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The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; 10(7): 1371-1374

www.thepharmajournal.com
Received: 20-05-2021
Accepted: 29-06-2021

Pradeep Kumar Kanaujiya
Research Scholar, Department of Agronomy, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, Uttar Pradesh, India

RP Singh
Assistant Professor, Department of Agronomy, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, Uttar Pradesh, India

Amit Kumar
Research Scholar, Department of Agronomy, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, Uttar Pradesh, India

Mahendra Pratap Singh
Research Scholar, Department of Agronomy, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, Uttar Pradesh, India

Adesh
M.Sc. Scholar, Department of Agronomy, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, Uttar Pradesh, India

Corresponding Author:
Pradeep Kumar Kanaujiya
Research Scholar, Department of Agronomy, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, Uttar Pradesh, India

Impact of different tillage, fertility levels and weed management practices on growth and quality characters of wheat under late sowing conditions in eastern Uttar Pradesh (*Triticum aestivum* L.)

Pradeep Kumar Kanaujiya, RP Singh, Amit Kumar, Mahendra Pratap Singh and Adesh

Abstract
A field experiment was conducted to study the effect of different tillage, fertility levels and weed management practices on growth and quality characters of wheat during two consecutive *rabi* seasons of years 2018-19 and 2019-20, respectively. The experiment was laid out in split plot design with two tillage practices *viz*., Conventional tillage (3 ploughing) and Zero tillage (ferti-cum-seed drill) along with three fertility levels *viz*., 100% RDF (120:60:40 NPK kg ha^{-1}), 75 % RDF + 25% RDN-FYM (6 t ha^{-1}) and 50% RDF + 50% RDN- FYM (12 t ha^{-1}) in main plot. Each main plot was further divided into four sub plots to accommodate sub plot treatments i.e. weed management practices comprising Weedy check, Weed free upto 60 DAS, Sulfosulfuron @ 30 g a.i. ha^{-1} (POE) and Sulfosulfuron @ 30 g a.i. ha^{-1} + Metsulfuron @ 4 g a.i. ha^{-1} (POE) - Ready mixture. The results reported that the higher growth parameters *viz*. plant height, number of tillers, leaf area index and dry matter accumulation were recorded under zero tillage during both the experimental years. Among the fertility levels, application of 100% RDF (120:60:40 NPK kg ha^{-1}) recorded higher growth parameters. In case of weed management practices, weed free upto 60 DAS exerted significant effect on growth of wheat. However, in herbicidal treatments, post emergence application of Sulfosulfuron @ 30 g a.i. ha^{-1} + Metsulfuron @ 4 g a.i. ha^{-1} (POE) - Ready mixture noted higher values of above parameters. Protein content was failed to show any significant effect due to above treatments except weed management.

Keywords: Dry matter accumulation, fertility levels, weed management and zero tillage

Introduction
Wheat (*Triticum aestivum* L.) is the most important staple food crop of the world and emerged as the backbone of India's food security. It provides food to 36 % of the global population. It contains about 12% protein, 2% total fat, 55% carbohydrates (Kumar *et al*., 2011) [9]. In India, food demand is expected to increase significantly in the coming decades; the study estimates that India's overall demand for food grains will increase from 236.2 million tonnes in 2010 to 272-277 million tonnes in 2020 and 303-318 million tonnes in 2030 (DACFW, 2017) [4]. Thus, we have to increase the production and productivity of wheat to fulfill that demand of food grains.

The possibility of the extension of the area under wheat in the near future is limited. Therefore, this extra wheat production has to come by increase in productivity. Productivity of wheat is becoming either stagnated or reduced in India due to various reasons like improper tillage practices, imbalanced fertilizer use, water scarcity, weed infestation, unpredictable monsoon seasons, poor quality seeds, over irrigation and over fertilization and soil become less fertile etc. (Kantwa *et al*., 2015) [8].

Under late sowing, the yield reduction is principally due to delayed germination, insufficient seedling emergence and inappropriate stand establishment because of low temperature prevailing at sowing time (Patra and Singh, 2018) [14].

Conservation agriculture is a part of sustainable agriculture, aiming at optimizing yields and profits but also at protecting land resources and the environment. It 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 (Dumanski *et al*., 2006) [5].

In additional to reduction in the cost of cultivation (Malik *et al.*, 2005) [10] and getting stable yield (Abrol and Sangar, 2006) [1].
Fertilizers play a pivotal role in increasing yield and improving the quality of crops. Application of NPK in balanced level has great impact on late sown wheat yield. Since, high yielding varieties of wheat have been found highly responsive to nitrogen fertilization. The efficiency of both nitrogen and phosphorus is greatly enhanced in the presence of each other (Stoeva and Tonev, 2003) [23]. Increased use of N without adding required K in soil has further aggravated K deficiency because, K play important role in improvement of the growth indices (Chesti *et al*., 2013) [3].
Adoption of zero tillage is likely to be primarily dependent upon the extensive use of chemicals herbicides, such as pre-sowing, pre- emergence and post emergence. Post emergence application of Sulfosulfuron provides effective control of Isoproturon resistant *Phalaris minor* along with marginal control of broadleaf weeds in wheat. Several broadleaf weeds are becoming a serious problem along with grassy weeds in wheat. Metsulfuron-methyl and 2, 4-D has been recommended for the control of broadleaf weeds in wheat (Yadav and Malik, 2005) [5]. Some available ready-mix herbicides such as, Sulfosulfuron + Metsulfuron methyl, Clodinafop + Metsulfuron methyl etc. effectively control both grassy and broad leaves (Bharat and Kachroo, 2002 and Singh P.K., 2008) [2, 20], as well.
To curb this trend of declining yield, there is a need to adopt the concept of tillage, fertility levels and weed management on late sown wheat. The appropriate combination of tillage practices, fertility levels along with weed management can be feasible and viable to sustain agriculture as a commercial and profitable means ensuring high yield of crop without deterioration in quality of the produce.
However, information regarding tillage, fertility levels and weed management in wheat production in Uttar Pradesh is lacking. Keeping in view the above discussed facts of sufficient information and sparce related research, the present investigation was undertaken to find out the effect of tillage, fertility levels and weed management practices on growth of wheat in Ayodhya conditions.

Material and Methods

The experiment was conducted during two consecutive *rabi* seasons of years 2018-19 and 2019-20, respectively at Agronomy Research Farm of the Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya (U.P.), situated at latitude of 26º 47' North and longitude of 82º 12' East, with altitude of 113 meters above the mean sea level. The total rainfall of 65.5 and 228.4 mm were received during crop growing season of year, 2018-19 and 2019-20, respectively. The soil of the experimental field was silty loam in texture having slightly alkaline in reaction (pH 8.30 & 8.20), low in organic carbon (0.33 & 0.32%) and available nitrogen (137.60 & 136.82 kg ha^{-1}), but medium in available phosphorus (15.20 & 14.70 kg ha^{-1}) and potassium (249.30 & 248.20 kg ha^{-1}) during first and second year, respectively. The total rainfall experienced during the crop growth season was 65.5 mm in 2018-19 and 228.4 mm in 2019-20. K-7903 (halna) variety of wheat was used for sowing of the experiment. Tillage, fertility levels and weed management were done as per treatment.
The experiment was laid out in Split Plot Design assigning two tillage practices *viz*., Conventional tillage (3 ploughing) and Zero tillage (ferti-cum-seed drill) alongwith three fertility levels *viz*., 100% RDF (120:60:40 NPK kg ha^{-1}), 75 % RDF + 25% RDN- FYM (6 t ha^{-1}) and 50% RDF + 50% RDN- FYM (12 t ha^{-1}) in main plot. Each main plot was further divided into four sub plots to accommodate sub plot treatments *i.e*. weed management practices comprising Weedy check, Weed free upto 60 DAS, Sulfosulfuron @ 30 g a.i. ha^{-1} (POE) and Sulfosulfuron @ 30 g a.i. ha^{-1} + Metsulfuron @ 4 g a.i. ha^{-1} (POE) - Ready mixture. Each main plot as well as sub plot were surrounded by a buffer of 1.0 m. All growth and quality characters were recorded with standard procedures. The data relating to each character were analyzed as per the procedure of analysis of variance and significance was tested by “F” test (Gomez and Gomez 1984) [6].

Results and Discussions

Effect of tillage

Tillage practices influenced significantly almost all the growth parameters *viz*, plant height, number of tillers (m^{-2}), leaf area index and dry matter accumulation (g m^{-2}) at harvest stage (Table 1 & 2). Zero tillage recorded significantly higher values during both the experimental years for plant height (78.60 and 79.64 cm), number of tillers (291.57 and 300.57 m^{-2}), leaf area index (4.93 and 5.06) and dry matter accumulation (998.52 and 1009.27 g m^{-2}) except leaf area index during second year with non-significant effect over conventional tillage. Protein content was reached the level of significance with tillage during both the years (Table 3).
This might be due to better placement of seed in soil and moderation of temperature, suppression of weeds and conserve soil moisture leads to better germination and crop growth. These results were line up with the findings of Rajkhowa and Borah (2008) [15] and Usman *et al*. (2010) [24].

Effect of fertility levels

Among the fertility levels, application of 100% RDF (120:60:40 NPK kg ha^{-1}) recorded significantly higher plant height (79.84 and 80.55 cm), no. of tillers (296.55 and 305.69 m^{-2}), leaf area index (4.98 and 5.08) and dry matter accumulation (1008.03 and 1020.53 g m^{-2}) during *rabi*, 2018-19 and 2019-20, respectively (Table 1 & 2). However, fertility levels could not exerted significant effect on protein content during both the years (Table 3).
Taller plant height was due to favourable environment in the root zone resulting in absorption of more water, optimum uptake and utilization of nutrient by plant, which increased the metabolic process and performed better mobilization of synthesized carbohydrate into amino acid and proteins, which in turn stimulated rapid cell division and cell elongation and facilitated faster growth. In line with the above-said facts, the experimental findings of Ram and Mir (2006) [16]; Singh *et al.* (2007) [22] and Singh *et al*. (2008) [20].
The reason behind more number of tillers m^{-2} might have been credited to healthiness of main Culm due to more availability of nutrients initially and nominal availability at the time of tillering together led to positive effect of tillers production by crop growth. These finding are supported by the findings of Singh *et al.* (2007) [22]; Pandey *et al*. (2009) [13]; Sepat *et al*. (2010) [17] and Singh *et al*. (2011) [9].
Maximum leaf area index and dry matter accumulation might be due to higher plant height and number of tillers. Similar results were observed by Sepat *et al*. (2010) [17] and Singh *et al*. (2011) [9].

Effect of weed management

Weed free upto 60 DAS showed significantly higher values of growth characters *viz*., plant height, number of tillers, leaf area index and dry matter accumulation at harvest as well as protein content of wheat (Table 1-3). In case of herbicidal treatments, post emergence application of Sulfosulfuron @ 30 g a.i. ha^{-1} + Metsulfuron @ 4 g a.i. ha^{-1} (POE) - Ready mixture noted significantly higher plant height (80.12 and 80.30 cm), no. of tillers (298.47 and 307.72 m^{-2}), leaf area index (4.94 and 5.06), dry matter accumulation (1018.25 and 1030.53 g m^{-2}) as well as protein content (10.98 and 11.17 %) during both the experimental years (Table 1-3).

The increasing trends in terms of plant height, number of tillers, leaf area index and dry matter accumulation of wheat due to better control of weeds leading to efficient utilization of moisture, nutrients, space and light resulting in optimum growth characters (Gopinath *et al*., 2007) [7]. Higher protein content might be due to higher nitrogen content. These results are in close conformity with those reported by Meena and Singh (2011) [9], Pandey and Verma (2005) [12] and Shekhar *et al*. (2014) [18].

Table 1: Effect of tillage, fertility levels and weed management practices on plant height and tiller numbers of wheat at harvest

Treatments	Plant height (cm)		Number of tillers (m^{-2})	
	2018-19	2019-20	2018-19	2019-20
Tillage Practices (Main plot)				
Conventional tillage (3 ploughing)	73.19	74.54	278.55	287.15
Zero tillage (ferti-cum-seed drill)	78.60	79.64	291.57	300.57
SEm±	1.06	1.10	4.06	4.14
CD. at 5%	3.34	3.48	12.80	13.06
Fertility Levels (Main plot)				
100%RDF (120:60:40 NPK kg ha^{-1})	79.84	80.55	296.55	305.69
75 % RDF + 25% RDN- FYM (6 t ha^{-1})	76.15	77.90	283.15	291.93
50% RDF + 50% RDN- FYM(12 t ha^{-1})	71.70	72.83	275.48	283.96
SEm±	1.30	1.35	4.97	5.07
CD. at 5%	4.10	4.26	15.68	15.99
Weed management (Sub plot)				
Weedy check	66.77	68.63	251.63	259.42
Weed free upto 60 DAS	83.10	85.00	304.13	312.98
Sulfosulfuron @ 30 g a.i. ha^{-1} (POE)	73.60	74.43	286.00	295.32
Sulfosulfuron @30 g a.i. ha^{-1} + Metsulfuron @4 g a.i. ha^{-1} (POE)-Ready mixture	80.12	80.30	298.47	307.72
SEm±	1.31	1.38	4.90	5.30
CD. at 5%	3.76	3.97	14.05	15.21

Table 2: Effect of tillage, fertility levels and weed management practices on leaf area index and dry matter accumulation of wheat at harvest

Treatments	Leaf area index		Dry matter accumulation (g m^{-2})	
	2018-19	2019-20	2018-19	2019-20
Tillage Practices (Main plot)				
Conventional tillage (3 ploughing)	4.64	4.90	946.75	961.17
Zero tillage (ferti-cum-seed drill)	4.93	5.06	998.52	1009.27
SEm±	0.06	0.07	15.09	12.45
CD. at 5%	0.21	NS	47.55	39.23
Fertility Levels (Main plot)				
100%RDF (120:60:40 NPK kg ha^{-1})	4.98	5.08	1008.03	1020.53
75 % RDF + 25% RDN- FYM (6 t ha^{-1})	4.83	5.06	982.31	995.63
50% RDF + 50% RDN- FYM(12 t ha^{-1})	4.55	4.79	927.56	939.50
SEm±	0.08	0.08	18.48	15.25
CD. at 5%	0.26	0.27	58.23	48.05
Weed management (Sub plot)				
Weedy check	4.35	4.76	845.58	856.42
Weed free upto 60 DAS	5.23	5.37	1041.08	1055.92
Sulfosulfuron @ 30 g a.i. ha^{-1} (POE)	4.63	4.73	985.62	998.00
Sulfosulfuron @30 g a.i. ha^{-1} + Metsulfuron @4 g a.i. ha^{-1} (POE)-Ready mixture	4.94	5.06	1018.25	1030.53
SEm±	0.08	0.08	15.80	17.15
CD. at 5%	0.23	0.25	45.33	49.20

Table 3: Effect of tillage, fertility levels and weed management practices on protein content of wheat

Treatments	Protein content (%)	
	2018-19	2019-20
Tillage Practices (Main plot)		
Conventional tillage (3 ploughing)	10.71	10.85
Zero tillage (ferti-cum-seed drill)	10.76	10.90
SEm±	0.15	0.15
CD. at 5%	NS	NS
Fertility Levels (Main plot)		
100%RDF (120:60:40 NPK kg ha^{-1})	10.73	10.88
75 % RDF + 25% RDN- FYM (6 t ha^{-1})	10.87	11.01
50% RDF + 50% RDN- FYM(12 t ha^{-1})	10.60	10.74
SEm±	0.18	0.18

CD. at 5%	NS	NS
Weed management (Sub plot)		
Weedy check	10.23	10.29
Weed free upto 60 DAS	11.05	11.24
Sulfosulfuron @ 30 g a.i. ha^{-1} (POE)	10.68	10.80
Sulfosulfuron @30 g a.i. ha^{-1} + Metsulfuron @4 g a.i. ha^{-1} (POE)-Ready mixture	10.98	11.17
SEm±	0.18	0.19
CD. at 5%	0.52	0.55

Conclusions
From the above overall study, it is recommended that to obtain higher growth attributes and protein of wheat should be grown by zero tillage with 100% RDF (120:60:40 NPK kg ha^{-1}) alongwith post emergence application of Sulfosulfuron @ 30 g a.i. ha^{-1} + Metsulfuron @ 4 g a.i. ha^{-1} (POE) - Ready mixture under ago-climatic conditions of Ayodhya region of Eastern Uttar Pradesh.

Acknowledgement
Authors are highly thankful to Department of Agronomy, Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya for providing all the necessary facilities and kind support.

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