C ratio (1.42) was also highest in Treatment T_1. The higher net return and B:C ratio obtained in T_1 may be due

Table 4: Effect of tillage practices on yield attributtes and yield of toria

Treatment	No. of capsules plant^{-1}	No. of Seeds capsules^{-1}	Siliqua length (cm)	Test weight (g)	Seed yield (q ha^{-1})	Stover yield (q ha^{-1})	HI (%)
T_1	26.47[a]	9.53[a]	4.66[a]	4.02	4.24[a]	11.25[a]	22.42
T_2	28.35[a]	9.67[a]	4.70[a]	3.98	4.30[a]	12.18[a]	22.43
T_3	23.25[b]	8.71[b]	4.38[b]	3.96	3.78[b]	10.38[b]	22.41
T_4	20.48[b]	8.60[b]	4.23[b]	3.95	3.58[b]	9.69[b]	21.48

Table 5: Effect of tillage practices on economics

Treatment	Cost of cultivation (Rs ha^{-1})	Gross return (Rs ha^{-1})	Net return (Rs ha^{-1})	B:C ratio
T_1	9287	13145[a]	3908[a]	1.42[a]
T_2	10487	13329[a]	2842[b]	1.27[b]
T_3	10487	11718[b]	1230[c]	1.12[c]
T_4	12187	11098[b]	1089[d]	0.91[d]

to reduction of cost of tillage operations in conservation tillage practice. These results are in agreement with the findings of Ram *et al. (*2010) and Mishra and Singh (2012). They also reported the highest gross return, net return and B:C ratio in zero tillage compared to conventional and other tillage practices.

Conclusion

The result of the experiment showed that the conservation tillage system using minimum tillage and line sowing of seeds at 3rd DAH of rice and zero tillage gave better growth, higher yield and economics of toria than the other tillage practices under rainfed conditions. These results indicate that using the minimum tillage and line sowing of seeds at 3rd DAH of rice is the best tillage practice that should be applied to sowing toria in the rainfed midland condition after medium duration rice in Chhattisgarh. The traditional tillage system using the farmer's practice - seeds and fertilizers broadcasting at 12th DAH of rice and minimum tillage and line sowing of seeds at 6th DAH of rice under rainfed conditions, were not effective tillage practices for the semiarid region of Chhattisgarh.

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