The Pharma Innovation Journal 2022; 11(3): 2053-2060

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(3): 2053-2060

www.thepharmajournal.com
Received: 12-12-2021
Accepted: 21-02-2022

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Effect of tillage and chemical weed control practices on the growth and quality characteristics of a late-sown wheat cultivar in Madhya Pradesh's Gird region (*Triticum aestivum* L.)

PK Para, SS Kushwah, J Sharma, BK Sharma and G Malgaya

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, Department of Agronomy, R.V.S.K.V.V. Gwalior (M.P.) during the Rabi season of 2019-20 and 2020-21.To find out the effect of various tillage and chemical weed control practices on growth, yield attribute, yield, nutrients content, after harvesting the wheat crop, and economics of various treatments. The combination of the five tillage systems (CT, ZT, MT) and seven weed management practices (Solfosulfuron, Metsulfuron-Methyl, Clodinafop, Solfosulfuron+ Metsulfuron-Methyl, Clodinafop+ Metsulfuron-Methyl, Two hand weeding, and weedy check) was laid out in Split Plot Design and replicated thrice. The results reported that the higher growth parameters *viz*., number of tillers, leaf area, dry weight per plant protein and starch content were recorded under during both the experimental years. Among the zero tillage conditions recorded higher growth parameters. In the case of chemical weed practices, weed-free up to 60 DAS exerted a significant effect on the growth of wheat. However, in herbicidal treatments, post emergence application of clodonafop + metsulfuron - methyl, (60+4) g/ha ready mixture noted higher values of the above parameters after weed-free treatment. Protein and starch content was to show significant effect due to the above treatments tillage and chemical weed practices.

Keywords: Effect of tillage, quality of wheat field experiment, and chemical weeds practices

Introduction
Wheat (*Triticum aestivum* L.) is the world's most important staple food crop and has emerged as the foundation of India's food security. It feeds approximately 36% of the world's population. It contains approximately 12% protein, 2% total fat, and 55% carbohydrates (Kumar *et al*., 2011). Food demand in India is expected to rise significantly in the coming decades; according to the study, India's total demand for food grains will rise from 236.2 million tonnes in 2010 to 272-277 million tonnes in 2020 and 303-318 million tonnes in 2030. (DACFW, 2017) [8]. As a result, in order to meet the demand for food grains, we must increase wheat production and productivity.
The possibility of expanding wheat production in the coming years is limited. As a result, any increase in wheat production must be accompanied by an increase in productivity. Wheat productivity in India is either stagnating or decreasing due to a variety of factors such as improper tillage practices, imbalanced fertilizer use, water scarcity, weed infestation, unpredictable monsoon seasons, poor quality seeds, over-irrigation and over-fertilization, and soil becoming less fertile, among others (Kantwa *et al.*, 2015) [11]. Formalized paraphrase late sowing reduces yield primarily due to delayed germination, insufficient seedling emergence, and insufficient stand establishment due to low temperatures at sowing time (Patra and Singh, 2018) [19]. Protein is the largest component of wheat grain. The storage protein (gliadin and glutenin) are the most important fractions determining the viscoelastic properties of dough for different foodstuff making (Leon *et al*. 2010) [16]. Wheat grain comprises three major tissues the embryo (germ), endosperm, and the outer layer which account for 3%, 80%, 85%, and 13%, 14% of the dry weight respectively (Barron *et al.*, 2007) [1].

Materials and Methods
The experiment was carried out at the Research Farm of the Department of Agronomy, College of Agriculture, and Gwalior (M.P.).

The field's topography was uniform, with proper drainage. The experimental field's soil type was sandy clay loam. The experiment was conducted using a split-plot design (SPD), with each treatment being replicated three times. The experiment included two components: tillage practices and chemical weed control methods. The combination of three tillage systems (CT, ZT, MT) and seven chemical weed management practices (Solfosulfuron, Metsulfuron-Methyl, Clodinafop, Solfosulfuron+ Metsulfuron-Methyl, Clodinafop+ Metsulfuron-Methyl, Clodinafop+ Metsulfuron-Methyl, Two hand weeding, Weeds were sprayed with herbicide at the 4-5 leaf stage (30 DAS). All other agronomic practices were applied in the same proportion to each experimental unit. Plant height and number of tillage were recorded. Leaf area, dry weight per plant, protein, and starch content, grain yield, biological yield straw yield (q ha-1), and harvest index are all factors to consider. All of the collected data was statistically analyzed using the appropriate split-plot design procedure. The treatment comparisons were conducted at a 5% level of significance.

Growth attributes

Leaf area /m row length

On each sampling, plants were harvested brought to the laboratory. Leaves and Stems were separated and the outline of all leaves from each plant was traced on a paper that had a uniform matter distribution with the area. The leaf shape was cut out from, the paper, the leaf was calculated. Montgomery (1911), first suggested that the leaf area of the plant can be calculated from linear measurements of leaves using a general relationship: LA= Length × Width × N× B, Where B is a coefficient, N is the number leaves/meter row length.

Total no. of tiller per meter row length

Total no of tiller/m row length were recorded after 30, 60, 90 days of sowing and stage of crop maturity. Effective tillers were counted from selected 5 tagged plants at maturity. Fallen tillers were ignored derive the count of effective tillers**.**

Dry weight /Plant

The plants were uprooted randomly at one place by quadrate of one square meter with the help of Khurpi in each plot at 30, 60, 90 days. These were oven-dried for ten days and their weight was recorded in grams.

The harvest index is the ratio of economic (grain) yield out of total biological (grain + straw) yield which is expressed in percentage. It estimates the partitioning of the dry matter between grain and straw. It was calculated under each treatment as per the formula suggested by Donald and Hamblin (1976) given below:

$$\text{Harvest Index (\%)} = \frac{\text{Economic yield/ha (grain yield) kg/plot}}{\text{Biological yield/ha (grain+ straw) kg/plot}} \text{X100}$$

Protein content

The protein percentage in seed was calculated by multiplying the nitrogen percentage with the factor 5.75. The percentage of nitrogen content in seed was determined by the following formula:

$$\text{Nitrogen percentage} = \frac{0.014 \text{ normality of } H_2SO_4 \times \text{volume of } H_2SO_4 \text{ required titration}}{\text{Weight of sample taken (g)}} \text{X100}$$

The nitrogen content of seeds was estimated by the micro – The Kjeldahl method (Piper, 1950). The protein percentage was calculated by using the following formula:

Total Protein = Total nitrogen x 5.75

$$\text{Protein yield (kg/ha)} = \frac{\text{Protein percent in grain x grain yield(kg/ha)}}{100}$$

Starch Content

The total starch, amylose, and amylopectin contents were determined via the dual-wavelength iodine binding method. Wheat grains that were marked flowering on the same day were first ground using a mortar, and the powder was then degreased twice with anhydrous ether. A 100 mg fraction of each sample was used to determine amylose and amylopectin contents. A calibration curve was derived using pure amylose from potato (A0512; Sigma–Aldrich, St. Louis, MO, USA) and pure amylopectin from potato (A8515; Sigma–Aldrich). The sum of amylose and amylopectin contents was designated as the total starch content.

Results and Discussion

Leaf area (cm^2)

The leaf area as influenced by the both factor like different tillage and chemical weed control practices. Leaf area is presented in table1.The maximum leaf area was recorded in zero tillage T_1 (11440cm^2 and 11296cm^2 in 2019-20 and 2020-21 respectively) followed by the minimum tillage and conventional tillage. The average data of the two-year experiment also shows that the maximum leaf area was recorded in zero tillage T_1 (11368cm^2) and the critical difference was non-significant in both year and average data.

Table 1: Effect of tillage and chemical weed control practices on leaf area per meter row length of wheat crop

Treatments		**Leaf area (cm2)**		
A. Tillage	**Sy.**	**2019 - 20**	**2020-21**	**Pooled**
Zero tillage	T_1	11440	11296	11368
Minimum tillage	T_2	11049	10684	10867
Conventional tillage	T_3	10987	10338	10663
S.E. m (d)		385	191	215
C.D. (at 5%)		NS	NS	NS
B. Weed control practices				
Sulfosulfuron (25g\ha)	W_1	11249	10724	10987
Metsulfouron -methyl(4g/ha)	W_2	10748	10483	10616
Coldinafop (60g\ha)	W_3	10621	10213	10417
Sulfosulfuron+Metsulfouron–methyl(30+2) g/ha (Ready mix)	W_4	11617	10811	11214
Coldinafop+ Metsulfouron-methyl (60+4g/ha) (Ready mix)	W_5	11837	11411	11624
Two hand weeding (30&60DAS)	W_6	12090	11747	11918

Weedy check	W_7	9948	10020	9984
S.E. m (d)		359	389	265
C.D. (at 5%)		1030	1116	746
Interaction (TxW)		NS	NS	NS

In the weed control practices, the highest leaf area was significantly recorded in treatment two hand weeding (30&60DAS) W_6 (12090 cm^2 and 11747cm^2 in 2019-20 and 2020-21 respectively) weed control practices while the minimum leaf area was recorded in treatment weedy check W_7 (9948cm^2 in 2019-20 and 10020cm^2 in 2020-21). The calculation of the pooled data, as influenced by the both factors and the highest leaf area was also recorded in the treatment two hand weeding (30&60DAS) W_6 (11918cm^2) weed control practices followed by treatment W_4 (11214cm^2) and W_5 (11624cm^2) while the minimum leaf area was recorded in the treatment weedy check W_7 (9984cm^2). The intraction was non-significant in both of the year and pooled also.

The effects of tillage significantly varied the leaf area and the two-year experiment also shows that the maximum leaf area was recorded in zero tillage followed by minimum tillage and conventional tillage.

The leaf area as influenced by weed control practices and the highest leaf area was also recorded in the treatment two hands weeding (30&60DAS) W6 while the minimum leaf area was recorded in the treatment weedy check W7. The variation in leaf area might be due to the positive response of treatment variation. Different types of tillage give an impact on plant height and different weed control practices also show variation. The closely finding are Benkherbache *et al*. (2012), Karrou, *et al*. (2013, and Karrou, (2013b) [3, 12, 13].

Table 2: Effect of tillage and weed control practices on tillers per meter row length at various stages of crop growth in wheat

Treatments		Total no of tiller per/m row											
		30 DAS			60 DAS			90 DAS			Maturity		
A. Tillage	Sy.	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled
Zero tillage	T_1	87.35	84.60	85.97	145.62	143.96	144.79	138.51	136.20	137.35	133.78	130.57	132.18
Minimum tillage	T_2	85.31	83.74	84.53	143.51	142.58	143.05	137.12	134.16	135.64	131.87	128.81	130.34
Conventional tillage	T_3	83.47	82.49	82.98	141.19	140.16	140.67	134.00	132.56	133.28	130.32	126.00	128.16
S.E. m (d)		0.52	0.38	0.32	1.92	1.30	1.16	0.76	0.20	0.39	1.46	1.92	1.21
C.D. (at 5%)		2.02	1.48	1.04	NS	NS	NS	2.99	0.77	1.28	NS	NS	NS
B. Weed control practices													
Sulfosulfuron (25g\ha)	W_1	84.47	83.64	84.06	140.10	139.26	139.68	134.29	132.98	133.64	130.67	126.67	128.67
Metsulfouron -methyl(4g/ha)	W_2	84.07	83.50	83.78	142.00	141.00	141.50	135.90	133.60	134.75	131.04	127.56	129.30
Coldinafop(60g\ha)	W_3	84.75	83.00	83.87	143.67	142.57	143.12	137.14	135.07	136.10	132.08	128.11	130.09
Sulfosulfuron+Metsulfouron–methyl (30+2) g/ha (Readymix)	W_4	86.02	84.19	85.10	145.40	144.47	144.93	138.06	135.55	136.80	132.93	129.56	131.24
Coldinafop+ Metsulfouron-methyl (60+4) g/ha, (ready mix)	W_5	86.85	84.41	85.63	146.97	145.62	146.30	138.55	136.77	137.66	134.62	131.33	132.98
Two hand weeding (30&60 DAS)	W_6	87.87	84.86	86.36	148.88	146.67	147.78	139.68	137.04	138.36	135.97	132.67	134.32
Weedy check	W_7	83.63	81.69	82.66	137.06	136.07	136.56	132.16	129.13	130.65	126.60	123.33	124.97
S.E. m (d)		1.26	1.04	0.82	1.61	1.18	1.00	0.82	0.68	0.53	2.26	2.92	1.85
C.D. (at 5%)		3.62	2.99	2.30	4.61	3.38	2.81	2.34	1.95	1.50	NS	NS	NS
Interaction (TxW)		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

The total no of tiller per/m row at 30 DAS

Data presented in table 2 shows that the total no of tiller per/m row at 30 DAS was significantly influenced by both of the factor *viz.*, tillage and weed control practices. The maximum total no of tiller per/m row was recorded in zero tillage T_1 (87.35 per/m row and 84.60 per/m row in 2019-20 and 2020-21) followed by the minimum tillage and conventional tillage. The average of the two-year experiment also shows that the maximum total no of tiller per/m row was recorded in zero tillage T_1 (85.97 per/m row) followed by the minimum tillage and conventional tillage.

During the evaluation of total no of tiller per/m row on weed control practices, the highest total no of tiller per/m row was recorded in treatment two hand weeding (30&60DAS) W_6 (87.87per/m row and 84.86per/m row in 2019-20 and 2020-21) weed control practices while the minimum total no of tiller per/m row was recorded in treatment weedy check W_7 (83.63 per/m row in 2019-20 and 81.69 per/m row in 2020-21). The calculation of the pooled data, as influenced by the both factors and the highest total no of tiller per/m row was also recorded in the treatment two hand weeding (30&60DAS) W_6 (86.36 per/m row) weed control practices followed by the treatment W_4 (85.10 per/m row) and W_5 (85.63 per/m row) while the minimum total no of tiller per/m row was recorded in the treatment weedy check W_7 (82.66 per/m row). The interaction was non-significant in both of the year and pooled also.

The total no of tiller per/m row at 60 DAS

The total no of tiller per/m row at 60 DAS was influenced by both of the factor *viz.*, tillage and chemical weed control practices. The maximum total no of tiller per/m row was recorded in zero tillage T_1 (145.62 per/m row and 143.96 per/m row in 2019-20 and 2020-21 respectively) followed by the minimum tillage and conventional tillage. The average of the two-year experiment also shows that the maximum total no of tiller per/m row was recorded in zero tillage T_1 (144.79 per/m row) followed by the minimum tillage and conventional tillage. The critical difference was non-significant in both year and pooled also.

During the working on weed control practices, the highest total no of tiller per/m row was significantly recorded in treatment two hand weeding (30&60DAS) W_6 (148.88 per/m row and 146.67 per/m row in 2019 - 20 and 2020 - 21 respectively) weed control practices while the minimum total no of tiller per/m row was recorded in treatment weedy check W_7 (137.06 per/m row in 2019-20 and 136.07 per/m row in 2020 - 21). The calculation of the pooled data, as influenced by the both factors and the highest total no of tiller per/m row was also recorded in the treatment two hand weeding (30 & 60 DAS) W_6 (147.78 per/m row) weed control practices followed by the treatment W_5 (146.30 per/m row) while the minimum total no of tiller per/m row was recorded in the treatment weedy check W_7 (136.56 per/m row). The intraction was non-significant in both of the year and pooled also.

The total no of tiller per/m row at 90 DAS

The total no of tiller per/m row at 90 DAS was significantly influenced by both of the factor *viz.*, tillage and weed control practices. The maximum total no of tiller per/m row was recorded in zero tillage T_1 (138.51 per/m row and 136.20 per/m row in 2019-20 and 2020-21 respectively) followed by the minimum tillage and conventional tillage. The average of the two-year experiment also shows that the maximum total no of tiller per/m row was recorded in zero tillage T_1 (137.35 per/m row) followed by the minimum tillage and conventional tillage.

During the working on weed control practices, the highest total no of tiller per/m row was recorded in treatment two hand weeding (30 & 60 DAS) W_6 (139.68 per/m row and 137.04 per/m row in 2019 - 20 and 2020 - 20 respectively) weed control practices while the minimum total no of tiller per/m row was recorded in treatment weedy check W_7 (132.16 per/m row in 2019 - 20 and 129.13 per/m row in 2020 - 21). The calculation of the pooled data, as influenced by the both factors and the highest total no of tiller per/m row was also recorded in the treatment two hand weeding (30 & 60 DAS) W_6 (138.36 per/m row) weed control practices followed by the treatment W_5 (137.66 per/m row) while the minimum total no of tiller per/m row was recorded in the treatment weedy check W_7 (130.65 per/m row). The intraction was non-significant in both of the year and pooled also.

The total no of tiller per/m row at maturity

The total no of tiller per/m row at maturity was influenced by both of the factor *viz.*, tillage and weed control practices. The maximum total no of tiller per/m row was recorded in zero tillage T_1 (133.78 per/m row and 130.57 per/m row in 2019 - 20 and 2020 - 21 respectively) followed by the minimum tillage and conventional tillage. The average of the two-year experiment also shows that the maximum total no of tiller per/m row was recorded in zero tillage T_1 (132.18 per/m row) followed by the minimum tillage and conventional tillage. The CD was non-significant in both year and average data also.

During the working on weed control practices in sub plot, the highest total no of tiller per/m row was recorded in treatment two hand weeding (30 & 60 DAS) W_6 (135.97 per/m row and 132.67 per/m row in 2019-20 and 2020-21 respectively) weed control practices while the minimum total no of tiller per/m row was recorded in treatment weedy check W_7 (126.60 per/m row in 2019 - 20 and 123.33 per/m row in 2020-21). The calculation of the pooled data, as influenced by the both factors and the highest total no of tiller per/m row was also recorded in the treatment two hand weeding (30 & 60 DAS) W_6 (134.32 per/m row) weed control practices while the minimum total no of tiller per/m row was recorded in the treatment weedy check W_7 (124.97 per/m row). The critical difference was found non-significant in both year and pooled. The intraction was also non-significant in both of the year and pooled.

The tiller per meter row significantly differs by both of the factors *viz.*, tillage and chemical weed control practices and total no of tiller per/m row is spread the habit of the wheat plant. The tiller per meter row was significantly recorded at 30 DAS, 60 DAS, 90 DAS, and at maturity.

During working on different tillage operations, the significant maximum total no of tiller per/m row was recorded in zero tillage T1 at 30 DAS, 60 DAS, 90 DAS, and at maturity followed by minimum tillage and conventional tillage. The data shows that the total no of tiller per/m row continuously increases from 30 DAS to maturity while the highest total no of tiller per/m row was recorded at the 60 DAS growth stage. The calculation of the pooled data, as influenced by both factors and the highest total no of tiller per/m row was also recorded in the treatment two hands weeding (30&60DAS) W6 at all growth stages *viz.*, 30 DAS, 60 DAS, 90 DAS, and at maturity while the minimum total no of tiller per/m row was recorded in the treatment weedy check W7. The variation in no of tiller per meter row found significant difference might be due to the treatment variation and impact of both factors positively. The supporting findings are Chaudhary *et al.* (2011) [7], Singh *et al.*(2011b), Shehzed *et al.* (2012), Kumar *et al.* (2013) [15], Punia *et al.* (2013) [21], Yadav *et al.* (2014) [27], Pal *et al.* (2016) [18] and Singh *et al.* (2017) [23].

Table 3: Effect of tillage and weed control practices on Dry weight per plant at various stages of crop growth in wheat

Treatments		Dry weight/ plant (g)											
		30 DAS			50 DAS			70 DAS			90 DAS		
A. Tillage	**Sy.**	**2019-20**	**2020-21**	**Pooled**	**2019-20**	**2020-21**	**Pooled**	**2019-20**	**2020-21**	**Pooled**	**2019-20**	**2020-21**	**Pooled**
Zero tillage	T_1	1.16	1.17	1.16	3.09	3.30	3.19	4.00	4.44	4.22	10.08	10.65	10.36
Minimum tillage	T_2	1.11	1.14	1.13	2.94	3.16	3.05	3.74	4.21	3.97	9.74	10.26	10.00
Conventional tillage	T_3	1.09	1.12	1.10	2.84	3.02	2.93	3.56	3.95	3.76	9.58	10.02	9.80
S.E. m (d)		0.01	0.01	0.01	0.03	0.03	0.02	0.05	0.05	0.03	0.06	0.08	0.05
C.D. (at 5%)		NS	NS	NS	0.10	0.11	0.06	0.18	0.19	0.11	0.25	0.30	0.16
B. Weed control practices													
Sulfosulfuron (25g\ha)	W_1	1.12	1.15	1.14	2.89	3.15	3.02	3.63	4.17	3.90	9.86	10.21	10.04

Metsulfouron -methyl(4g/ha)	W_2	1.09	1.11	1.10	2.77	3.00	2.89	3.43	3.92	3.67	9.60	9.95	9.77
Coldinafop(60g\ha)	W_3	1.05	1.09	1.07	2.67	2.94	2.81	3.25	3.83	3.54	9.35	9.90	9.62
Sulfosulfuron+Metsulfouron-methyl (30+2) g/ha(Ready mix)	W_4	1.16	1.18	1.17	3.07	3.25	3.16	3.95	4.34	4.15	10.01	10.51	10.26
Coldinafop+Metsulfouron-methyl(60+4) g/ha (Ready mix)	W_5	1.20	1.22	1.21	3.32	3.49	3.41	4.41	4.78	4.60	10.18	10.73	10.46
Two hand weeding (30&60DAS)	W_6	1.25	1.27	1.26	3.56	3.68	3.62	4.85	5.11	4.98	10.62	11.17	10.89
Weedy check	W_7	0.95	0.99	0.97	2.41	2.61	2.51	2.83	3.27	3.05	8.96	9.70	9.33
S.E. m (d)		0.02	0.01	0.01	0.05	0.07	0.04	0.10	0.13	0.08	0.09	0.12	0.07
C.D. (at 5%)		0.04	0.04	0.03	0.15	0.19	0.12	0.29	0.38	0.24	0.25	0.34	0.21
Interaction (TxW)		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 4: Effect of tillage and chemical weed control practices on Dry weight per plant at Maturity stages of crop growth in wheat

Treatments		**Dry weight/ plant (g)**		
		Maturity		
A. Tillage	**Sy.**	**2019-20**	**2020-21**	**Pooled**
Zero tillage	T_1	10.84	10.63	10.74
Minimum tillage	T_2	10.63	10.42	10.52
Conventional tillage	T_3	10.46	10.28	10.37
S.E. m (d)		0.03	0.03	0.02
C.D. (at 5%)		0.12	0.10	0.07
B. Weed control practices				
Sulfosulfuron (25g\ha)	W_1	10.70	10.48	10.59
Metsulfouron –methyl (4g/ha)	W_2	10.53	10.35	10.44
Coldinafop (60g\ha)	W_3	10.34	10.15	10.25
Sulfosulfuron+Metsulfouron–methyl (30+2)g/ha (Ready mix)	W_4	10.88	10.67	10.78
Coldinafop+Metsulfouron-methyl (60+4)g/ha (Ready mix)	W_5	11.10	10.89	10.99
Two hand weeding (30&60DAS)	W_6	11.16	10.98	11.07
Weedy check	W_7	9.78	9.60	9.69
S.E. m (d)		0.06	0.04	0.04
C.D. (at 5%)		0.18	0.11	0.10
Interaction (TxW)		NS	NS	NS

The dry weight/ plant at 30 DAS

Data presented in table 3 shows that the dry weight/ plant at 30 DAS was influenced by both of the factor *viz.*, tillage and weed control practices. The maximum dry weight/ plant was recorded in zero tillage T_1 (1.16g and 1.17g in 2019-20 and 2020-21 respectively) followed by the minimum tillage and conventional tillage. The average of the two-year experiment also shows that the maximum dry weight/ plant was recorded in zero tillage T_1 (1.16g) followed by the minimum tillage and conventional tillage. The CD was non-significant in both year and pooled.

During the evaluation of dry weight per plant in weed control practices, the highest dry weight/ plant was recorded in treatment two hand weeding (30&60DAS) W_6 (1.25g and 1.27g in 2019-20 and 2020 - 21 respectively) weed control practices while the minimum dry weight/ plant was recorded in treatment weedy check W_7 (0.95g in 2019-20 and 0.99g in 2020-21). The calculation of the pooled data, as influenced by the both factors and the highest dry weight/ plant was also recorded in the treatment two hand weeding (30&60DAS) W_6 (1.26g) weed control practices while the minimum dry weight/ plant was recorded in the treatment weedy check W_7 (0.97g). The interaction was non-significant in both of the year and pooled also.

The dry weight/ plant at 50 DAS

The dry weight/ plant at 50 DAS was significantly influenced by both of the factor *viz.*, tillage and weed control practices. The maximum dry weight/ plant was recorded in zero tillage T_1 (3.09g and 3.30g in 2019 - 20 and 2020 - 21 respectively) followed by the minimum tillage and conventional tillage. The average of the two-year experiment also shows that the maximum dry weight/ plant was recorded in zero tillage T_1 (3.19g) followed by the minimum tillage and conventional tillage.

During the evaluation of dry weight per plant in weed control practices, the highest dry weight/ plant was recorded in treatment two hand weeding (30&60DAS) W_6 (3.56g and 3.68g in 2019 - 20 and 2020 - 21 respectively) weed control practices while the minimum dry weight/ plant was recorded in treatment weedy check W_7 (2.41g in 2019-20 and 2.61g in 2020-21). The calculation of the pooled data, as influenced by the both factors and the highest dry weight/ plant was also recorded in the treatment two hand weeding (30&60DAS) W_6 (3.62g) weed control practices while the minimum dry weight/ plant was recorded in the treatment weedy check W_7(2.51g). The intraction was non-significant in both of the year and pooled also.

The dry weight/ plant at 70 DAS

The dry weight/ plant at 70 DAS was significantly influenced by both of the factor *viz.*, tillage and weed control practices. The maximum dry weight/ plant was recorded in zero tillage T_1 (4.00g and 4.44g in 2019 - 20 and 2020 - 21 respectively) followed by the minimum tillage and conventional tillage. The average of the two-year experiment also shows that the maximum dry weight/ plant was recorded in zero tillage T_1 (4.22g) followed by the minimum tillage and conventional tillage.

During the evaluation of dry weight per plant in weed control practices, the highest dry weight/ plant was recorded in treatment two hand weeding (30&60DAS) W_6 (4.85g and 5.11g in 2019 - 20 and 2020 - 21 respectively) weed control practices while the minimum dry weight/ plant was recorded in treatment weedy check W_7 (2.83g in 2019-20 and 3.27g in 2020-21). The calculation of the pooled data, as influenced by the both factors and the highest dry weight/ plant was also recorded in the treatment two hand weeding (30 & 60 DAS) W_6 (4.98g) weed control practices while the minimum dry weight/ plant was recorded in the treatment weedy check W_7 (3.05g). The intraction effect of the both fector on both year and pooled was found non-significant.

The dry weight/ plant at 90 DAS

The dry weight/ plant at 90 DAS was significantly influenced by both of the factor *viz*., tillage and weed control practices. The maximum dry weight/ plant was recorded in zero tillage T_1 (10.08g and 10.65g in 2019 - 20 and 2020 - 21 respectively) followed by the minimum tillage and conventional tillage. The average of the two-year experiment also shows that the maximum dry weight/ plant was recorded in zero tillage T_1 (10.36g) followed by the minimum tillage and conventional tillage.

During the evaluation of dry weight per plant in weed control practices, the highest dry weight/ plant was recorded in treatment two hand weeding (30&60DAS) W_6 (10.62g and 11.17g in 2019-20 and 2020-21 respectively) weed control practices while the minimum dry weight/ plant was recorded in treatment weedy check W_7 (8.96g in 2019-20 and 9.70g in 2020-21). The calculation of the pooled data, as influenced by the both factors and the highest dry weight/ plant was also recorded in the treatment two hand weeding (30&60DAS) W_6 (10.89g) weed control practices followed by the treatment W_5 (10.99g) while the minimum dry weight/ plant was recorded in the treatment weedy check W_7 (9.33g). The interaction was non-significant in both of the year and pooled also.

The dry weight/ plant at maturity

Data presented in table 4 shows that the dry weight/ plant at maturity was significantly influenced by both of the factor *viz.*, tillage and weed control practices. The maximum dry weight/ plant was recorded in zero tillage T_1 (10.84g and 10.63g in 2019 - 20 and 2020 - 21 respectively) followed by the minimum tillage and conventional tillage. The average of the two-year experiment also shows that the maximum dry weight/ plant was recorded in zero tillage T_1 (10.74g) followed by the minimum tillage and conventional tillage.

During the evaluation of dry weight per plant in weed control practices, the highest dry weight/ plant was recorded in treatment two hand weeding (30&60DAS) W_6 (11.16g and 10.98g in 2019 - 20 and 2020 - 21 respectively) weed control practices while the minimum dry weight/ plant was recorded in treatment weedy check W_7 (9.78g in 2019 - 20 and 9.60 g in 2020 - 21). The calculation of the pooled data, as influenced by the both factors and the highest dry weight/ plant was also recorded in the treatment two hand weeding (30&60DAS) W_6 (11.07g) weed control practices followed by the treatment w_5 (10.99g) while the minimum dry weight/ plant was recorded in the treatment weedy check W_7 (9.69g). The intraction was non-significant in both of the year and pooled also.

Dry weight/ plant is an indication of the total accumulation of photosynthates in wheat plants. More dry weight/ plant indicates good growth and more accumulation of photosynthates. Dry weight/ plant was recorded at different growth intervals *viz*., 30 DAS, 50 DAS, 70 DAS, 90 DAS, and at maturity. The presented table shows that the dry weight/ plant continuously increases from 30 DAS to maturity while the highest dry weight/ plant was recorded at the harvest stage.

The average of the two-year experiment also shows that the maximum dry weight/ plant was recorded in zero tillage T1 followed by the minimum tillage and conventional tillage. About the calculation of the mean effect of both factors like tillage operation and weed control practices as influenced significantly and the highest dry weight/ plant was also recorded in the treatment two hands weeding (30&60DAS) W6 weed control practices while the minimum dry weight/ plant was recorded in the treatment weedy check W7. The variation in dry weight/ plant found significant difference might be due to the treatment variation and minimum completion of the wheat crop for different weeds. The supporting findings Brar *et al*. (2010) [6], Pradhan *et al*. (2010) [20], Bharat *et al.* (2012) [4], Dwivedi *et al.* (2012) [10], and Singh *et al.* (2017) [23].

Table 5: Effect of tillage and weed control practices on protein content (%) and starch content (%) of wheat

Treatments		Quality parameters					
		Protein content (%)			Starch content (%)		
A. Tillage	**Sy.**	**2019-20**	**2020-21**	**Pooled**	**2019-20**	**2020-21**	**Pooled**
Zero tillage	T_1	12.96	12.79	12.88	67.74	65.32	66.53
Minimum tillage	T_2	12.78	12.56	12.67	66.49	66.41	66.45
Conventional tillage	T_3	12.62	12.37	12.49	65.72	67.31	66.52
S.E. m (d)		0.02	0.12	0.06	0.17	0.37	0.20
C.D. (at 5%)		0.08	0.49	0.21	0.67	1.44	0.66
B. Weed control practices							
Sulfosulfuron (25g\ha)	W_1	12.90	12.69	12.79	66.22	66.88	66.55
Metsulfouron -methyl(4g/ha)	W_2	12.73	12.47	12.60	66.80	66.16	66.48
Coldinafop(60g\ha)	W_3	12.64	12.31	12.47	66.15	65.75	65.95
Sulfosulfuron+Metsulfouron-methyl(30+2)g/ha(Ready mix)	W_4	13.00	12.82	12.91	67.65	67.10	67.38
Coldinafop+Metsulfouron-methyl(60+4)g/ha(Ready mix)	W_5	13.11	12.91	13.01	67.95	67.65	67.80
Two hand weeding(30&60DAS)	W_6	13.22	13.11	13.17	68.32	67.94	68.13
Weedy check	W_7	11.89	11.70	11.80	63.46	62.96	63.21
S.E. m (d)		0.19	0.27	0.16	0.49	0.53	0.36
C.D. (at 5%)		0.53	0.77	0.46	1.42	1.51	1.02
Interaction (TxW)		NS	NS	NS	NS	NS	NS

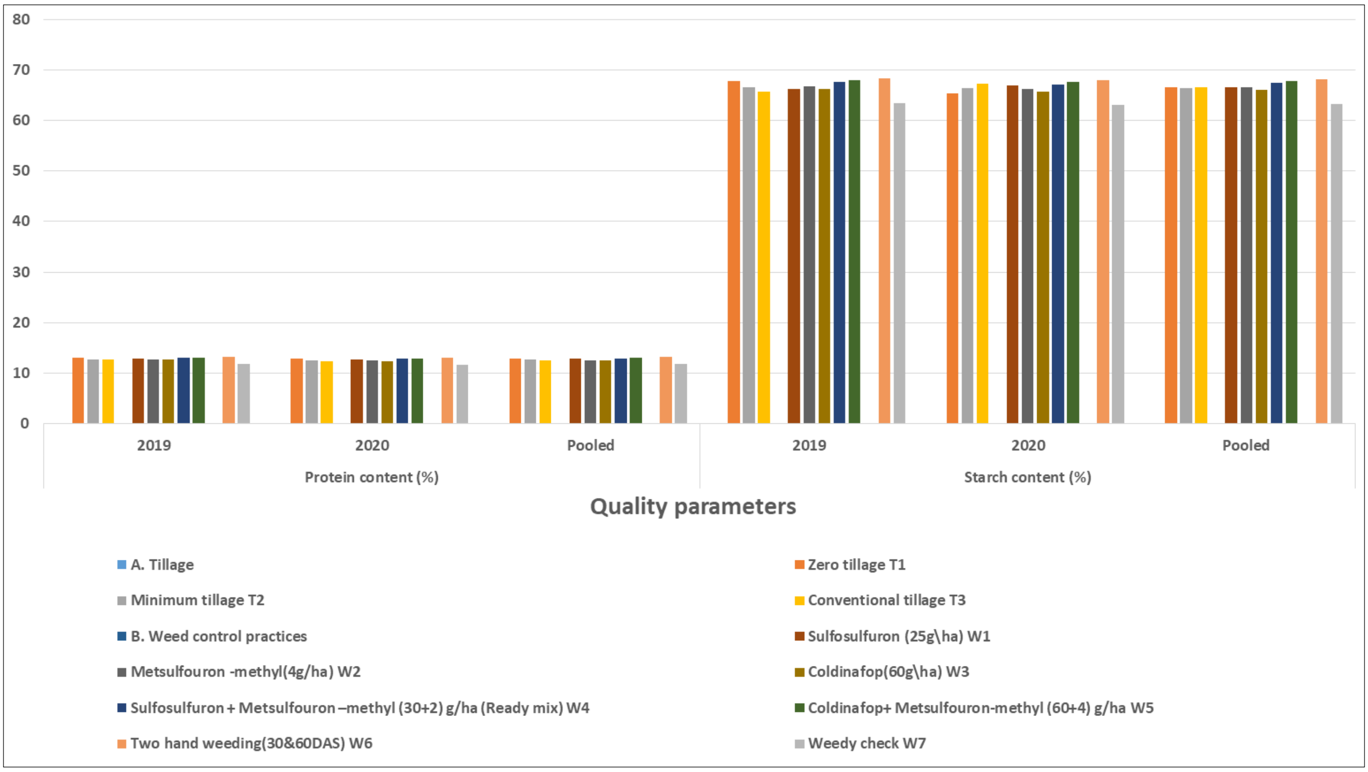

Fig 1: Effect of tillage and weed control practices on protein content (%) and starch content (%) of wheat

Protein content (%)

The data presented in table 3 and graphically illustrate in figure1.The protein content was significantly influenced by both of the factor *viz.*, tillage and weed control practices. The maximum protein content was recorded in zero tillage T_1 (12.96% and 12.79% in 2019-20 and 2020-21 respectively) followed by the minimum tillage and conventional tillage. The average of the two-year experiment also shows that the maximum protein content was recorded in zero tillage T_1 (12.88%) followed by the minimum tillage and conventional tillage.

During the evaluation of protein content in different weed control practices, the maximum protein content was recorded in treatment two hand weeding (30&60DAS) W_6 (13.22% and 13.11% in 2019-20 and 2020-21 respectively) weed control practices while the minimum protein content was recorded in treatment weedy check W_7 (11.89% and 11.70% in 2019-20 and 2020-21 respectively). The calculation of the pooled data, as influenced by the both factors and the highest protein content was also recorded in the W_6 (13.17%) weed control practices followed by treatment W_1 (12.79%), W_4 (12.91%) and W_5 (13.01%) while the protein content was recorded in the treatment weedy check W_7 (11.80%). The intraction was non-significant in both of the year and pooled also.

Starch content (%)

The starch content was varied in both of the year and significantly influenced by both of the factor *viz.*, tillage and weed control practices. The maximum starch content was recorded in zero tillage T_1 (67.74% in 2019-20) and conventional tillage T_3 (67.31% in 2020-21) while the minimum starch content was recoded in conventional tillage T_3 (65.72% in 2019-20) and zero tillage T_1 (65.32% in 2020-21). The average of the two-year experiment also shows that the maximum starch content was recorded in zero tillage T_1 (66.53%) followed by the minimum tillage and conventional tillage.

During the evaluation of starch content in different weed control practices, the highest starch content was recorded in treatment two hand weeding (30&60DAS) W_6 (68.32% and 67.94% in 2019-20 and 2020-21 respectively) weed control practices while the minimum starch content was recorded in treatment weedy check W_7 (63.46% and 62.96% in 2019-20 and 2020-21 respectively). The calculation of the pooled data, as influenced by the both factors and the highest starch content was also recorded in the treatment two hand weeding (30&60DAS) W_6 (68.13%) weed control practices followed by treatment W_4 (67.38%) and W_5 (67.80%) while the minimum starch content was recorded in the treatment weedy check W_7 (63.21%). The intraction was non-significant in both of the year and pooled also.

The significant variation in quality parameters was recorded and it was significantly influenced by both of the factors. The quality parameters like protein content and starch content were recorded in this paragraph.

The average data of the two-year experiment also shows that the maximum protein content and starch content were recorded in zero tillage T_1 followed by the minimum tillage and conventional tillage. During the work on the weed control practices, as influenced by both factors and the highest protein content and starch content were also recorded in the treatment two hands weeding (30&60DAS) W6 weed control practices while the minimum protein content and starch content was recorded in the treatment weedy check W_7. The variation in quality parameters recorded might be due to the accumulation of photosynthates for the formation of protein and starch and absorbing the nutrient from the soil. The formation of protein and starch varied as per the minimum weed competition for the wheat plant anabolism. The closely finding are Ugalde and Jenner, (1990b) [26], Barron *et al.* (2007) [2], Leon *et al.* (2010) [17], Zhang *et al.* (2010) [28], and Tosi *et al.* (2011) [25]

Acknowledgment
We would like to thank the Department of Agronomy. The authors acknowledge the funding support from R.V.S.K.V.V University.

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