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The effect of tillage and weed management practices on yield and nutrient uptake in wheat (*Triticum aestivum* L)

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Abstract

A field experiment entitled “The effect of tillage and weed management practices on yield and nutrient uptake in wheat (*Triticum aestivum* L)” was carried out at Agronomy research form, N.D University of Agriculture and Technology Narendra Nagar, Kumarganj, Ayodhya (U.P.) during *rabi* season of 2017-18 to find out the effect of various tillage and weed management practices on growth, yield attribute, yield, nutrients, uptake, change in Physico- chemical properties of soil after harvesting the wheat crop and economic of various treatments. The combination of the five tillage systems (CT, ZT, CT, ZT+R, and ZT+R) and three weed management practices (Clodinafop + metsulfuron 60+4 g ha⁻¹ + one hand weeding) was laid out in Split Plot Design and replicated thrice. The soil of the experiment field was silt loam in texture and medium in fertility status. The result revealed that among various tillage and weed management practices conventional tillage (CT) and Clodinafop + metsulfuron 60+4 g ha⁻¹ + one hand weeding were found effective as compared to zero tillage system in increasing growth, yield attributes and yield of wheat during 2017-18. Adaptation of conventional tillage along with integrated weed management practices was also found most effective in increasing the uptake of nutrient. It can be concluded that under wet land condition for obtaining, better growth, yield attributes grain and straw yield, nutrients uptake, conventional tillage should be adopted / applied in wheat crop. However, for improving soil health, zero tillage + crop residue should be applied.

Keywords: Effect of tillage, field experiment, weed management

Introduction

Wheat is an important prime cereal crop among the food-grain is grown in an area of 29.65 m ha in India, with the production 93.5 million tonnes and average productivity 31.53 q ha⁻¹ (FAO, 2013). Conservation agriculture is a part of sustainable agri- culture, aiming at optimizing yields and profits but also at protecting land resources and the environment. Conservation agriculture involves zero or minimum soil disturbance through tillage (no-tillage, reduced tillage, mulch tillage and strip-tillage), a balanced use of fertilizers and herbicides, a permanent soil biomass cover enhancing water and soil conservation, crop rotation and integrated pest management, reduced production costs and increased farming efficiency (Derpsch, 2008; Dumanski *et al.*, 2006; Koepke, 2003; Koller, 2003) [2, 3, 5, 7]. Wheat varieties coupled with improved facilities of irrigation and fertilizers have led to the problem to grassy weeds particularly Phalaris minor Retz and wild oats (*Avena ludoviciana* Dur). Losses due to *A. ludoviciana* in wheat have been to the extent of 16 to 65% depending upon intensity of its infestation. The acute problem of grassy weeds along-with broadleaf weeds is also not uncommon in many parts of country, which often results in huge yield losses and makes the weed management issue more complex (Singh and Singh 2002, Malik *et al.* 2005) [10]. In order to control isoproturon resistant P. minor and other weed flora of wheat, sulfosulfuron & fenoxaprop (100 g ha⁻¹) are recommended as post emergence (Walia & Singh, 2005) [12]. Other new molecules of herbicides viz, clodinafop (60-80 g ha⁻¹), metribuzin (75-210 g ha-1) metsulfuron methyle (4 g ha-1) have been introduced for effective control of weeds (Tiwari and Vaishya, 2004 and Balyan, 2001) [10, 2].

Materials and methods

A field experiment was conducted at Agronomy Research Farm of the Narendra Deva University of Agriculture and Technology, (Kumarganj), Ayodhya (U.P.), during rabi season 2017-18, The experiment was carried out in split plot design (SPD), Each treatment was replicated 3 times. Experiment was comprised of two factors namely tillage practices and weed control methods. The combination of the five tillage systems (CT, ZT, CT, ZT+R, and ZT+R) and three weed management practices (Clodinafop + metsulfuron 60+4 g ha⁻¹ + one hand weeding). HUW-234 variety of Wheat was sown with a seed rate 100 kg ha⁻¹. Row to row distance (ZT) + (CT) 20 cm. Herbicide, clodinafop + metsulfuron was applied at the rate of 60+4g g. ha⁻¹ at 30 days to suppress both grassy weeds and broad leaf weeds. The herbicide was sprayed at 4-5 leaf stage of weeds (30 days after sowing of wheat crop). All other agronomic practices were applied equally to each experimental unit. Data was recorded on weeds population at 60 days after sowing (DAS), Length of spike (cm), Number of grain spike⁻¹, Test weight (g), Grain weight spike⁻¹, Grain and straw yield (q ha⁻¹)

All the collected data was analyzed statistically according to the appropriate procedure used for split plot design. The treatment comparisons were made at 5 per cent level of significance.

Crop studies

Growth attributes

Number of shoot (m⁻²)

For counting number of shoots a 50 cm x 50 cm quadrat was placed in each plot at 30th, 60th, 90th, 120 DAS and at harvest stages and finally average number of shoots were calculated.

Plant height (cm)

The height of main shoot of tagged plants was measured at 30th, 60th, 90th DAS and at harvest stages. The height was measured from the ground level to the tip of top most leaf prior to ear emergence and from ground to the base of ear after ear emergence with the help of meter scale and average plant height was reported in centimeter.

Yield attribute

Panicle length (cm)

Five spikes were randomly selected from tagged plants in each plot and their length (cm) was measured from neck node

to tip of the top most spikes and average length was calculated.

No. of grains Panicle⁻¹

The randomly selected five spikes for spike length were separately threshed and then counted the seeds separately for each ear and after that their average was computed.

Test weight of grain (g)

The samples were collected randomly from the cleaned grains of each plot and 1000 grains were counted out with the help of electronic balance the weight of their 1000-grain was recorded.

Weight of grains spike⁻¹

Five spikes from each plot were threshed manually and grain were cleaned collected and weight to calculate the average grain weight per spike.

Yield

Grain yield (q ha⁻¹)

The total weight of grain harvested from net area was recorded. The yield per plot was converted into quintals ha⁻¹.

Straw yield (q ha⁻¹)

The weight of straw calculated by subtracting the grain yield from the total biological yield of crop. Finally, straw yield per plot was converted into quintals ha⁻¹.

Harvest index (%)

The harvest index was calculated by dividing grain yield by total biological production and presented in terms of percent. The harvest index was calculated by the formula given as under:

Harvest index was calculated as per the following formula

$$\text{Harvest index (\%)} = \frac{\text{Economical yield}}{\text{Biological yield}} \times 100$$

Chemical studies

Nutrient uptake

Nutrient uptake of nitrogen, phosphorus, potash at harvest stage in grain and straw samples were completed multiplying dry matter yield at this stage with concentration of these nutrients.

$$\text{Nitrogen uptake by grain (kg ha}^{-1}\text{)} = \frac{\text{N content in grain (\%)} \times \text{Grain yield (kg ha}^{-1}\text{)}}{100}$$

$$\text{Nitrogen uptake by straw (kg ha}^{-1}\text{)} = \frac{\text{N content in straw (\%)} \times \text{straw yield (kg ha}^{-1}\text{)}}{100}$$

Growth and yield attributes

Result and discussion

Number of shoot m⁻¹

Number of shoot recorded at different days after showing 30, 60, 90 and 120 DAS have been presented. At 30 DAS among various tillage system maximum shoot (227 m⁻²) was recorded in conventional tillage M₁, CT treatment followed by M₃ CT (219 m⁻²), M₄ (ZT+R) (209.88 m⁻²) M₅ (ZT+R) (209.55m⁻²) and M₂ (ZT) (201.30 m⁻²) treatment respectively. While under

different weed management maximum number of shoot (215.42 m⁻²) recorded in W₂ of (IWM) treatments.

At 60, 90 and 120 DAS maximum number of shoot were observed in M₁ (CT) (626.52, 696.14, and 689.94 m⁻²) treatment respectively. however under various weed management practices maximum number of shoot were also observed 577.06, 641.18, and 634.83 m⁻² in W₂ (clodinafop + metsulfuron 60+4g ha⁻¹ fb one hand weeding) treatment at 60, 90, and 120 DAS respectively (Table-1).

Table 1: Effect of tillage and weed management practices on number of shoot

Treatments	Number of shoot (m ⁻¹)			
	30 DAS	60DAS	90 DAS	120 DAS
Tillage system				
M ₁ (CT)	227.62	626.52	696.14	689.24
M ₂ (ZT)	201.30	489.13	543.47	538.09
M ₃ (CT)	219.78	604.54	671.71	665.06
M ₄ (ZT+R)	209.88	505.61	561.79	556.23
M ₅ (ZT+R)	209.55	522.10	580.11	574.37
SEm±	6.586	16.870	16.226	19.090
CD at 5%	NS	55.871	53.736	63.220
Weed management				
W ₁ - Clodinafop+ metsulfuron @ 60 +4g ha ⁻¹ (30 DAS)	211.42	544.09	604.54	598.55
W ₂ -Clodinafop + metsulfuron @ 60+4g ha ⁻¹ (30 DAS) fb 1 hand weeding (45 DAS)	215.42	577.06	641.18	634.83
W ₃ -1 hand weeding (45 DAS)	214.04	527.60	586.22	580.42
SEm±	3.84	8.60	8.41	8.33
CD at 5%	NS	25.55	24.98	24.77

Plant height (cm)

Plant height recorded at different days after showing 30, 60, 90, and 120 DAS have been presented at 30 DAS among various tillage system maximum plant height 22.97 cm was recorded in conventional tillage M₁ (CT) Treatment followed by M₃ (CT) 22.20 cm, M₄ (ZT+R) 21.20 cm M₅ (ZT+R) 21.17 cm and M₂ (ZT) 20.33 cm treatment respectively. While under different weed management maximum plant height

21.76 cm was recorded in W₂ (IWM) treatment. At 60, 90, and at 120 DAS maximum plant height were observed in M₁ (CT) (76.08, 87.72, and 88.01 cm) treatment respectively. However, under various weed management practices maximum number of shoot were also observed 70.08, 80.80, 81.06 cm in W₂ (clodinafop+metsulfuron 60+4 g ha⁻¹ and one hand weeding) treatment at 60, 90, and 120 DAS respectively (Table-2).

Table 2: Effect of tillage and weed management practices on plant height

Treatments	Plant height (cm)			
	30 DAS	60 DAS	90 DAS	120DAS
Tillage system				
M ₁ (CT)	22.97	76.08	87.72	88.01
M ₂ (ZT)	20.33	59.40	68.49	68.71
M ₃ (CT)	22.20	73.41	84.65	84.92
M ₄ (ZT+R)	21.20	61.40	70.79	71.02
M ₅ (ZT+R)	21.17	63.40	73.10	73.34
SEm±	0.681	1.880	2.056	2.368
CD at 5%	NS	6.22	6.90	7.84
Weed management				
W ₁ - Clodinafop+ metsulfuron @ 60 +4 g ha ⁻¹ (30 DAS)	21.34	66.07	76.18	76.43
W ₂ -Clodinafop + metsulfuron @ 60+4 g ha ⁻¹ (30 DAS) fb 1 hand weeding (45 DAS)	21.76	70.08	80.80	81.06
W ₃ -1 hand weeding (45 DAS)	21.62	64.07	73.87	74.11
SEm±	0.36	1.12	1.15	1.20
CD at 5%	NS	3.34	3.43	3.58

Yield attributes**Length of spike (cm)**

Data summarized in Table 4.4 and depicted in Fig. 4.4 revealed that among the various tillage system, conventional tillage system was found better and maximum (9.13 cm) as compared to other tillage system. While in weed management maximum was observed with W₂ IWM (clodinafop + metsulfuron 60+4g ha⁻¹ applied at 30 DAS + one hand weeding at 45 DAS) treatment.

Number of grain spike⁻¹

Data summarized in Table 4.4 and depicted in Fig. 4.4 revealed that among various tillage system maximum number of spike⁻¹ (46.28) was recorded with M₁ (CT) treatment followed by M₃ (CT), M₅ (ZT) +R, M₄ (ZT+R) and M₂ (ZT) tillage system respectively, however under different weed

management practices, maximum number of grain spike⁻¹ (8.50) was observed with W₂ (IWM) treatment.

Test weight (g)

Data detailed in Table 4.4 and depicted in Fig. 4.4 revealed that among various tillage system, conventional tillage was found superior over rest of the tillage system. However, among various weed management practices W₂ (herbicide +one hand weeding) treatment was observed better over rest of the weed control measure. Various treatments was found non-significant in the investigation.

Grain weight spike⁻¹

Data pertaining to table 4.4 and depicted in Fig. 4.4 clearly indicate that among various tillage system maximum grain weight spike⁻¹ (1.72) was observed with conventional tillage followed by M₃ (CT), M₅ (ZT+R), M₄ (ZT+R) and M₂ (ZT)

i.e 1.66, 1.43, 1.39 and 1.34 tillage system respectively while in case of weed management practices maximum (1.59) was

recorded with W_2 and minimum (1.45) in W_3 treatment (Table-3).

Table 3: Effect of tillage and weed management practices on yield attributes

Treatments	Length of spike (cm)	No of grain spike ⁻¹	Grain weight spike ⁻¹	Test weight (g)
Tillage system				
M ₁ (CT)	9.13	46.28	1.72	39.04
M ₂ (ZT)	7.75	32.50	1.34	37.50
M ₃ (CT)	8.57	42.04	1.66	38.65
M ₄ (ZT+R)	8.02	37.01	1.39	37.89
M ₅ (ZT+R)	8.04	36.75	1.43	38.27
SEm±	0.20	1.04	0.04	1.13
CD at 5%	0.70	3.65	0.14	3.95
Weed management				
W ₁ - Clodinafop+ metsulfuron @ 60 +4 g ha ⁻¹ (30 DAS)	8.14	37.41	1.49	38.34
W ₂ -Clodinafop + metsulfuron @ 60+4 g ha ⁻¹ (30 DAS) /b				
I hand weeding (45DAS)	8.50	40.41	1.59	38.78
W ₃ -1 hand weeding (45 DAS)	8.27	38.93	1.45	37.70
SEm±	0.17	0.90	0.03	0.98
CD at 5%	0.50	2.62	0.10	NS

Grain and straw yield (q ha⁻¹)

The data on grain, straw yield of wheat and harvest index as affected by various tillage system and weed management practices have been presented in high grain (39.14 q ha⁻¹) and straw (55.37 q ha⁻¹) was recorded with conventional tillage system (M₁) treatment, which was significantly superior with M₅ (ZT+R), M₄ (ZT+R) and M₂ (ZT) tillage system. However, non-significant differences were observed in grain and straw between M₁ (CT) and M₃ (CT) tillage system further table 4.5 revealed that among various weed management maximum, grain and straw yield (34.54 and 51.93 q ha⁻¹) was observed with W₂ treatment were herbicide clodinafop + metsulfuron 60+4 g ha⁻¹ /b one hand weeding applied, while minimum grain and straw yield (31.90) and (47.96 q ha⁻¹) was recorded under one hand weeding

treatment which showed an increases of 5.29, 7.65% in grain and 4.02, 7.65% in straw over W₁ and W₃ treatment respectively. The harvest index ranged from 38.87 to 41.08 with various tillage system and 39.69 to 40.07 with weed management practices with maximum value of 41.08 in M₅ (ZT+R) tillage system and 40.07 in weed control W₂ (herbicide + one hand weeding) treatment. All the growth and yield attributes affected by tillage system viz. weed population (m-2), number of shoot (m-2), plant height (cm), length of panicle (cm) number of grain panicle-1, test weight (g), grain weight panicle-1, grain yield (q ha-1) straw yield (q ha-1) and harvest index The similar results have also reported by Verma and Srivastav (1989) [12], chital *et al.* (2007) [1], Gopinath *et al.* (2007) [4], Mishra and Singh (2012) [9], Paighan *et al.* (2013) and Kumar *et al.* (2017) [8] (Table-4).

Table 4: Effect of tillage and weed management practices on yield

Treatments	Grain yield (q ha ⁻¹)	Straw yield (q ha ⁻¹)	Harvest index
Tillage system			
M ₁ (CT)	39.14	55.37	38.87
M ₂ (ZT)	27.76	43.87	39.75
M ₃ (CT)	36.75	53.07	39.28
M ₄ (ZT+R)	29.99	47.35	40.40
M ₅ (ZT+R)	33.24	50.12	41.08
SEm±	0.89	1.39	0.990
CD at 5%	2.96	4.60	3.457
Weed management			
W ₁ - Clodinafop+ metsulfuron @ 60 +4 g ha ⁻¹ (30 DAS)	33.68	49.97	39.87
W ₂ -Clodinafop + metsulfuron @ 60+4 g ha ⁻¹ (30 DAS) /b 1 hand weeding (45 DAS)	34.54	51.93	40.07
W ₃ -1 hand weeding (45 DAS)	31.90	47.96	39.69
SEm±	0.42	0.85	0.85
CD at 5%	1.25	2.53	2.47

Effect of nutrients uptake (N, P and K)

All the growth, yield attributes and grain and straw yield as affected with the adaptation of various tillage system weed control measures, maximum nutrient contents were recorded under T₅ (ZT-ZT) treatments this was mainly due to better soil health (addition of organic matter into soil and Corban sequestration). Maximum uptake of nutrients (N P & K) were observed under conventional tillage system. It was mainly due

to Increase in grain and straw yield of wheat under CT-CT treatment, conventional tillage manage the good cultivation technique, environmental condition into soil. The above finding was also related with the Neugseh wandtner *et al.* (2014) [13] and kumar *et al.* (2017) [8] Weed control management did not any significant effect on content the nutrients (N P & K) while with nutrients uptake were affected significantly, maximum content and uptake of

nutrients were observed with W₂ treatment where redimix herbicide +one hand weeding applied. This was mainly due to effective herbicide and inter culture operation. They provide better environment condition for absorption of nutrients, herbicide check the weed intensity and inter culture operation

enhance the appearance of aeration and sun light into soil. The results are agreement with the Gangwar *et al.* (2004)^[15], Neugsch wandtner (2014)^[13], Martineg *et al.* (2016)^[14] (Table-5)

Table 5: Effect of tillage and weed management on N, P and K content in wheat crop

Treatments	N in grain (%)	N in straw (%)	P in grain (%)	P in straw (%)	K in grain (%)	K in straw (%)
Tillage system						
M1 (CT)	1.57	0.537	0.377	0.131	0.361	1.48
M2 (ZT)	1.58	0.537	0.379	0.132	0.363	1.44
M3 (CT)	1.50	0.510	0.359	0.131	0.344	1.36
M4 (ZT+R)	1.66	0.563	0.399	0.135	0.383	1.51
M5 (ZT+R)	1.72	0.580	0.409	0.139	0.392	1.55
SEm±	0.06	0.03	0.02	0.01	0.03	0.08
CD at 5%	NS	NS	NS	NS	NS	NS
Weed management						
W1- Clodinafop+ metsulfuron @ 60 +4 g ha-1 (30 DAS)	1.59	0.538	0.381	0.132	0.365	1.47
W2-Clodinafop + metsulfuron @ 60+4 g ha-1 (30 DAS) /b 1 hand weeding (45 DAS)	1.62	0.552	0.388	0.135	0.372	1.47
W3-1 hand weeding (45 DAS)	1.60	0.546	0.385	0.135	0.369	1.46
SEm±	0.04	0.03	0.02	0.01	0.01	0.08
CD at 5%	NS	NS	NS	NS	NS	NS

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