International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2020; 8(2): 195-200

Received: 16-01-2020
Accepted: 18-02-2020

Hiremath KA
Associate Professor and Extension Leader, Agriculture Extension Education Centre, Nalwar, Karnataka, India

Halepyati AS
Department of Agronomy, University of Agricultural Sciences, Raichur, Karnataka, India

Bellakki MA
Department of Soil science, University of Agricultural Sciences, Raichur, Karnataka, India

Dodamani BM
Department of Agronomy, University of Agricultural Sciences, Raichur, Karnataka, India

Chittapur BM
Department of Agronomy, University of Agricultural Sciences, Raichur, Karnataka, India

Kuchanur PH
Department of Genetics and plant breeding, University of Agricultural Sciences, Raichur, Karnataka, India

Ameregouda
Department of Crop physiology, University of Agricultural Sciences, Raichur, Karnataka, India

Corresponding Author:
Hiremath KA
Associate Professor and Extension Leader, Agriculture Extension Education Centre, Nalwar, Karnataka, India

Influence of tillage and target yield approach on growth, yield and economics of maize – chickpea cropping system

Hiremath KA, Halepyati AS, Bellakki MA, Dodamani BM, Chittapur BM, Kuchanur PH and Ameregouda

DOI: https://doi.org/10.22271/chemi.2020.v8.i2c.8767

Abstract
A field experiment was conducted during *kharif* and *rabi* seasons of 2013-14 and 2014-15 at Agricultural Research Station, Bheemarayanagudi to study the influence of tillage and target yield approach on growth, yield and economics of maize – chickpea cropping system. The results indicated that the growth and yield parameters of maize and chickpea at harvest did not influence due to tillage practices. All these yield parameters were relatively higher in zero tillage with mulch @ 5 t ha^{-1} when compared to conventional tillage. Grain and stover yield of maize did not differ significantly due to different tillage management practices. But, zero tillage with mulch @ 5 t ha^{-1} produced relatively higher yield (65.9 q ha^{-1}) than the zero tillage (64.3 q ha^{-1}) followed by conventional tillage (55.8 q ha^{-1}). Further, due to nutrient management strategies, the growth and yield parameters of maize differed significantly. Target yield of 10 t ha^{-1} exhibited significantly higher growth and yield attributes at harvest when compared to other treatments except targeted yield of 8 t ha^{-1} and 150% RDF. The lowest values of these attributes were recorded in farmer's practice of nutrient management followed by RDF. The grain yield and stover yield (69.9 q ha^{-1}and 89.5 q ha^{-1}, respectively) of maize was significantly higher with targeted yield of 10 t ha^{-1} followed by targeted yield of 8 t ha^{-1} and 150% RDF. The lowest grain and stover yield (53.6 q ha^{-1} and 74.3 q ha^{-1}, respectively) was recorded in farmers practice followed by RDF. Non significant differences for grain and stover yield of maize was recorded due to interaction of tillage and target yield approach. The growth and yield and yield parameters of chickpea did not differ due to tillage practices and target yield approaches followed for maize. Maize equivalent yield of chickpea and system productivity were followed same trend as that of maize yield. Among different tillage practices, significantly higher gross returns (Rs.1,25,981 ha^{-1}) and net returns (Rs. 88,017 ha^{-1}) were recorded with zero tillage with mulch @ 5 t ha^{-1} followed by zero tillage. But, B:C ratio (2.33) in zero tillage was slightly higher than zero tillage with mulch @ 5 t ha^{-1} (2.32). Significantly lower gross return (Rs.1,10,391 ha^{-1}), net returns (Rs. 69,527 ha^{-1}) and B:C (1.70) ratio were recorded in conventional tillage. Significantly higher gross return (Rs.1,33,050 ha^{-1}), net returns (Rs. 92,570 ha^{-1}) and B:C ratio (2.30) were recorded in target yield of 10 t ha^{-1} and was followed by target yield of 8 t ha^{-1}. The lowest gross returns (Rs.1,05,762 ha^{-1}) and net returns (Rs. 71,018 ha^{-1}) were obtained with farmers' practice' followed by RDF. Significantly lowest B:C ratio was recorded with RDF (1.88) followed 150% RDF (1.95) and found to be on par with farmers' practice (2.07).

Keywords: Tillage, crop residue, mulch, target yield, maize equivalent yield, system productivity

Introduction
In present scenario of agriculture in the world as well as in the country, the rising cost of cultivation and in availability of inputs in agriculture are now redefining the farming practices and hence increased attention is paid towards the deployment of conservation agriculture practices. Conservation agriculture maintains permanent and semi permanent soil cover with residues to conserve, improve and make more efficient use of natural resources such as soil, water and biological resources. The productivity of cropping system is a function of soil type, climate, tillage practices and nutrient availability which are dynamic and highly variable. To achieve the higher productivity nutrient management holds the key role. Optimum use of existing resources like residues on surface and application of FYM and timely applications of soil test based optimum rates of nutrients etc, are pivotal in achieving food security. There are many options to achieve efficient utilization of resources by following the practices of green

manuring, brown manuring, conservation agriculture, crop nutrition through target yield approach etc. The application of inorganic fertilizers even in balanced form may not sustain soil fertility and productivity under continuous cropping. Zero tillage with crop residues management is capable of increasing the soil health and quality by improving soil properties, minimizing soil erosion, soil water evaporation and conserving soil moisture which has been well documented. Hence, reduced tillage practices have been widely used in the last decade as an attractive alternative over conventional tillage practice because of their potential to reduce production or operating costs and benefit for the environment and can save considerable time with seed bed preparation compared with conventional tillage practices.

Site specific nutrient management (SSNM) is one tool employed to apply nutrients at right rate, right source, right time with right method based on the soil test value for getting higher yields and to save nutrients. Among the several technologies for nutrient management, the site specific nutrient management is seen as one of the main objectives in present scenario of agriculture. It is one of the techniques most relevant to Indian Farming community. Due to the importance of plant nutrition and its influence on crop yield and quality, it is expected that SSNM would improve the economic and environmental outcome of crop production. It is an approach for need based feeding of the crops with nutrients (Dhillon *et al*. 2006) [4]. The approach further aims at increasing farmers profit by achieving the goal of maximum crop yields. Further under irrigated condition, there is an opportunity to take two crops in a year following maize-wheat and maize-chickpea cropping systems in order to get efficient utilization of existing available resources. Such kind of cropping system needs full season nutrient requirement through nutrient supply system on sustainable manner. There are many options that are available to fulfill the requirement of nutrients regularly in cropping system while keeping the productivity of land sustainable.

Therefore, an investigation was undertaken to know the effect of tillage and target yield approach on growth, yield and yield attributes and economics of maize – chick pea cropping system.

Material and methods

The present study was carried out with maize – chick pea cropping system during *kharif* and *rabi* seasons of 2013-14 and 2014-15 at Agricultural Research Station, Bheemarayanagudi, University of Agricultural Sciences, Raichur, Karnataka. The nutrient management through targeted yield approach under varying tillage and residue management practices was followed for maize during *kharif* and its residual effect was tested on succeeding chickpea during *rabi* season. The soil of the experimental site was medium deep black soil with 7.90 pH. The soil was low in available nitrogen (207 kg ha^{-1}), high in available phosphorus (52.3 kg ha^{-1}) and high in available potassium (344 kg ha^{-1}). The organic carbon content of the soil was low (0.49%). The Agricultural Research Station represents the UKP command where in rice - rice, chilli and cotton are the predominant crops. The rainfall during cropping seasons in the year 2013 - 14 and 2014 - 15 received 759 mm and 646 mm respectively. The experiment was laid out in split plot design consists of three main plots *viz.*, conventional tillage, zero tillage and zero tillage with mulch @ 5 t ha^{-1} and six sub plots *viz.*, target yield (6 t ha^{-1}), target yield (8 t ha^{-1}), target yield (10 t ha^{-1}), RDF, 150% RDF and farmers practice in three replications. The hybrid 900M was used for maize and the variety JG 11 was used for chickpea. The fertilizers were applied as per treatments for maize. For chickpea, the fertilizers were applied as per the recommendation. Pre emergent herbicide pendimethalin 30 EC @ 2.5 kg ha^{-1} was used to control weeds in initial stage in maize as well as in chickpea. Post emergent herbicide 2, 4 - D 80% @ 1.25 kg ha^{-1} was used for suppressing the weed growth in maize at 25 DAS. Other agronomic practices were followed commonly in all the treatments as per the recommendations.

Results and Discussion

Effect of crop residue and tillage management practices on growth and yield of maize

The data revealed that the grain yield and stover yield of maize did not differ due to different tillage practice. However the numerically higher grain yield (65.9 q ha^{-1}) and stover yield of maize (88.3 q ha^{-1}) were noticed with zero tillage with mulch @ 5 t ha^{-1} followed by zero tillage (64.3 q ha^{-1} and 84.2 q ha^{-1}respectively). Numerically the lowest grain yield and stover yield were recorded in conventional tillage (55.8 q ha^{-1} and 76.2 q ha^{-1}respectively). The higher value of grain yield could be attributed to relatively higher cob length (14.92 cm), cob girth (12.87 cm), number of grains per cob(426.71), grain weight per plant (184.91 g) and test weight (24.58 g). The lowest cob length (12.71 cm), cob girth (10.99 cm), grain weight per plant (169.88 g) and test weight (22.70 g) were recorded in conventional tillage. These results are in accordance with those obtained by Prashanth and Patil (2013), Singh *et al*. (2013), Bahar (2013) and Yaseen *et al*. (2014) [9, 13, 2, 14]. The differences in yield parameters due to different tillage practices can be attributed to plant height, leaf area, leaf area index and total dry matter production. However, zero tillage with mulch @ 5 t ha^{-1} recorded relatively higher total dry matter production (379.72 g plant^{-1}), leaf area, leaf area index and plant height compared to conventional tillage and zero tillage Further, the same treatment recorded higher dry matter production closely followed by zero tillage (335.49 g plant^{-1}) when compared to conventional tillage which recorded lower dry matter production (319.86 g plant^{-1}). The increase in plant height, leaf area and leaf area index could be due to profuse growth of plants enhanced by balanced application of nutrients. The increase in the plant height might be due to luxuriant growth and development of the crop which resulted from favourable conditions created by zero tillage or/with mulch. Further this treatment was found to be better in recording higher stover yield and harvest index.

Effect of nutrient management practices (target yield approach) on growth and yield of maize

In the present study, the effect of nutrient application through targeted yield approach exerted significant influence on the grain yield of maize. The highest grain yield of maize was obtained with target yield of 10 t ha^{-1} (69.90 q ha^{-1}) followed by target yield of 8 t ha^{-1} (65.8 q ha^{-1}) and by 150% RDF (64.0 q ha^{-1}). The significantly lower grain yield was observed in farmers' practice (53.6 q ha^{-1}) followed by RDF (56.2 q ha^{-1}). Significantly higher stover yield was recorded in target yield of 10 t ha^{-1} (89.5 q ha^{-1}) followed target yield of 8 t ha^{-1} (86.7 q ha^{-1}) and 150% RDF (85.7 q ha^{-1}). The lower stover yield was recorded in farmers' practice (74.3 qha^{-1}) followed by RDF (78.3 q ha^{-1}). The increase in grain yield of maize in target yield of 10 t ha^{-1} and target yield of 8 t ha^{-1} was 30.41 and 22.76 per cent respectively over farmers' practice and 24.38 and 17.1 per cent respectively over RDF. Higher grain yield of maize could be attributed due to higher cob length, cob girth, number of grains per plant (462.30), grain weight per plant (188.77 g) and test weight (25.14 g) due to balanced supply of nutrients which enhanced luxuriant growth and development of crop. These results corroborated with the findings of Paramasivan *et al* (2012) [10] and Ashok Biradar and Jayadeva (2013) [1]. Markedly lesser cob length, cob girth, number of grains per plant (313.26), grain weight per plant (163.80 g) and test weight (21.76 g) were recorded in farmers' practice followed by RDF. This could be attributed to less quantity of total nutrients supplied under these treatments resulting in the reduction of growth and yield parameters. The differences in yield parameters due to different target yield approach can be attributed to plant height, leaf area, leaf area index and dry matter production. In the present study, significantly higher plant height, leaf area, leaf area index and total dry matter production were recorded with target yield of 10 t ha^{-1} followed by target yield of 8 t ha^{-1}. Significantly lower plant height, leaf area, leaf area index and total dry matter production were recorded in farmers' practice followed by RDF. The higher values of these parameters could be attributed to luxuriant growth of the crop.

Non-significant differences for grain and straw yields of maize were noticed due to interaction of tillage and nutrient management through target yield approaches.

Effect of crop residue, tillage practices and target yield approach on succeeding chickpea

In the present study, with respect to tillage practices, the pooled data indicated that the seed and haulm yield of chickpea did not differ due to tillage practices. However, grain and haulm yields of chickpea were relatively higher due to zero tillage with mulch @ 5 t ha^{-1} (11.79 q ha^{-1} and 15.21 q ha^{-1}, respectively) compared to zero tillage (11.40 q ha^{-1} and 15.04 q ha^{-}1, respectively) and conventional tillage (11.08 q ha^{-1} and 14.91 q ha^{-1}, respectively). Zero tillage with mulch @5 t ha^{-1} increased the seed yield by 2.03 and 6.40 per cent than zero and conventional tillage. The increase in seed yield could be attributed to relatively higher yield components such as number of branches, number of pods per plant, pod weight, seed weight and 100 grain weight. Several workers suggested higher productivity of crops due to residual effect of nutrients on succeeding crops. Bhattacharyya *et al.* (2008) [3], Gangawar *et al.* (2004) [5] and Jat *et al*. (2010) [7]. Number of branches, number of pods per plant, pod weight, seed weight and 100 grain weight did not differ due to target yield approach for preceding maize. However, numerically slight differences among the treatments were observed. Zero tillage with mulch @ 5 t ha^{-1} recorded relatively higher values of these parameters compared to zero tillage and farmers' practice. Higher number of pods per plant might be attributed to higher number of branches per plant. The higher value of seed and 100 grain weight might be attributed to higher dry matter production due to accumulation of more photosynthates.

The differences in yield attributes can also be related to differences in growth components namely, plant height, number of branches and dry matter production at harvest. The dry matter production per plant of chickpea at harvest did not differ due to target yield approach for preceding maize. However, zero tillage with mulch @ 5 t ha^{-1} had relatively higher dry matter production compared to conventional tillage. The increase in the dry matter production might be due to increase in plant and number of branches per plant. The plant height and number of branches per plant did not differ significantly due to tillage practices. However, numerically higher plant height and number of branches per plant was associated with zero tillage with mulch @ 5 t ha^{-1} as compared to other treatments. As a result of increased plant height and number of branches per plant, relatively higher haulm yield and harvest index produced. Similar findings were reported by Bhattacharyya *et al*. (2008) [3], Gangawar *et al.* (2004) [5] and Jat *et al*. (2010) [7].

Nutrient management through target yield approach for maize did not influence grain yield of chickpea grown as succeeding crop. However, the seed yield of chickpea was numerically higher (12.34 q ha^{-1}) with the plot received target yield of maize @ 10 t ha^{-1} compared to other treatments. The lower grain yield was recorded in farmers' practice (10.57 q ha^{-1}) followed by RDF (11.04 q ha^{-1}). The seed yield was increased by 16.70 and 11.77 per cent over farmers' practice of nutrient management and RDF respectively. The increase in seed yield could be attributed to higher value of yield contributing parameters namely number of pods per plant, pod weight per plant, seed weight per plant and 100 grain weight.

The seed and 100 grain weight are the most important yield parameters to assess the grain yield of any crop. The seed and 100 grain weight did not differ due to target yield approaches. However, the treatment which received target yield of 10 t ha^{-1} for maize was recorded relatively higher seed weight per plant compared to the treatment which received farmers' practice of nutrient management and RDF. The higher seed and test weight might be attributed to higher number of pods per plant and accumulation of photosynthesis to higher leaf area which helped to sink more assimilates in seed resulting into bolder seeds. Results are in agreement with findings of Gangawar *et al*. (2004) [5], Bhattacharyya *et al*. (2008) [3], Jat *et al*. (2010) [7], Sepat and Rai (2013) [11] and Sharma and Jain (2014) [12].

Number of pods per plant is another important parameter to assess the yield of crop. The target yield approach did influence on number of pods per plant. However, the plot which received target yield of 10 t ha^{-1} for maize recorded numerically higher values towards pod numbers as compared to farmers' practice and RDF. The higher number of pods could be attributed to more photosynthesis which resulted into higher dry matter production to sink. The seed weight per plant might be attributed to higher number of pods and test weight which might be attributed to bold seeds due to accumulation of higher photosynthesis due to residual effect of nutrients supplied. Results are in agreement with findings of Gangawar *et al*. (2004) [5], Bhattacharyya *et al*. (2008) [3], Jat *et al*. (2010) [7] and Sharma and Jain (2014) [12].

The differences in yield contributing attributes of chickpea due to target yield approach followed for maize could be related to plant height, leaf area, leaf area index and dry matter production. The plant height, leaf area, leaf area index and drymatter production did not differ significantly due to target yield approach used for preceeding maize. However, higher value of these growth parameters was registered in the plot which received target yield of 10 t ha^{-1} compared to other treatments. The increase in these growth parameters might be attributed to luxuriant growth and development of crop due to supply of higher nutrients under residual effect of nutrients applied for target yield in preceeding maize. Thus, the same treatment produced relatively higher haulm yield and harvest index. Results are in line with findings of Gangawar *et al*. (2004) [5], Bhattacharyya *et al*. (2008) [3], Jat *et al*. (2010) [7], Sepat and Rai (2013) [11] and Sharma and Jain (2014) [12].

Interaction effect due to tillage and target yield approach did not have influence on succeeding chickpea crop

Economics of tillage and nutrient management practices in maize – chickpea cropping system

Maize equivalent yield

With respect to maize equivalent yield of maize - chickpea cropping system, the different tillage practices did not influence the maize equivalent yield. However, higher maize equivalent yield (29.77 q ha^{-1}) was recorded with zero tillage with mulch @ 5 t ha^{-1}. The lower maize equivalent yield (28.00 q ha^{-1}) was noticed with conventional tillage. The different target yield approaches did not differ. However, target yield of 10 t ha^{-1} recorded numerically higher maize equivalent yield (31.16 q ha^{-1}). The lowest maize equivalent yield (26.68 q ha^{-1}) was recorded in conventional tillage followed by RDF which recorded maize equivalent yield of 27.89 q ha^{-1}. The interaction effect due to tillage practices as well as target yield approaches did not differ.

System productivity

With respect to system productivity of maize - chickpea cropping system, the different tillage practices influenced the system productivity. Significantly higher system productivity (95.66 q ha^{-1}) was recorded with zero tillage with mulch @ 5 t ha^{-1}. Significantly the lowest system productivity (83.82 q ha^{-1}) was noticed with conventional tillage. Similar findings were reported by many research workers which conclusively proved that zero tillage with or without mulch is more productive under cropping systems (Gupta and Seth, 2007; Najafinezhad *et al*., 2007 and Bhattacharyya *et al*., 2008) [6, 8, 3]. The different target yield approaches differed significantly. However, target yield of 10 t ha^{-1} recorded significantly higher system productivity (101.02 q ha^{-1}). The lowest system productivity (80.31 q ha^{-1}) was recorded in conventional tillage followed by RDF which recorded system productivity of 84.06 q ha^{-1}. The interaction effect due to tillage practices as well as target yield approaches did not differ.

Economics of maize - chickpea

With respect to economics of maize - chickpea cropping sequence under tillage and target yield approaches, gross returns, net returns and B:C were affected due to tillage practices. Significantly higher gross returns (Rs.1,25,981 ha^{-1}) and net returns (Rs. 88,017 ha^{-1}) were recorded with zero tillage with mulch @ 5 t ha^{-1} followed by zero tillage. But, B:C ratio (2.33) in zero tillage was slightly higher than zero tillage with mulch @ 5 t ha^{-1} (2.32). The slightly higher B:C ratio might be due to cost of mulching. Significantly lower gross return (Rs.1,10,391 ha^{-1}), net returns (Rs. 69,527 ha^{-1}) and B:C (1.70) ratio were recorded in conventional tillage.

The gross returns, net returns and B:C ratio differed significantly due to target yield approach. Significantly higher gross return (Rs.1,33,050 ha^{-1}), net returns (Rs. 92,570 ha^{-1}) and B:C ratio (2.30) were recorded in target yield of 10 t ha^{-1} and was followed by target yield of 8 t ha^{-1}. The lowest gross returns (Rs.1,05,762 ha^{-1}) and net returns (Rs. 71,018 ha^{-1}) were obtained with farmers' practice' followed by RDF. Significantly lowest B:C ratio was recorded with RDF (1.88) followed 150% RDF (1.95) and found to be on par with farmers' practice (2.07). The lowest B:C ratio could be attributed to cost of fertilizers in consequence with their yields.

Table 1: Growth parameters of maize and chickpea at harvest as influenced by different tillage practices and target yield approaches in maize - chickpea cropping system (Mean of two years)

Treatment	Maize				Chickpea		
	Plant height (cm)	Leaf area (dm^2)	LAI	Total dry matter production (g $plant^{-1}$)	Plant height (cm)	Number of branches per plant	Total dry matter production (g $plant^{-1}$)
Main plots (M)							
M_1 - Conventional tillage	176.40	40.89	2.27	319.86	35.99	4.98	14.95
M_2 - Zero tillage	191.10	44.09	2.45	335.49	37.09	5.39	15.64
M_3 - Zero tillage with mulch @ 5 t / ha	195.60	48.99	2.72	379.72	39.76	5.78	16.41
S. Em ±	6.86	3.01	0.17	21.40	1.83	0.39	1.21
C.D. (0.05)	NS	NS	NS	NS	NS	NS	NS
Sub plots (S)							
S_1 - Targeted yield (6 t / ha)	187.10	44.17	2.45	331.47	37.99	5.36	15.36
S_2 - Targeted yield (8 t / ha)	193.60	47.64	2.65	374.33	40.48	5.68	16.24
S_3 - Targeted yield (10 t / ha)	197.40	50.23	2.79	398.94	42.64	5.88	16.96
S_4 - RDF	183.80	42.21	2.35	317.60	35.04	5.07	14.89
S_5 - 150% RDF	189.50	46.26	2.57	352.98	39.16	5.51	15.98
S_6 - Farmer's practice	174.90	37.41	2.08	294.83	32.04	4.80	14.57
S. Em±	4.36	2.53	0.14	17.89	1.83	0.23	1.06
C.D. (0.05)	12.66	7.35	0.40	51.91	3.67	NS	NS
Interaction (M x S)							
S. Em±	9.50	5.01	0.28	31.22	2.71	0.53	2.07
C.D. (0.05)	NS	NS	NS	NS	NS	NS	NS

Table 2: Yield parameters of maize and chickpea at harvest as influenced by different tillage practices and target yield approaches in maize - chickpea cropping system (Mean of two years)

Treatment	Maize					Chickpea			
	Cob length (cm)	Cob girth (cm)	Number of grains per cob	Grain weight (g plant^{-1})	Test weight (g)	Number of pods (Plant^{-1})	Pod weight (g plant^{-1})	Seed weight (g plant^{-1})	100 grain weight (g)
Main plots (M)									
M_1 - Conventional tillage	12.71	10.99	348.44	169.88	22.70	17.75	7.27	6.87	21.66
M_2 - Zero tillage	14.32	12.51	406.15	179.70	23.89	19.42	8.14	7.84	22.47
M_3 - Zero tillage with mulch @ 5 t / ha	14.92	12.87	426.71	184.91	24.58	20.81	8.49	8.24	23.64
S. Em ±	0.76	0.67	27.90	5.30	0.67	1.67	0.47	0.23	1.24
C.D. (0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS
Sub plots (S)									
S_1 - Targeted yield (6 t / ha)	14.09	12.08	402.19	178.49	23.75	19.04	7.95	7.57	21.56
S_2 - Targeted yield (8 t / ha)	15.04	13.22	431.80	186.20	24.83	20.25	8.29	8.01	23.44
S_3 - Targeted yield (10 t / ha)	15.65	13.91	462.30	188.77	25.14	20.82	8.67	8.27	24.79
S_4 - RDF	12.57	10.60	333.73	169.82	22.58	18.32	7.60	7.27	21.72
S_5 - 150% RDF	14.47	12.79	419.33	181.87	24.29	19.54	8.09	7.85	22.57
S_6 - Farmer's practice	12.07	10.15	313.26	163.80	21.76	17.99	7.19	6.92	21.45
S. Em±	0.70	0.70	29.19	5.44	0.72	1.19	0.55	0.37	1.32
C.D. (0.05)	2.06	2.03	84.71	15.78	2.08	NS	NS	NS	NS
Interaction (M x S)									
S. Em±	1.23	1.23	51.55	9.52	1.26	2.52	0.10	0.55	2.43
C.D. (0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS

NS – Non significant

Table 3: Grain yield, stover yield and harvest index of maize and grain yield, haulm yield and harvest index of chickpea as influenced by different tillage practices and target yield approaches in maize - chickpea cropping system (Mean of two years)

Treatment	Maize			Chickpea			Maize equivalent yield of chickpea (q ha^{-1})	System productivity (q ha^{-1})
	Grain yield of maize (q ha^{-1})	Straw yield (q ha^{-1})	Harvest Index	Seed yield (q ha^{-1})	Haulm yield (q ha^{-1})	Harvest Index		
Main plots (M)								
M_1 - Conventional tillage	55.8	76.5	0.42	11.08	14.91	0.43	28.00	83.82
M_2 - Zero tillage	64.3	84.2	0.43	11.40	15.04	0.43	28.79	93.12
M_3 - Zero tillage with mulch @ 5 t / ha	65.9	88.3	0.43	11.79	15.21	0.43	29.77	95.66
S. Em ±	3.60	4.21	0.01	0.55	0.28	0.01	0.49	1.33
C.D. (0.05)	NS	NS	NS	NS	NS	NS	NS	5.36
Sub plots (S)								
S_1 - Targeted yield (6 t / ha)	62.7	83.5	0.43	11.29	14.97	0.43	28.52	91.19
S_2 - Targeted yield (8 t / ha)	65.8	86.7	0.43	11.71	15.28	0.43	29.58	95.37
S_3 - Targeted yield (10 t / ha)	69.9	89.5	0.44	12.34	15.48	0.44	31.16	101.02
S_4 - RDF	56.2	78.3	0.42	11.04	14.79	0.42	27.89	84.06
S_5 - 150% RDF	64.0	85.7	0.43	11.59	15.09	0.43	29.29	93.26
S_6 - Farmer's practice	53.6	74.3	0.42	10.57	14.68	0.41	26.68	80.31
S. Em±	3.1	2.9	0.005	0.42	0.26	0.01	1.11	2.79
C.D. (0.05)	9.1	9.0	0.016	NS	NS	NS	NS	8.10
Interaction (M x S)								
S. Em±	5.6	5.5	0.01	0.82	0.50	0.02	1.20	3.26
C.D. (0.05)	NS	NS	NS	NS	NS	NS	NS	NS

NS – Non significant

Table 4: Economics of maize - chickpea cropping system as influenced by different tillage and target yield approaches in maize - chick pea cropping system

Treatment	Cost of cultivation of maize – chickpea system (Rs. ha^{-1})			Gross returns (Rs. ha^{-1})			Net returns (Rs ha^{-1})			B C ratio		
	2013	2014	Pooled	2013	2014	Pooled	2013	2014	Pooled	2013	2014	Pooled
Main plots (M)												
M_1	40278	41450	40864	117993	102789	110391	77715	61339	69527	1.92	1.47	1.70
M_2	36778	36950	36864	130306	114981	122643	93528	78031	85779	2.55	2.12	2.33
M_3	37778	38150	37964	134158	117804	125981	96381	79654	88017	2.56	2.09	2.32
S. Em ±	-	-	-	2808	1441	1747	2808	1441	1747	0.08	0.04	0.05
C.D. (0.05)	-	-	-	11320	5809	7042	11320	5809	7042	0.31	0.15	0.21
Sub plots (S)												
S_1	37044	37644	37344	127571	112617	120094	90527	74973	82750	2.45	2.00	2.23
S_2	38136	38698	38417	133583	117627	125605	95447	78929	87188	2.51	2.05	2.28
S_3	40092	40867	40480	141150	124949	133050	101058	84082	92570	2.53	2.07	2.30

S_4	38438	38816	38627	118353	103053	110703	79915	64237	72076	2.09	1.67	1.88
S_5	41388	42154	41771	130970	114663	122816	89582	72509	81045	2.17	1.73	1.95
S_6	34568	34921	34745	113286	98239	105762	78718	63318	71018	2.30	1.84	2.07
S. Em±	-	-	-	3909	5170	3679	3909	5170	3679	0.10	0.14	0.10
C.D. (0.05)	-	-	-	11346	15006	10679	11346	NS	10678	0.30	NS	0.28
Interaction (M x S)												
S. Em±	-	-	-	6,789	3,529	4,277	6,790	3,529	4,279	0.18	0.22	0.12
C.D. (0.05)	-	-	-	NS	NS	NS	NS	NS	NS	NS	NS	NS

Rate: Maize – Rs 1325/ q (2013-14) and Rs. 1310/q (2014-15), Chickpea – Rs.3500/q (2013-14) and Rs. 3200/q (2014-15), NS – Non significant
Main plots: M_1 - Conventional tillage, M_2 - Zero tillage, M_3 - Zero tillage with mulch @ 5 t / ha
Sub plots: S_1 - Targeted yield (6 t / ha), S_2 - Targeted yield (8 t / ha), S_3 - Targeted yield (10 t / ha), S_4 - RDF, S_5 - 150% RDF, S_6 - Farmer's practice

Conclusion

Based on the data obtained during the investigation in maize – chickpea cropping system, it could be inferred that zero tillage with mulch @ 5 t ha^{-1} followed by zero tillage alone produced relatively higher yields compare to conventional tillage. Further, target yield of 10 t ha^{-1} followed by target yield of 8 t ha^{-1} exhibited significantly higher yield. Thus, application of nutrients through targeted yield approach is more useful and profitable since benefit cost ratio is higher compared to application of farmers practice and 100 per cent RDF + FYM @ 10 t ha^{-1}. Application of nutrients through targeted yield approach in combination with organic source is more useful sustaining the productivity of cropping system.

Acknowledgement

The senior author is thankful to University of Agricultural Sciences, Raichur for providing an opportunity to study the higher education on deputation.

Reference

1. Ashok Biradar, Jayadeva HM. Influence of target yield approach on yield, yield attributes, nutrient uptake and economics of maize. Madras Agric. J. 2013; 100(1-2):146-149.
2. Bahar FA. Relative performance of resource conservation technologies in maize based cropping system under temperate Kashmir. Trends Bio sci. 2013; 6(1):43-45.
3. Bhattacharyya R, Kundu S, Pandey SC, Singh KP, Gupta HS. Tillage and irrigation effects on crop yields and soil properties under the rice–wheat system in the Indian Himalayas. Agric. Water Management. 2008; 95:993-1002.
4. Dhillon NS, Brar BS, Benipal DS, Mavi MS. Economics of various soil test based fertilization approaches for different crops. Crop Res. 2006; 32(3):377-381.
5. Gangawar KS, Sharma SK, Tomar OK. Alley cropping of subabul (*Leucaena leucocephala* L.) for sustaining higher crop productivity and soil fertility of rice (*Oryza sativa* L.) – wheat (*Triticum aestivum* L.) system in semi arid conditions. Indian J. Agron. 2004; 49(2):84-88.
6. Gupta R, Seth A. A review of resource conserving technologies for sustainable management of the rice–wheat cropping systems of the Indo-Gangetic plains (IGP). Crop Prot. 2007; 26:436-447.
7. Jat NK, Ashok Kumar, Shivadhar. Influence of *Sesbania* green manure with or without wheat residues and N fertilization on maize (*Zea mays* L.) – wheat (*Triticum aestivum* L.) cropping system. Indian Journal of Agronomy. 2010; 55(4):253-258.
8. Najafinezhad H, Ali Javaheri M, Gheibi M, Ali Rostami M. Influence of tillage practices on the grain yield of maize and some soil properties in maize – wheat cropping system. Iran J Agri. Sci. 2007; 3:87-90.
9. Prashanth, Patil. Nutrient management as influenced by tillage and crop residue management in maize (*Zea mayz* L.). M. Sc. (Agri.) Thesis, University of Agricultural Sciences, Raichur, 2013.
10. Paramasivan M, Malarvizhi P, Thiyageswari. Balanced use of inorganic fertilizer on ?55r4tr3maize (*Zea mays* L.) yield, nutrient uptake and soil fertility in Alfisols. Karnataka J. Agric. Sci. 2012; 25(4):423-426.
11. Sepat S, Rai RK. Effect of phosphorus levels and sources on productivity, nutrient uptake and soil fertility of maize (*Zea mays*)-wheat (*Triticum aestivum*) cropping system. Indian J. Agron. 2013; 58(3):292-297.
12. Sharma SK, Jain NK. Nutrient management in wheat (*Triticum aestivum* L.)-based cropping systems in sub-humid southern zone of Rajasthan. Indian J Agron. 2014; 59(1):26-33.
13. Singh YP, Singh D, Tomar SS, Gupta RK. Effect of time of pre-irrigation and tillage practices on wheat under pigeonpea - wheat cropping sequence. Indian J Agric. Sci. 2013; 83(12):1317-1321.
14. Yaseen R, Shafi J, Ahmad W, Rana MS, Salim M, Quisrani A. Effect of deficit irrigation and mulch on soil physical properties, growth and yield of maize. Environment Ecol. Res. 2014; 2(3):122-137.