Original Research Article

Effect of Tillage and Weed Management Practices on Growth and Yield Attributes of Wheat (*Triticum Aestivum* L.)

ABSTRACT

A field experiment was conducted during the Rabi season of 2017-18 at Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya 224229 (U.P.) to study the effect of various tillage and weed management practices on growth parameters, yield attributes and yield of wheat crop. The combination of treatments were five tillage system in main plot viz., TPR-CT, W-CT (T_1), TPR-CT+W-ZT+S-ZT (T_2), DSR-CT+W-CT+S-ZT (T_3), DSR-ZT+W-ZTR+S-ZT (T_4) and DSR-ZTR+W-ZTR+S-ZT (T_5) and three-level of weed management practices in sub plot viz., Clodinafop + metsulfuron @ 60 + 4g/ha at 30 DAS (W_1), Clodinafop + metsulfuron @ 60 + 4g/ha at 30 DAS fb 1 hand weeding at 45 DAS (W2) and 1 hand weeding at 45 DAS (W3) in wheat were tested with 3 replication in split-plot design. The soil was silt loam in texture and medium in fertility status. Among various tillage and weed management practices DSR-ZT+R, W-ZT+R, S-ZT (T_5) and Clodinafop + metsulfuron 60 + 4g/ha at 30 DAS fb 1 hand weeding at 45 DAS (W_2) resulted in lowest in total weed density and total weed dry weight (g/m^2) and highest values of growth parameters, yield attributes and yield in comparison to other tillage practices and weed management practices.

Keywords: Wheat, Tillage practices, Weed management, Conservation Agriculture, Cropping System.

INTRODUCTION

"Wheat (*Triticum aestivum* L.) is the most important staple food crop of India which provides food security to the country's population" [Nath et al, 2017]. "Rice-wheat cropping is the most important cropping system in northern India" [Brar et al, 2009]. "It is estimated that productivity of wheat also decreased at the rate of 25-50 kg/ha/day due to delayed sowing beyond its optimum time range" [Chhokar et al, 2007]. "This situation becomes more critical particularly in Eastern U.P. where more than 50 % area under wheat is sown late after harvest of rice" [Ghosh et al, 2021]. "Under the rice-wheat cropping system, farmers face major problems such as rice straw burning, delayed wheat sowing, abnormal climatic conditions such as cold

injury, terminal heat stress, depleting water table, increasing fossil fuel emissions, depleting natural resources, and so on" [Nath et al, 2017]. "In the rice-wheat system, zero till wheat (ZT-W) with rice residue retention could be alternative conservation agriculture (CA)-based option to conventionally till wheat. Zero tillage eliminates field preparation for sowing and lowers the cost of wheat tillage operations" [Stanzen et al, 2016]. "It improves crop productivity and resource efficiency, allows for early sowing, and thus increases crop yield" (Das *et al*., 2014 and Jat *et al*., 2020). However, weeds are the most important barrier under both CT and ZT tillage practices, diminishing wheat yield up to 60.5% under conventional and 70% under zero tillage practices (Jain *et al*., 2007 and Das *et al*., 2020). Crop residue retention on the soil surface combined with zero tillage (ZT), results in enhanced soil quality and overall resource conservation. (Das *et al*., 2018; Ghosh *et al*., 2019, 2021). These issues necessitate appropriate mitigation measures such as proper crop establishment methods, residue management, and weed management. To solve the above problems, an experiment was conducted at NDUAT, Ayodhya 2017-2018 to know the effect of tillage and weed management practices on growth, yield attributes and yield of conservation agriculture based wheat.

MATERIALS AND METHODS

Experimental Site and Climate

The field experiment was carried out during *rabi* season of 2017-2018 to study the effect of tillage and weed management practices on growth, yield attribute and yield of conservation agriculture based wheat at agronomy farm of Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya 224229, (U.P.) located between 26° 47" N latitude and 82º12" E longitude with an elevation of 113 meters above mean sea level. The region enjoys sub-humid climate receiving a mean annual precipitation of about 1200 mm, out of which about 80-85 per cent received during mid-June to end of September. The average minimum and maximum temperature during the crop season were ranged from 4.7 to 19.5 ºC and 21.8 to 39.2ºC, respectively. The total rainfall of 9.6 mm was recorded during wheat growing season.

Soil Description

The soil of the experimental plot was silty loan consisting of 28.5% sand, 56.60% of silt and 15.15% of clay with pH 8.0 which was slightly alkaline in reaction, low in organic carbon (0.41%) and available nitrogen (165.5 kg/ha), while medium in phosphorus (18.0 kg/ha) and rich in potassium (290.8 kg/ha) which was suitable for wheat growing.

Treatment Detailed

This long term experiment was started in 2011-2012 up to 2017-2018. This article is based on M.Sc. thesis, which was conducted in last year of experiment 2017-2018. Main plot tillage treatment was based on *Kharif* -rice, *rabi*-wheat and summer-sesbania tillage operations. In order to facilitate their reference the symbol assigned to different treatment are given as under.

1. Tillage and residue management (main plot)

S.N	Kharif	Rabi	Summer
T_1	CT(Transplanted)	Conventional tillage	-
T_2	CT(Transplanted)	Zero tillage	ZT
T_3	CT(Direct - seeded)	Conventional tillage	ZT
T_4	ZT(Direct - seeded)	Zero tillage + Residues	ZT
T_5	ZT(Direct - seeded)+R	Zero tillage + Residues	ZT

2. Weed management sub (plot)

W_1	Clodinafop+metsulfuron 60+4g ha-1 at 30 DAS
W_2	Clodinafop+metsulfuron 60+4g ha-1 at 30 DAS fb 1 HW at 45 DAS
W_3	1 hand weeding (HW) at 45 DAS

The field experiment was conducted on rabi wheat in a split-plot design with 15 treatments combinations consisting of 5 tillage practices in main plots *viz.*, T_1 (TPR-CT, W-CT), T_2 (TPR-CT, W-ZT, S-ZT), T_3 (DSR-CT, W-CT, S-ZT), T_4 (DSR-ZT, W-ZT+R, S-ZT) and T_5 (DSR-ZT+R, W-ZT+R, S-ZT) and 3 weed management practices in subplots *viz.*, W_1 (Clodinafop + metsulfuron @ 60+4 g/ha at 30 DAS),W_2 (Clodinafop + metsulfuron @ 60 + 4 g/ha at 30 DAS fb 1 HW at 45 DAS) and W_3 (1 hand weeding (HW) at 45 DAS) with 3 replications.

Variety Description

Malviya-234 (HUW-234) was used for this study. The field was ploughed thoroughly using 3 cross harrowing were done with tractor in case of conventional tillage treatments. The seed was sown directly in zero tillage treatments. Seed was sown in line at 20 cm apart with 100 kg/ha dose. Fertilizer was applied at the rate of 120 kg/ha N, 60 kg/ha P_2O_5 and 40 kg/ha K_2O in the form of Urea, single super phosphate and muriate of potash, respectively. The other agronomic practices were kept normal and uniform to all the treatments. The observation were recorded on growth characteristics was taken at 30, 60, 90 DAS and at harvest stages and yield

attributes and yield of wheat.

Results and discussion

The total weed density was varied non-significantly at 30 DAS but it was significantly resulted at 60, 90 DAS and at harvest stage under various tillage and weed management practices (Table 1). The highest total weed density (9.56/m^2) was recorded with treatment T_1 (TPR-CT, W-CT) and lowest total weed density (9.03 /m^2) in T_5 (DSR-ZT+R, W-ZT+R, S-ZT) at all the stages of crop growth. This was due to the coverage of soil surface with crop residue which caused suppressing and smothering effect on weed and the similar result is also reported Chhokar *et al*. (2007) and Nath *et al*. (2016). Among weed management practices Clodinafop + metsulfuron @ 60+4 g/ha at 30 DAS fb 1 hand at 45 DAS weeding (W_2) was most effective in reducing total population of weeds and recorded significantly lower number total weeds density which was being at par with Clodinafop + metsulfuron @ 60 + 4 g/ha at 30 DAS (W_1). It might be due to fating effect of herbicide on weed and corresponding result was reported by (Tiwari *et al*., 2015).

The total weed dry weight (g/m^2) was found no-significant at 30 DAS under various tillage practices **(Table 1).** At 60, 90 DAS and at harvest stage total weed dry weight was significantly highest in T_1 in comparison to all other treatments while T_5 was recorded significantly lowest total weed dry weight which is *at par* with T_4. This might be due to soil disturbance in conventional tillage which facilitates favorable environment for weed growth and emergence. This might be attributed due to presence of residue covering soil surface acted as mulch. These results are in conformity with the findings of Brar and Walia (2007). Among the weed management treatments, Clodinafop + metsulfuron @ 60 + 4 g/ha at 30 DAS *fb* 1 hand weeding at 45 DAS (W_2) recorded lower dry matter accumulation of weed which was with treatment W_1. This might be due to higher efficacy of Clodinafop + metsulfuron in controlling both narrow and broad leaf weeds and followed by weed free.

Table 1. Total density m^{-2} as influence by various tillage and weed management practices

Treatments	Total weed density (m^{-2})				Total weeds dry weight (gm^{-2})			
	30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS	At harvest
Tillage practice								
T_1	9.56 (91.23)	8.29 (68.57)	8.06(63.89)	7.98 (63.45)	2.85 (7.63)	3.45 (11.42)	4.61(20.79)	4.44 (19.25)
T_2	9.25 (85.36)	7.28(52.75)	7.33(52.37)	6.78 (45.75)	2.86 (7.71)	3.07 (8.97)	4.13(16.61)	4.01(15.59)
T_3	9.38 (87.66)	7.62(57.82)	7.42(54.30)	7.48 (55.71)	2.90 (7.91)	3.22 (9.91)	4.27(17.74)	4.03(15.80)
T_4	9.14 (83.06)	6.84(46.52)	6.84(52.06)	6.43 (41.08)	2.83 (7.50)	2.78 (7.24)	3.58(12.40)	3.70(13.24)
T_5	9.03 (81.03)	6.29(39.33)	6.23(42.89)	6.28 (39.18)	2.79 (7.31)	2.73 (6.97)	3.54(12.08)	3.55(12.15)
SEm±	0.20	0.24	0.23	0.22	0.04	0.05	0.06	0.05
CD at 5%	NS	0.79	0.76	0.71	NS	0.15	0.20	0.18
Weed management								
W_1	9.27 (80.92)	7.05 (49.83)	7.02 (57.83)	6.73 (45.40)	2.85 (7.63)	3.00 (8.57)	3.92 (15.06)	3.88 (14.68)
W_2	9.19 (80.21)	6.99 (49.00)	6.93 (47.71)	6.66 (44.42)	2.82 (7.45)	2.93 (8.14)	3.84 (14.43)	3.81 (14.13)
W_3	9.36 (81.87)	7.76 (60.17)	7.58 (53.77)	7.57 (57.28)	2.87 (7.75)	3.23 (9.99)	4.32 (18.28)	4.16 (16.80)
SEm±	0.17	0.05	0.04	0.04	0.02	0.02	0.03	0.03
CD at 5%	NS	0.14	0.13	0.13	NS	0.06	0.10	0.09

The data clearly indicated that the growth parameters *viz*., number of shoots/m^2 and dry matter accumulation (g) influenced significantly by tillage and weed management practices at all the stages of crop growth, except at 30 DAS data was non-significant presented in **Table 2** and Depicted in **Fig. 1.** The maximum number of shoots (674.9, 725.8 and 711.1/m^2, respectively) and dry matter accumulation (449.3, 778.8 and 942.2 g, respectively) were recorded with DSR-ZT+R, W-ZT+R, S-ZT (T_5) which was remained *on par* with DSR-ZT, W-ZT, S-ZT (T_4) and significantly superior over rest of the treatments at 60, 90 DAS and at harvest. This is due to better soil moisture conducive for good germination brought good establishment and less weed infestation. Contrary to this the treatment consisting without residue retention recorded poor growth attributes due to more weed competition and less soil moisture. Similar findings were also reported by Susha *et al.* 2018.

Among weed management practices, the significantly maximum number of shoots (610.8, 647.0 and 634.3/m^2, respectively) and dry matter accumulation (401.3, 717.4 and 868.3 g, respectively) were recorded with Clodinafop + metsulfuron 60 + 4g/ha at 30 DAS fb 1 hand weeding at 45 DAS (W_2) which was followed by Clodinafop + metsulfuron 60+4g/ha at 30 DAS (W_1) at 60, 90 DAS and at harvest because of lower number of weed species, weed biomass and their dry weight.

The relevant data related to yield attributes and yield *viz*., length of spike (cm) number of grain/spike, grain weight/spike (g), and grain and straw yield kg/ha as significantly influenced by tillage and weed management practices, except test weight (1000 grain weight) are presented in **Table 3**. The significantly highest spike length (9.41 cm), grains/spike (46.67), grains weight/spike (1.93 g), grain yield (3881 kg/ha) and straw yield (5546 kg/ha) was recorded with DSR-ZT+R, W-ZT+R, S-ZT (T_5) which was with DSR-ZT, W-ZT+R, S-ZT (T_4) while significantly superior over rest other tillage practices *viz.*, T_1, T_2 and T_3. This was attributed to more dry matter production due to better portioning of photosynthates from source to sink as a result of lower crop weed competition and better crop growth which lead to effective formation of structural components under DSR-ZT+R, W-ZT+R, S-ZT (T_5) and thus resulted in better development of yield attributes. These findings are in conformity with of Ghosh *et al.* 2021**.**

Among weed management practices, the highest spike length (8.97 cm), grains/spike (42.42), grains weight/spike (1.65 g), grain yield (3453 kg/ha) and straw yield (5193 kg/ha) was recorded with treatment W_2 (Clodinafop + metsulfuron 60+4g/ha at 30 DAS fb 1 hand weeding

at 45 DAS) which was remained *on par* with treatment W_1 (Clodinafop + metsulfuron 60+4g/ha at 30 DAS) and significantly superior over treatment W_3 (1 hand weeding at 45 DAS). The minimum yield attribute and yield was recorded under treatment W_3which was attributed to more weed growth, total weeds dry weight and poor yield attributing characters. Similar results were also observed by Baghel *et al.* 2020.

Table 2. Number of shoots and dry matter accumulation as influenced by various tillage and weed management practices

Treatments	Number of shoots/m^2				Dry matter accumulation (g)			
	30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS	At harvest
Tillage practice								
T_1	207.3	476.0	504.6	494.5	64.8	332.0	581.1	718.3
T_2	220.3	568.7	602.9	590.8	66.1	372.6	677.5	832.6
T_3	214.0	526.8	558.4	547.3	64.5	349.2	634.9	780.5
T_4	225.8	665.3	703.2	690.6	70.5	426.7	720.1	891.4
T_5	230.8	674.9	725.8	711.1	71.3	449.3	778.8	942.2
SEm±	6.9	14.7	15.3	16.8	1.8	12.1	20.5	22.9
CD at 5%	NS	48.8	50.6	55.7	NA	39.9	71.5	75.9
Weed management								
W_1	219.7	586.0	626.4	614.8	67.2	388.5	667.1	833.7
W_2	221.6	610.8	647.0	634.3	68.5	401.3	717.4	868.3
W_3	217.6	550.3	583.6	571.5	66.6	368.1	651.0	797.0
SEm±	3.8	9.7	10.3	10.8	1.0	5.7	17.7	14.5
CD (P=0.05)	NS	28.7	30.5	32.2	NS	17.1	51.2	43.1

Fig.1. Number of shoots and dry matter accumulation as influenced by various tillage and weed management practices

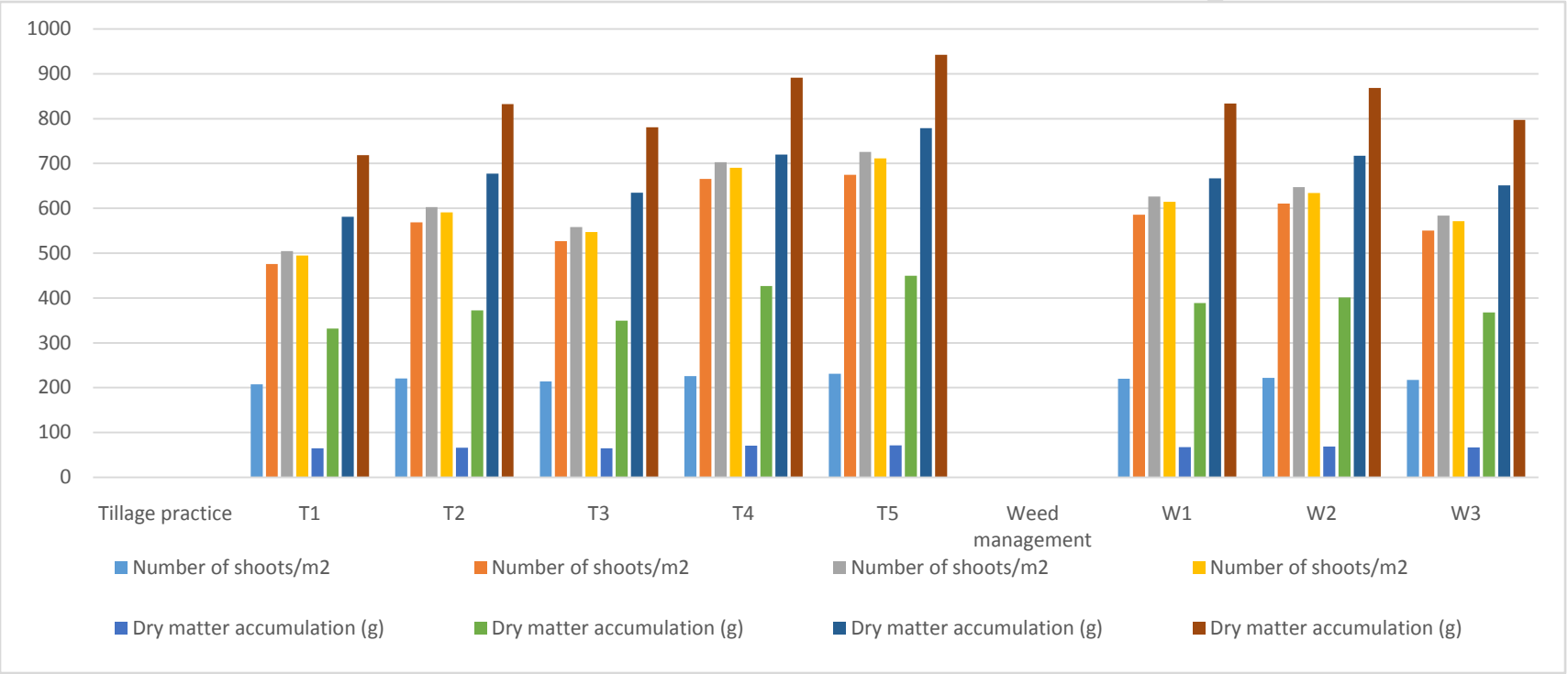

Table 3. Yield attribute and yield as influenced by tillage and weed management practices

Treatments	Yield attributes				Yield	
	Length of spike (cm)	grains/spike	Grains weight/spike (g)	Test weight (g)	Grain yield (kg/ha)	Straw yield (kg/ha)
Tillage practice						
T_1	8.12	33.89	1.21	35.88	2824	4387
T_2	8.53	39.70	1.43	37.78	3291	5012
T_3	8.37	36.17	1.36	36.85	3039	4735
T_4	8.69	45.27	1.89	38.04	3626	5307
T_5	9.41	46.67	1.93	41.07	3881	5546
SEm±	0.22	0.82	0.04	1.18	88	138
CD at 5%	0.74	2.72	0.13	NS	291	457
Weed management						
W_1	8.59	40.48	1.58	37.89	3360	5003
W_2	8.97	42.42	1.65	38.93	3453	5193
W_3	8.31	38.12	1.46	36.96	3183	4796
SEm±	0.13	0.65	0.03	0.54	48	87
CD (P=0.05)	0.40	1.92	0.08	NS	141	257

CONCLUSION

Based on the findings, it can be concluded that, application of DSR-ZT+R, W-ZT+R, S-ZT (T_5) with Clodinafop + metsulfuron 60 + 4g/ha at 30 DAS *fb* 1 hand weeding at 45 DAS (W_2) exhibited significantly lowest total weed density, total weed dry weight and higher growth, yield attributes and yield of wheat over the other treatment combinations (make it simple). Although, the DSR-ZT, W-ZT+R, S-ZT (T_4) and Clodinafop + metsulfuron 60 + 4g/ha at 30 DAS (W_1) showed positive effects on growth, yield attributes and yield parameters of wheat

REFERENCES

Baghel, J.K., Das, T.K., Mukherjee, I., Nath, C.P., Bhattacharyya, R., Ghosh, S. and Raj, R. 2020. Impacts of conservation agriculture and herbicides on weeds, nematodes, herbicide residue and productivity in direct-seeded rice. *Soil and Tillage Research*, **201**: 104.

Brar, A.S. and Walia, U.S. 2007. Influence of planting techniques and weed control treatments on nutrient uptake by *Phalaris minor* Retz. And broad leaf weeds in wheat (*Triticum aestivum*). *Indian Journal Weed Science*, **39**(1 & 2): 55-61.

Chhokar, R.S., Sharma, R.K., Jat, G.R., Pundir, A.K. and Gathala, M.K. 2007. Effect of tillage and herbicides on weeds and productivity of wheat under rice-wheat growing system. *Crop Protection*, **26**: 1689-1696.

Das, T. K., Bhattacharyya, R., Sudhishri, S., Sharma, A. R., Saharawat, Y. S., Bandyopadhyay, K. K.and Jat, M. L. (2014). Conservation agriculture in an irrigated cotton–wheat system of the western Indo-Gangetic Plains: Crop and water productivity and economic profitability. *Field Crops Research*, **158:** 24-33.

Das, T.K., Ghosh, S., Gupta, K., Sen, S., Behera, B. and Raj, R. (2020). The weed Orobanche: species distribution, diversity, biology and management. *Journal of Research in Weed Science*, **3** (2): 162-180.

Das, T.K., Saharawat, Y.S., Bhattacharyya, R., Sudhishri, S., Bandyopadhyay, K.K., Sharma, A. R. and Jat, M.L. (2018). Conservation agriculture effects on crop and water productivity, profitability and soil organic carbon accumulation under a maize-wheat cropping system in the North-western Indo-Gangetic Plains. *Field Crops Research*, **215**: 222-231.

Ghosh S., Das T.K., Shivay, Y.S., Bhatia, A., Biswas, D.R., Bandyopadhyay, K.K., Sudhishri, S., Yeasin, M., Raj, R., Sen, S. and Rathi, N. (2021). Conservation agriculture effects on weed dynamics and maize productivity in maize-wheat-greengram system in north-western Indo-Gangetic Plains of India. *Indian journal of weed science*, **53**(3): 244-251.

Ghosh, S., Das, T.K., Sharma, D. and Gupta, K. 2019. Potential of conservation agriculture for ecosystem services: A review. *Indian Journal of Agriculture Science*, **89**(10): 1572-1579.

Jain, N., Jain, V., Mishra, J. S., & Kewat, M. L. (2011). Effect of tillage packages and herbicides on energy and economics of wheat in transplanted rice (*Oryza sativa*) wheat (*Triticum aestivum*) system. *Indian Journal of Agricultural Sciences*, **77**(3): 174-6

Jat, H.S., Choudhary, K.M., Nandal, D.P., Yadav, A.K., Poonia, T., Singh, Y., Sharma, P.C. and Jat, M.L. (2020). Conservation agriculture-based sustainable intensification of cereal systems leads to energy conservation, higher productivity and farm profitability. *Environmental Management*, **65** (6): 774-786.

Nath, C.P., Das, T.K. and Rana, K.S. 2016. Effects of herbicides and tillage practices on weeds and summer mungbean in wheat-mungbean cropping sequence. *Indian Journal of Agriculture Sciences*, **86**(7): 860-864.

Nath, C.P., Das, T.K., Rana, K.S., Bhattacharyya, R., Pathak, H., Paul, S. and Singh, S.B. (2017). Greenhouse gases emission, soil organic carbon and wheat yield as affected by tillage systems and nitrogen management practices. *Archives of Agronomy and Soil Science*, **63**(12): 1644-1660.

Susha, V.S., Das, T.K., Nath, C.P., Pandey, R., Paul, S., Ghosh, S., 2018. Impacts of tillage and herbicide mixture on weed interference, agronomic productivity and profitability of maize-wheat system in the North-western Indo-Gangetic Plains. *Field Crops Research*, **219**: 180-191.

Tiwari, A., Verma, B.K., Dev, J. and Kumar, R. 2015. Bio efficacy of clodinafoppropargyl + metsulfuron-methyl against complex weed flora in wheat. *Indian Journal Weed Science*, **47**(4): 422-424.

Brar AS, Walia US. Weed dynamics and wheat (Triticum aestivum L.) productivity as influenced by planting techniques and weed control practices. Indian Journal of Weed

Science. 2009;41(3and4):161-6.

Stanzen L, Kumar A, Sharma BC, Puniya R, Sharma A. Weed dynamics and productivity under different tillage and weed-management practices in maize (Zea mays)-wheat (Triticum aestivum) cropping sequence. Indian Journal of Agronomy. 2016;61(4):449-54.