Biological Forum – An International Journal **14(1): 554-559(2022)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Yield and Nutrient Uptake Influenced by Conservation Agriculture Practices in Rice-Winter Maize Cropping System

B.L. Dudwal[1*], T.K. Das[2] and A.R. Sharma[3]
[1]Department of Agronomy, S.K.N. Agriculture University, Jobner, (Rajasthan), India.
[2]Indian Agricultural Research Institute, (New Delhi), India.
[3]Rani Lakshmi Bai Central Agricultural University, Jhansi, (Uttar Pradesh), India.

(Corresponding author: B.L. Dudwal)*
(Received 18 October 2021, Accepted 23 December, 2021)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: The studies were undertaken at the research farm of Indian Agricultural Research Institute, New Delhi in *kharif* and *rabi* season on a fixed site to assess the effect of conservation agriculture practices on yields and nurient uptake by crops in rice (*Oryza sativa* L.) – winter maize (*Zea mays* L.) cropping system. Direct seeding under unpuddled condition, transplanting under puddled condition, brown manuring and mungbean residue incorporation before sowing of direct-seeded rice were practiced in rice, while zero-till sowing, conventional till sowing and rice residue application with zero-till maize were tested in maize crop. During first year nutrient uptake under transplanted rice (TPR) was significantly higher than the rest of the treatments. In second year, rice grown after maize and the treatments where rice residue was applied in previous season maize crop and mungbean residue incorporation showed comparable N, P and K uptake with the TPR treatments. The highest values for N, P and K uptake were recorded under TPR grown after zero-tilled maize followed by the rice sown after conventional till maize and treatment in which rice and mungbean residue incorporation was done. In winter maize the uptake of nutrients were not much influenced in first year but in second year, significantly higher nutrient uptake recorded in conventional till winter maize followed by treatment where rice residue was applied with zero-till winter maize and mungbean residue was incorporated in previous direct seeded crop showed higher N, P and K uptake than the rest of the treatments. In first year of study TPR produced significantly higher yield (5.37 t ha^{-1}) while in second year mungbean residue application with direct seeded rice also produced comparable yield (5.04 t ha^{-1}). In first year, conventional tilled maize produced significantly highest yield and other treatments remained at par but in second year MBR+DSR-ZTM+RR-MB produced significantly at par yield (3.62 tha^{-1}) than the conventional tilled maize (3.83 tha^{-1}) and lowest yield (3.36 t ha^{-1}) was recorded under zero till winter maize (DSR-ZTM), which was grown after direct seeded rice.

Keywords: Direct-seeded rice, Winter maize Nutrient uptake, Brown manuring, Zero-tillage, Productivity.

INTRODUCTION

Rice (*Oryza sativa* L.) and maize (*Zea mays* L.) are major cereals contributing to food security and income in South Asia. These crops are grown either as a monoculture or in rotations in tropical and sub-tropical environments of South Asia. In the irrigated and favorable rainfed lowland areas, rice-rice (R-R) and rice-wheat (R-W) and rice-maize (R-M) are the predominant cropping systems (Timsina *et al.,* 2011). Similarly, rice and maize in rotation are grown on 3.5 M ha in Asia, of which, 1.5 M ha is in South Asia. These crops are grown in sequence either in double or triple-crop systems to meet the food demand of a rapidly expanding human population, and feed demand of livestock and poultry (Timsina *et al.*, 2011). Despite the endowment of good soil, highest percentage of land under cultivation, and ample sunshine and vast human resources in the Indo-Gangetic plains, the crop productivity is low (Jain *et al.,* 2011). Among the various factors responsible for low productivity, availability of water is regarded as the most limiting factor because crops are very much sensitive to soil moisture stress, particularly at their critical growth stages. Strategies to minimize crop water stress include irrigation and conservation of soil moisture by increased infiltration, reduced evaporation and optimum use of available soil water (Ali *et al.*, 2012). Mulching in this regard seems vital option to increase the water holding capacity. Besides irrigation, tillage is one of the basic inputs of crop production that alters the rhizosphere environment by modifying most of the physical properties of the soil (Guzha, 2004). However, the extent of the impact of tillage is variable depending upon the inherent soil characteristics and climatic conditions. The efficiency of input use, *viz.* water, fertilizer and others depends on tillage and crop establishment practices. It is, therefore, essential that soil environment be manipulated suitably for ensuring a good crop stand and improving resource-use efficiency. Resource degradation problems are manifesting in several ways in the present-day agriculture (Ibragimov *et al.,* 2011). Conservation agriculture systems are adopted globally on about 120 M ha areas (Derpsch and Friedrich, 2009). In India, these systems have been adopted on a limited scale in the irrigated rice-wheat areas of north-western plain zone. It is estimated that about 3.0 M ha of wheat is cultivated adopting zero-till seed drills (Gupta *et al.,* 2003). The area under rice-winter maize cropping system is static and the productivity and sustainability of the system are threatened because of the inefficiency of current production practices, shortage of resources, such as water and labour, fuel and socio-economic changes (Malhi *et al.,* 2011). Rice–maize is an emerging cropping system in many parts of India but its potential is yet to be assessed in north-western plain zone and there is lack of information on resource-conserving techniques, such as direct-seeding of rice, brown manuring with *Sesbania aculeata*, zero-till sowing of maize as well as effect of residue management on productivity, nutrient uptake by crops and soil health. Comparative evaluation of direct-seeded and transplanted rice and the performance of following crop of maize under conventional and zero tillage conditions require a thorough investigation.

MATERIALS AND METHODS

The field experiments were conducted on a fixed site during rainy season (June to October) and winter season (November to April) of 2010-11 and 2011-12 at the research farm of Indian Agricultural Research Institute, New Delhi (28.4°N latitude, 77.1°E longitude and 228.6 m above mean sea level). The mean annual rainfall of Delhi is 672 mm and more than 80% generally occurs during the monsoon season (July-September) with mean annual evaporation 850 mm. The soil at site was sandy clay loam with bulk density of 1.48 Mg/m^3 and field capacity of 25.4 % (w/w). It had 0.54 % organic carbon, 170.6 kg $KMnO_4$ oxidizable N/ha, 18.6 kg 0.5 N $NaHCO_3$ extractable P/ha, 275 kg 1.0 N NH_4OAc exchangeable K/ha, 8.0 pH and 0.36 dS/m EC in the top 15 cm of soil. The experimental treatments comprised *viz.* direct-deeded rice – zerotill maize (DSR-ZTM), direct seeded rice – zerotill maize + rice residue (DSR-ZTM+RR), direct seeded rice + brown manuring – zerotill maize (DSR+BM-ZTM), direct seeded rice + brown manuring – zerotill maize + rice residue (DSR+BM-ZTM+RR), mungbean residue + direct seeded rice –zerotill maize + relay mungbean (MBR+DSR-ZTM+MB), mungbean residue + direct seeded rice –zerotill maize + rice residue + relay mungbean (MBR+DSR-ZTM+RR+MB), transplanted rice – conventional till maize (TPR-CTM) and transplanted rice – zerotill maize (TPR-ZTM). The experiment was laid out in randomized block design and replicated thrice. Rice 'PRH 10'and maize HQPM-1, varieties were taken for experimentation. The sowing for direct-seeded rice and nursery raising was done in the second forth-night of June and transplanting of seedling was done in second week of July, while rice was harvested in the last week of October during both the years. Zerotill and conventional till maize were sown in the second week of November and last week of November respectively and harvested in last week of May during both the years. For brown manuring practice seeds of *sesbania* @ 40 kgha^{-1} was broadcasted together with the sowing of direct seeded rice as per treatments and then *sesbania* crop was knocked down at 30 days after sowing with 2,4-D ester. Sowing of relay mungbean was done into the respective treatments in the second forth-night of march by broadcasting in the standing maize crop and after one picking of pods, it's residues was incorporated into soil in respective treatments through rotavator in June before sowing of direct-seeded rice. After harvesting of rice, it's choped residue was applied into respective treatments @ 5.0 t/ha before sowing of zerotill maize through happy seeder. The cultivation of both season crops was done with the recommended package of practices. The number of irrigations applied in direct seeded rice, transplanted rice, zerotill maize and conventional till maize were 11, 21, 7, 7 and 17, 23, 9, 9 during 2010-11 and 2011-12 respectively. Comparatively higher number of irrigations were applied during 2011-12 in rice crop due to shortage of rainfall. Nitrogen content (%) in grain and straw was determined by modified Kjeldahl method, phosphorus content by vanadomolybdo phosphoric acid yellow colour method and potassium content by flame photometer (Prasad *et al.,* 2006). Nitrogen, phosphorus and potassium uptake were calculated by using the following expression:

Nutrient uptake(kgha^{-1}) in grain/straw = [% Nutrient in grain/straw × grain/straw yield(kgha^{-1})]

Total uptake of N/P/K (kg ha^{-1}) = Nutrient uptake in grain + Nutrient uptake in straw

All the observations of the study were recorded as per standard methods at different intervals and at harvest. All these experimental data recorded under observations were statistically analyzed in accordance with the 'Analysis of Variance' technique as described by Fisher (1950). Wherever variance ratio (F value) was found significant, critical difference (CD) values at

5% level of probability were computed for making a comparison between treatments. To elucidate the nature and magnitude of treatments effects, standard errors of means (SEm±) and CD (p=0.05) were computed.

RESULTS AND DISCUSSION

A. Yields of rice and maize

Productivity of rice in terms of yield was influenced due to tillage and residue management. During first year the transplanted rice produced significantly higher yields than the rest treatments but in second year treatments where residues were applied showed comparable yields than TPR (Table 1). Mungbean, rice and brown manuring residue applied treatments produced significantly higher yield than the direct seeded no residue application treatment (DSR-ZTM). Treatment MBR+DSR-ZTM+RR-MB produced highest yield among residue treatments. Lowest yield was recorded under the treatment (DSR-ZTM) where no-residue was applied during both the seasons. Residue management practices over time enhances the physico-chemical properties of soil, which results better yields. Under transplanted rice, better availability of water, nutrients and less weed infestation resulted comparatively higher yields (Johnson *et al.*, 2002). In maize, tillage, residue management and brown manuring practices in previous rice crop could not affect grain and stover yields significantly in first cropping cycle (Dudwal *et al*., 2018). However, significantly higher yield was recorded under conventional tilled maize (4.21 t ha^{-1}) than the residue treatments and DSR-ZTM treatment. Residue applied treatments produced higher yields than no residue applied treatment (DSR-ZTM). During second year lowest yield performance was recorded under zero-till maize without residue (DSR-ZTM) which was grown after direct seeded rice. Conventional tilled maize produced highest yield (3.83 t ha^{-1}) during second year due to better seed germination and establishment. Treatment MBR+DSR-ZTM+RR-MB produced higher yield (3.62 t ha^{-1}) among residue applied treatments. Productivity of winter maize recorded lower in second year due to prolonged low temperature than base temperature required for maize. Mungbean is a leguminous crop and its cultivation and residue incorporation improves soil properties and fertility status which resulted better yields of succeeding crops (Adil *et al.*, 2010). Manguiat *et al*., (1997) also reported positive effects of mungbean cultivation and residue incorporation. Similarly rice residue application increases organic matter into the soil over time, smoother weeds growth and maintain moisture in soil for longer time and finally owing to better yield of crops (Singh *et al*., 2011).

Table 1: Productivity of rice and maize as influenced by tillage, crop establishment, brown manuring and residue management.

*Treatment	First year					Second year			
	Rice		Maize			Rice		Maize	
	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Grain yield (t ha^{-1})	Stover yield (t ha^{-1})		Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Grain yield (t ha^{-1})	Stover yield (t ha^{-1})
[1]DSR-ZTM	4.66	7.22	3.75	5.53		4.56	7.22	3.36	5.77
[1]DSR-ZTM+RR	4.62	7.16	3.81	5.60		4.79	7.28	3.43	5.81
[2]DSR+BM-ZTM	4.36	6.97	3.87	5.64		4.72	7.21	3.48	5.89
[2]DSR+BM-ZTM+RR	4.30	6.88	3.93	5.68		4.85	7.45	3.54	6.03
[1]MBR+DSR-ZTM- MB	4.56	7.14	3.77	5.55		4.81	7.40	3.58	6.14
[1]MBR+DSR-ZTM+RR-MB	4.61	7.02	3.80	5.60		5.04	7.68	3.62	6.21
[3]TPR-CTM	5.37	7.97	4.21	6.03		5.52	8.17	3.83	6.42
[3]TPR-ZTM	5.30	7.93	3.90	5.66		5.58	8.21	3.50	5.89
SEm±	0.12	0.20	0.07	0.09		0.11	0.16	0.08	0.12
CD (P=0.05)	0.36	0.62	0.22	0.27		0.35	0.48	0.24	0.38

*Treatments with superscript 1, 2, and 3 were maintained similarly in first year rice crop

B. Nutrient uptake in rice and maize

Total uptake of macronutrients (N, P and K) by rice was influenced by different treatments (Table 2 & 3). In general, the pattern of grain and straw yield followed in nutrient uptake too. Crop establishment and tillage practices, brown manuring and residue management practices showed significant variations in nutrient uptake. During first year nutrient uptake under TPR was significantly higher than the rest of the treatments. Direct seeding and brown manuring showed similar response in first season rice crop. In second year rice crop which was sown after winter maize, the treatments where rice residue was applied in previous season maize crop and mungbean residue incorporation showed comparable N, P and K uptake with the TPR treatments. The highest values for N, P and K uptake in grain and straw were recorded under TPR grown after zero-tilled winter maize followed by the TPR-CTM and treatment in which rice and mungbean residue incorporation was done. The higher total nutrient uptake was due to increased dry matter production with tillage and application of crop residues. The overall improvement in growth and nutrients uptake of rice crop due to tillage, residual effect of crop residues applied to previous season could be ascribed to their pivotal role in improvement of several physiological and bio-chemical processes, viz. root development, photosynthesis, energy transformation (ATP and ADP), symbiotic biological N_2 fixation and in protein synthesis (Tisdale *et al.*, 1995; Ali *et al.*, 2002). In case of maize, nutrients uptake in grain and stover were not significantly influenced due residue management practices but tillage had significant effect during first year of study (Table 4). Though, the maximum N, P and K uptake in grain and strover was recorded under DSR-CTM treatment. In second year, the treatments where rice residue was applied with zero-till winter maize and mungbean residue was incorporated in previous DSR crop, showed higher N, P and K uptake than the rest of the residue management treatments. N, P and K uptake in both grain and stover were found to be maximum under TPR-CTM treatment in second year maize crop. While, minimum was recorded under DSR-ZTM treatment. The residue application in both the seasons resulted in production of higher dry matter and thus uptake of higher N, P and K than other treatments. Tillage in current season crop improve the physical properties of previously puddled soil and hence affect the germination, crop establishment and uptake of nutrients. The higher uptake of nutrients in maize crop was due to tillage and residues applied to crops (Singh *et al.*, 2003).

Table 2: Nutrient uptake (kg ha^{-1}) in rice as influenced by tillage, crop establishment and brown manuring in first year of study.

*Treatment	N			P			K		
	Grain	Straw	Total	Grain	Straw	Total	Grain	Straw	Total
[1]DSR-ZTM	61.98	41.37	103.35	5.28	6.08	11.37	14.14	115.70	129.83
[1]DSR-ZTM+RR	61.14	40.95	102.09	5.12	6.01	11.12	14.02	114.81	128.83
[2]DSR+BM-ZTM	58.14	40.01	98.15	4.94	5.90	10.84	13.24	111.94	125.18
[2]DSR+BM-ZTM+RR	57.15	39.46	96.61	4.91	5.76	10.67	13.11	110.59	123.69
[1]MBR+DSR-ZTM- MB	60.46	40.91	101.37	5.16	6.00	11.15	13.84	114.47	128.31
[1]MBR+DSR-ZTM+RR-MB	60.85	40.16	101.01	5.15	5.87	11.02	14.01	112.60	126.61
[3]TPR-CTM	71.79	45.84	117.63	6.24	6.99	13.24	16.40	128.20	144.60
[3]TPR-ZTM	70.86	45.53	116.39	6.07	6.92	12.99	16.20	127.57	143.77
SEm±	1.75	1.14	2.32	0.22	0.17	0.31	0.38	3.21	3.34
CD (P=0.05)	5.32	3.46	7.05	0.67	0.53	0.93	1.16	9.74	10.14

*Treatments with superscript 1, 2, and 3 were maintained similarly in first year rice crop

Table 3: Nutrient uptake (kg ha^{-1}) in rice sown after winter maize as influenced by tillage, crop establishment, brown manuring and residue management in second year.

Treatment	N			P			K		
	Grain	Straw	Total	Grain	Straw	Total	Grain	Straw	Total
DSR-ZTM	60.34	41.23	101.57	5.04	6.01	11.05	13.76	115.60	129.37
DSR-ZTM+RR	63.86	41.74	105.60	5.37	6.07	11.44	14.58	116.83	131.41
DSR+BM-ZTM	63.09	41.38	104.47	5.39	6.03	11.42	14.36	115.60	129.96
DSR+BM-ZTM+RR	64.83	42.93	107.76	5.58	6.31	11.89	14.81	119.75	134.56
MBR+DSR-ZTM-MB	64.27	42.59	106.87	5.58	6.27	11.85	14.67	118.90	133.57
MBR+DSR-ZTM+RR-MB	67.43	44.26	111.69	5.88	6.58	12.46	15.43	123.34	138.77
TPR-CTM	73.76	46.90	120.66	6.31	7.14	13.45	16.89	131.32	148.22
TPR-ZTM	74.54	47.20	121.74	6.42	7.12	13.54	17.11	132.04	149.15
SEm±	1.44	0.89	1.55	0.24	0.16	0.26	0.34	2.59	2.88
CD (P=0.05)	4.38	2.70	4.69	0.74	0.49	0.78	1.03	7.84	8.72

Table 4: Nutrient uptake (kg ha^{-1}) in winter maize as influenced by tillage and residue management in first year.

*Treatment	N			P			K		
	Grain	Stover	Total	Grain	Stover	Total	Grain	Stover	Total
[1]DSR-ZTM	66.0	62.1	128.1	23.5	19.0	42.5	12.3	86.8	99.1
[2]DSR-ZTM+RR	67.1	63.1	130.2	24.0	19.3	43.3	12.6	88.6	101.2
DSR+BM-ZTM	68.5	63.7	132.2	24.4	19.6	44.0	12.8	89.3	102.1
DSR+BM-ZTM+RR	69.7	64.5	134.2	24.9	19.8	44.7	13.2	90.0	103.2
[1]MBR+DSR-ZTM-MB	66.4	62.4	128.8	23.7	19.1	42.8	12.5	87.3	99.8
[2]MBR+DSR-ZTM+RR-MB	66.9	63.6	130.5	23.9	19.3	43.2	12.6	88.5	101.1
TPR-CTM	74.5	68.5	143.0	26.5	21.0	47.5	14.1	95.3	109.4
TPR-ZTM	68.8	64.1	132.9	24.5	19.6	44.1	13.0	89.2	102.2
SEm±	1.35	1.02	1.61	0.45	0.30	0.51	0.25	1.30	1.34
CD (P=0.05)	4.09	3.09	4.83	1.37	0.91	1.54	0.77	3.94	4.05

*Treatments with superscript 1 and 2 were maintained similarly in first year rice crop.

Table 5: Nutrient uptake (kg ha^{-1}) in winter maize as influenced by tillage and residue management in second year.

Treatment	N			P			K		
	Grain	Stover	Total	Grain	Stover	Total	Grain	Stover	Total
DSR-ZTM	59.2	65.1	124.3	21.2	19.9	41.1	11.1	91.0	102.1
DSR-ZTM+RR	60.4	65.5	125.9	21.7	20.1	41.8	11.4	91.8	103.2
DSR+BM-ZTM	61.7	66.6	128.4	22.1	20.5	42.6	11.6	93.3	104.9
DSR+BM-ZTM+RR	62.8	68.3	131.1	22.5	21.0	43.5	11.9	95.5	107.4
MBR+DSR-ZTM-MB	63.6	69.7	133.3	22.7	21.4	44.2	12.1	97.5	109.6
MBR+DSR-ZTM+RR-MB	64.3	70.6	134.9	23.0	21.7	44.8	12.2	98.6	110.9
TPR-CTM	67.9	73.1	141.0	24.3	22.4	46.7	12.9	102.1	115.0
TPR-ZTM	61.9	66.8	128.7	22.0	20.4	42.48	11.7	92.9	104.7
SEm±	1.50	1.06	1.83	0.50	0.48	0.55	0.31	2.17	2.07
CD (P=0.05)	4.54	3.21	5.54	1.52	1.44	1.67	0.93	6.57	6.26

CONCLUSION

This study indicates that transplanted rice gave significantly higher yield (5.37 t ha^{-1}) and uptake of major nutrients in initial year than direct seeded rice. However, in second year, treatment mungbean residue incorporation plus direct seeded rice followed by zerotill maize plus rice residue (MBR+DSR-ZTM+RR-MB) uptake comparable major nutrients and gave grain yield of 5.04 t ha^{-1}. Tillage affect the nutrient uptake and productivity of maize during both the years and different residue management practices could not bring out significant difference in nutrient uptake and maize productivity in starting year. Among residue management treatments, higher nutrient uptake and yield of maize (3.62 t ha^{-1}) was recorded with the incorporation of mungbean residue in rice, followed by zero-till maize with rice residues (MBR+DSR-ZTM+RR-MB) in second year of study.

FUTURE SCOPE

Research on tillage and residue management practices needs to be carried forward on long-term basis in a fixed layout and dynamic crop rotations. Nutrient management and dynamics of essential nutrients need to be critically reviewed.

Acknowledgement. The authors duly acknowledge the support received from the ICAR- Indian Agricultural Research Institute, New Delhi for providing facilities for accomplishing the research work.

Conflict of Interest. None.

REFERENCES

Aase, J. K. and Pikul, J. L. 1995. Crop and soil response to long-term tillage practices in the northern great plains. *Agronomy Journal, 87*: 652-656.

Adil, K.K., S. Qureshi, W. K., Kayani, R., Qureshi, A., Waheed, M., Arshad, M., Gulfraz and Laghari, M.K. (2010). Assessment of wheat yield potential after cropping of mungbean (*Vigna radiata*). *Pakistan Journal of Botany, 42*(3): 1535-1541.

Ali, Masood, Ganeshsmurthy, A. N. and Srinivasan Rao, Ch. (2002). Role of pulses in soil health and sustainable crop production, *Indian Journal of Pulse Research, 15*(2): 107–117.

Ali, R. I., Awan, T. H., Ahmad, M., Saleem, M. U. and M. Akhtar. (2012). Diversification of rice-based cropping systems to improve soil fertility, sustainable productivity and economics. *The Journal of Animal & Plant Sciences, 22*(1): 108-112.

Derpsch, R. and Friedrchedrich, T. (2009). Global overview of conservation agriculture adoption, pp. 429–438. In: *Proceedings, Lead Papers. 4th World Congress on Conservation Agriculture*. 4-7 February 2009, New Delhi, India.

Dudwal, B. L., Das, T. K. and Sharma, A. R. (2018). Effect of Tillage and Residue Management on Productivity of Crops in Rice-Wheat Cropping System, *Chemical Science Review and Letters, 7*(26): 474-478.

Gupta, R. K., Hobbs, P. R., Jiaguo, J. and Ladha, J. K. (2003). Sustainability of post-green revolution agriculture, pp. 1–25. In: Ladha, J.K. *et al.* (Eds.). *Improving the Productivity and Sustainability of Rice–Wheat Systems: Issues and Impacts.* ASA Spec. Publ. 65, ASA, CSSA, and SSSA, Madison, WI.

Guzha, A. C. (2004). Effects of tillage on soil micro-relief, surface depression storage and soil water storage. *Soil and Tillage Research, 81*(1): 57-69.

Ibragimov, N., Evett, S., Esenbekov, Y., Khasanova, F., Karabaev, I., Mirzaev, L. and Lamers, J. (2011). Permanent Beds vs. Conventional Tillage in Irrigated Arid Central Asia. *Agronomy Journal, 103*(4): 1002-1011.

Jain, N. K., Besarwal, H. S. and Dashora, L. N. (2011). Production potential, profitability, sustainability and energetics of different wheat (*Triticum aestivum*)–based cropping systems. *Archives of Agronomy and Soil Science, 57*(5): 477–487.

Johnson, A. M., Clayton, G. W., Wall, P. C. and Sayre, K. D. (2002). Sustainable cropping systems for semiarid regions. *Paper Presented in the International Conference on Environmentally Sustainable Agriculture for Dry Areas for the Second Millennium*. 15–19 September, Shijiazhuang, Hebei Province, China.

Malhi, S. S., Nyborg, M., Goddard, T. and Puurveen, D. (2011.) Long-term tillage, straw and N rate effects on quantity and quality of organic C and N in a Gray Luvisol soil. *Nutrient Cycling in Agroecosystems, 90*: 1-20.

Manguiat, I. J., Singletin, P. W., Rocamera, P. M. and Calomora, M. U. (1997). Effectiveness of *Sesbania natrala* and *Phaseolus calearatus* as green manure for upland rice grown in acid soil. *Plant and Soil, 182*(2): 321-331.

Prasad, R., Shivay, Y. S., Kumar, D. and Sharma, S. N. (2006). Learning by doing exercise in soil fertility (A practical manual for soil fertility), Division of Agronomy, Indian Agricultural Research Institute, New Delhi, pp. 68.

Singh, B. P., Mundra, M. C. and Gupta, S. C. (2003). Productivity, stability and economics of various cropping systems in semi-arid ecosystem. *Crop Research* (Hisar) *25*(3): 472-477.

Singh, R., Sharma, A. R., Dhayani, S. K. and Dube, R. K. (2011). Tillage and mulching effects on performance of maize (*Zea mays*) – wheat (*Triticum aestivum*) cropping system under varying land slopes. *Indian Journal of Agricultural Sciences, 81*(4): 330–335.

Timsina, J., Buresh, R. J., Dobermann, A., and Dixon, J. (2011). Rice-maize systems in Asia: Current situation and potential, Los Banos (Philippines): IRRI and CIMMYT, 232p.

Tisdale, S. L., Nelson, W. L., Beaton, J. D. and Havlin, J. L. (1995). Soil Fertility and Fertilizers, 5th edition, pp. 62–75. Prentice Hall of India Pvt. Ltd., New Delhi.

How to cite this article: B.L. Dudwal, T.K. Das and A.R. Sharma (2022). Yield and Nutrient Uptake Influenced by Conservation Agriculture Practices in Rice-Winter Maize Cropping System. *Biological Forum – An International Journal, 14*(1): 554-559.