



Influence of seed rate and fertilizer levels on agro physiological parameters and yield of dual-purpose wheat (*Triticum aestivum*)

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ABSTRACT

The experiment was conducted at Research Farm of Agronomy, CCS HAU, Hisar during *rabi* season of the year 2017-18 and 2018-19 to study the influence of seed rate and fertilizer levels on agro-physiological parameters and yield of dual purpose wheat (*Triticum aestivum* L.). Four treatments, viz: C 306 without cut (S_1), C 306 with cut at 60 DAS (S_2), WH 1105 without cut (S_3), WH 1105 with cut at 60 DAS (S_4) in main plot and six seed rate and fertilizer combinations, viz: 100 kg/ha seed rate + 100% RDF (M_1), 100 kg/ha seed rate + 115% RDF (M_2), 100 kg/ha seed rate + 130% RDF (M_3), 125 kg/ha seed rate + 100% RDF (M_4), 125 kg/ha seed rate + 115% RDF (M_5), 125 kg/ha seed rate + 130% RDF (M_6) in subplot with three replications were laid out in split-plot design. Results of this study indicate that wheat plant population was not influenced by different cultivars and different dose of fertilizers, but it was significantly affected by seed rate and fertilizer levels. Plant population was significantly higher (55.66 and 54.55/m.r.l.) in wheat sown at 125 kg/ha seed rate with 130% RDF over wheat sown at 100 kg/ha seed rate with either dose of fertilizer during both the years. Significantly higher dry matter accumulation (417.41 and 384.10 g/m.r.l. at harvest), LAI and total tillers were recorded in WH 1105 under without cut management, whereas, significantly taller plants (140.55 and 136.19 cm at harvest) was recorded in C 306 under without cut management. While comparing the seed rate and fertilizer combination treatments, significantly higher dry matter accumulation (320.88 and 295.87 g/m.r.l. at harvest), plant height (115.92 and 113.01 cm at harvest), LAI and total tillers was recorded in wheat sown at 125 kg/ha seed rate with 130% RDF. Significantly higher grain yield (6590 and 6091 kg/ha) was recorded in WH 1105 under without cut management sown at 125 kg/ha seed rate with 130% RDF over C 306 under either cut management sown at either seed rate with either fertilizer levels during both years, which was statistically at par with WH 1105 sown at 125 kg/ha seed rate with 115% RDF and WH 1105 sown at 100 kg/ha seed rate with 130% RDF.

Key words: Cultivars, Leaf area index, Seed rate, Wheat, Yield

Wheat (*Triticum aestivum* L.) is one of the most important food crops among cereals and also source of fodder for animals (Devi *et al.* 2017). It contributes about 35% of the total food grains production in country. The area, production and productivity of wheat in India is 29.95 mha, 99.87 mt and 3368 kg/ha and in Haryana is 2.44 mha, 10.76 mt and 4413 kg/ha, respectively (FAO STAT 2017-18).

The nitrogen fertilization is the most limiting factor in the production of grain and forage production of dual-purpose wheat. The quantity and time of application of nitrogen fertilizer is very crucial for attaining the normal growth of the regenerated vegetative material in wheat after cut for fodder. Application of higher doses of fertilizers particularly nitrogen may not be always seen in the form of grain yield, but may be in form of production of vegetative

parts such as plant height, number of leaves and number of tillers etc.

Many researchers have found that late season top dressed nitrogen addition as dry fertilizer material were most effective in attaining higher grain protein concentration, yield and increased fertilizer recovery and efficiency (Yousaf *et al.* 2015). Seed rate also plays a key role in the plant growth, development like nitrogen grain yield and quality of wheat. Seed rate governs inter and intra plant competition, the numbers of tillers per plant, spikelet number per spike, grain size, grain shape etc.

MATERIALS AND METHODS

The present investigation was conducted at Research Farm of Department of Agronomy, CCSHAU, Hisar, during *rabi* season of the year 2017-18 and 2018-19. The soil of experimental field was slightly saline in reaction (pH 7.9), sandy loam in texture, low in organic carbon (0.44 %) and available nitrogen (128 kg/ha), medium in available phosphorus (28.5 kg/ha) and high in available potassium (378 kg/ha). Soil texture was determined by international

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pipette method (Piper 1966), pH by Glass electrode pH meter (Jackson 1973), organic carbon by Walkley and Black's rapid titration method (Walkley and Black 1934), available nitrogen by alkaline permanganate method (Subbiah and Asija 1956), available phosphorus by Olsen's method (Olsen *et al.* 1954) and available potassium by flame photometric method (Jackson 1958). Four treatments, viz: C 306 without cut (S_1), C 306 with cut at 60 DAS (S_2), WH 1105 without cut (S_3), WH 1105 with cut at 60 DAS (S_4) in main plot and six seed rate and fertilizer combinations viz: 100 kg/ha seed rate + 100% RDF (M_1), 100 kg/ha seed rate + 115% RDF (M_2), 100 kg/ha seed rate + 130% RDF (M_3), 125 kg/ha seed rate + 100% RDF (M_4), 125 kg/ha seed rate + 115% RDF (M_5), 125 kg/ha seed rate + 130% RDF (M_6) in subplot with three replications were laid out in split-plot design. Recommended doses of N:P:K @ 150-60-30 kg/ha were applied through urea, diammonium phosphate (DAP) and muriate of potash (MOP), respectively. N fertilizer was applied in 2 splits in without cut, *i.e.* 50% as basal dose and 50% after 1st irrigation, whereas, in cut management N was applied in 3 splits, *i.e.* 50% as basal dose, 25% after 1st irrigation and 25% after cut. After 60 days of sowing, dual-purpose tall wheat crop was harvested for fodder at 10 cm stubble height and left for regrowth for grain purpose. The data of plant population, plant height and dry matter accumulation was recorded periodically. The leaf area of the selected leaves was measured using leaf area meter. Leaf area index (LAI) was calculated according to Watson (1952). The crop was harvested at maturity and grain yield was recorded after threshing. Data analyzed by the method of analysis of variance (ANOVA) as described by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

Plant population (No. of plants/m.r.l.)

Plant population at 15 DAS of dual purpose wheat was not significantly affected by wheat cultivars and dose of nitrogen fertilizer (Table 1), however, higher plant population (53.66 and 52.59/m.r.l.) were recorded in WH 1105 wheat cultivar as compared to C 306 during both the years of study which might be due to bolder seed size of C 306. While comparing the seed rate and fertilizer combination treatments, significantly higher (about 20%) plant population was recorded in wheat sown with 125 kg/ha seed rate over wheat sown with 100 kg/ha with either dose of fertilizers. It may be due to the fact that plant population under lower seed rate was reduced. The result of present study was on the line of finding of Pandey (2005), Khalil *et al.* (2011), Naveed *et al.* (2014) and Atis and Akar (2018).

Dry matter accumulation (g/m.r.l.)

Before cutting for fodder (at 60 DAS), significantly higher dry matter accumulation was observed in no-cut plots as compared with cut-plots with either wheat cultivar during both the years of study (Table 2). In case of cultivars, higher dry matter accumulation was observed

Table 1 Effect of different seed and fertilizer levels on plant population of dual-purpose wheat

Treatment	Plant population (No./m.r.l.)	
	2017-18	2018-19
C 306 without cut	49.23	48.25
C 306 with cut at 60 DAS	49.33	48.34
WH 1105 without cut	52.30	51.25
WH 1105 with cut at 60 DAS	53.66	52.59
SEm ±	1.72	1.69
CD at 5%	NS	NS
100 kg/ha seed rate + RDF	46.23	45.31
100 kg/ha seed rate + 115% RDF	47.43	46.48
100 kg/ha seed rate + 130% RDF	48.00	47.04
125 kg/ha seed rate + RDF	54.33	53.24
125 kg/ha seed rate + 115% RDF	55.10	54.00
125 kg/ha seed rate + 130% RDF	55.66	54.55
SEm ±	0.96	0.94
CD at 5%	3.01	2.95

in C 306 at 30 and 60 DAS as compared with WH 1105 cultivar during both years. After fodder cut, significantly higher dry matter accumulation was observed in WH 1105 over C 306 after during both years. The possible reason of more dry matter accumulation under no-cut treatment might be the absence of cutting shock with no interruption in normal plant growth. At maturity, 45.12% higher dry matter accumulation was observed in WH 1105 over C 306 under without cut condition, whereas under with cut condition, 20.80 and 21.27% higher dry matter accumulation at maturity was observed in WH 1105 over C 306 during both the years. In case of cultivars, significantly higher dry matter accumulation was observed in WH 1105 cultivar as compared to C 306 after cut at 60 DAS during both years which might be due to more number of tillers in WH 1105 as compared to C 306.

In case of seed rate and fertilizer combination treatments, significantly higher dry matter accumulation at 30 DAS and 60 DAS was observed in wheat sown with 115% RDF over wheat sown with 100% RDF with either seed rate which was statistically at par with 130% RDF during both the years of study (Table 2). Abedi *et al.* (2011) also reported that increasing the N fertilization rate had a beneficial effect on grain yield and its quality. At maturity 10.74 and 10.94% higher dry matter accumulation was observed in wheat sown at 125 kg/ha seed rate with 130% RDF over wheat sown at 100 kg/ha seed rate with 100% RDF during both the years. It may be due to the fact that poor plant growth under nitrogen stress conditions. Khalil *et al.* (2011), Naveed *et al.* (2014) and Atis and Akar (2018) also reported similar results.

Plant height (cm)

In case of cultivars, significantly taller plants were

Table 2 Effect of different seed rate and fertilizer levels on dry matter accumulation (g/m.r.l.) of dual-purpose wheat

Treatment	Dry matter accumulation (g/m.r.l.)									
	2017-18					2018-19				
	30 DAS	60 DAS	90 DAS	120 DAS	At harvest	30 DAS	60 DAS	90 DAS	120 DAS	At harvest
C 306 without cut	12.19	65.03	121.37	225.90	287.64	11.95	62.47	113.49	210.16	264.69
C 306 with cut at 60 DAS	11.83	62.04	102.50	190.78	236.58	11.60	59.60	95.84	177.49	217.69
WH 1105 without cut	11.21	63.67	136.61	307.65	417.41	10.99	61.17	127.73	286.21	384.10
WH 1105 with cut at 60 DAS	10.88	60.01	91.69	206.49	285.78	10.66	57.64	85.73	192.10	264.00
SEm ±	0.08	0.43	1.02	1.89	3.30	0.08	0.42	0.95	1.76	2.94
CD at 5%	0.24	1.39	3.68	6.33	11.03	0.25	1.34	3.45	5.90	9.84
100 kg/ha seed rate + 100% RDF	11.35	61.28	108.77	223.96	289.77	11.12	58.87	101.70	208.36	266.64
100 kg/ha seed rate + 115% RDF	11.56	62.69	113.13	232.91	307.51	11.33	60.22	105.78	216.68	283.00
100 kg/ha seed rate + 130% RDF	11.64	63.38	115.09	236.91	316.81	11.42	60.89	107.61	220.40	291.69
125 kg/ha seed rate + 100% RDF	11.36	61.92	110.11	226.73	295.18	11.14	59.48	102.96	210.93	272.08
125 kg/ha seed rate + 115% RDF	11.57	63.11	114.49	235.62	310.98	11.35	60.62	107.05	219.20	286.38
125 kg/ha seed rate + 130% RDF	11.67	63.73	116.67	240.10	320.88	11.44	61.22	109.08	223.37	295.87
SEm ±	0.06	0.31	0.69	1.62	2.83	0.06	0.30	0.65	1.51	2.52
CD at 5%	0.18	1.00	2.30	4.99	8.71	0.18	0.96	2.16	4.65	7.76

observed in C 306 cultivar as compared to WH 1105 throughout crop season before and after cut at 60 DAS during both years (Table 3). At harvest, 37.25 and 34.96 per cent, taller plant height was observed in C 306 over WH 1105 under without cut condition, whereas under with cut condition, 31.93 and 30.01% taller plant height at harvest was observed in C 306 over WH 1105 during both the years. Reduction in plant height may be due to that cutting imposed stress causing termination of growth and new growth of shoot could not attain the same plant height. Similar results were observed by Jan *et al.* (2002), Khalil *et al.* (2011) and Iqbal *et al.* (2012).

In case of seed rate and fertilizer combination treatments, significantly taller plants were observed at 30 DAS and 60 DAS in wheat sown with 115% RDF over wheat sown with 100% RDF with either seed rate which was statistically at par with 130% RDF during both the years of study. This might be due to more nitrogen (N) availability resulting in taller plants and enhanced crop growth. Plant height showed direct relation with N and increased with increase of N availability. Similar trend were followed (after fodder cut at 60 DAS) at 90 DAS, 120 DAS and at harvest were observed in wheat sown with 115% RDF over wheat sown with 100% RDF with either seed rate remaining statistically at par with 130% RDF during both the years (Table 3). More than 4%

higher plant height at maturity was observed in wheat sown at 125 kg/ha seed rate with 130% RDF over wheat sown at 100 kg/ha seed rate with 100% RDF during both the years. Taller plants were observed with higher seed rate.

Leaf area index (LAI)

The data presented in Fig 1 shows that more leaf area was observed in C 306 at 30 and 60 DAS as compared with WH 1105 cultivar. After cutting for fodder at 60 DAS, significantly more leaf area was observed under no-cut plots with either wheat cultivar at 90 and 120 DAS during both years. The possible reason of more leaf area obtained under no-cut treatment might be the absence of cutting shock with no interruption in which result in or helps in fully developed

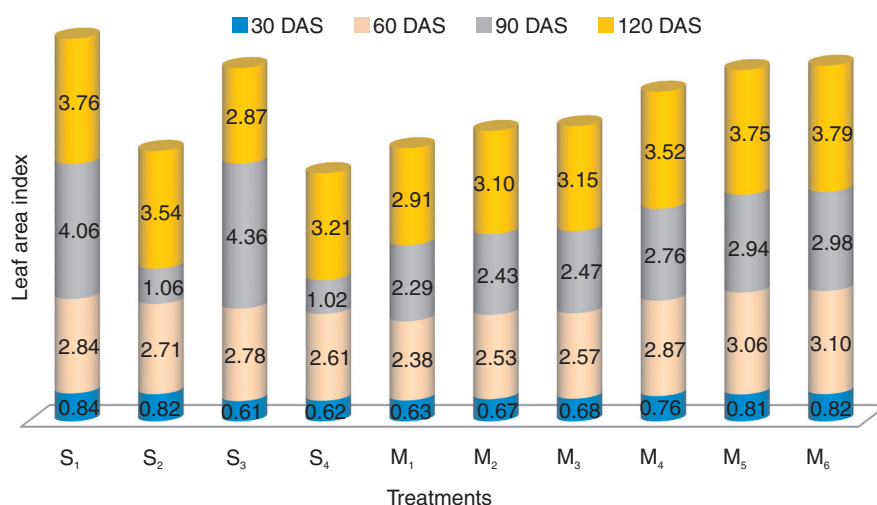


Fig 1 Effect of different seed and fertilizer levels on leaf area index (LAI) of dual-purpose wheat (2017-18).

Table 3 Effect of different seed rate and fertilizer levels on plant height (cm) of dual-purpose wheat

Treatment	Plant height (cm)									
	2017-18					2018-19				
	30 DAS	60 DAS	90 DAS	120 DAS	At harvest	30 DAS	60 DAS	90 DAS	120 DAS	At harvest
C 306 without cut	22.77	47.63	97.74	128.53	140.55	22.55	46.97	95.26	124.79	136.19
C 306 with cut at 60 DAS	22.12	45.44	78.15	109.84	120.06	21.89	44.81	76.17	106.64	116.34
WH 1105 without cut	20.92	46.43	85.74	98.80	102.68	20.73	45.99	84.64	97.34	100.91
WH 1105 with cut at 60 DAS	20.30	43.76	69.60	85.76	91.00	20.12	43.34	68.71	84.49	89.43
SEm ±	0.15	0.32	0.79	0.96	1.15	0.15	0.32	0.78	0.94	1.12
CD at 5%	0.51	1.04	2.88	3.51	3.86	0.49	1.03	2.83	3.41	3.77
100 kg/ha seed rate + 100% RDF	21.19	44.79	79.64	101.60	111.00	20.99	44.26	78.09	99.31	108.21
100 kg/ha seed rate + 115% RDF	21.59	45.82	82.87	105.82	113.54	21.38	45.28	81.25	103.38	110.69
100 kg/ha seed rate + 130% RDF	21.75	46.32	84.32	107.70	114.50	21.54	45.78	82.68	105.24	111.63
125 kg/ha seed rate + 100% RDF	21.22	45.25	80.63	102.87	111.99	21.02	44.72	79.06	100.55	109.18
125 kg/ha seed rate + 115% RDF	21.61	46.11	83.88	107.17	114.47	21.41	45.58	82.24	104.69	111.59
125 kg/ha seed rate + 130% RDF	21.79	46.57	85.50	109.23	115.92	21.59	46.03	83.83	106.73	113.01
SEm ±	0.11	0.23	0.54	0.65	0.70	0.11	0.23	0.53	0.64	0.68
CD at 5%	0.34	0.75	1.80	2.17	2.31	0.35	0.74	1.77	2.12	2.26

leaf with large leaf area normal plant growth. In case of cultivars, significantly more leaf area was observed in WH 1105 cultivar as compared to C 306 at 90 DAS which might be due to more number of tillers in WH 1105, while at 120 DAS, leaf area in C 306 was lesser as compared to WH 1105 during both years which might be due the fact that C 306 is longer duration variety as compared to WH 1105.

In case of seed rate and fertilizer combination treatments, significantly more leaf area was observed in wheat sown with 115% RDF at 30 DAS and 60 DAS over wheat sown with 100% RDF with either seed rate which was statistically at par with 130% RDF during both the years of study. Similar trend was followed by sown with 115% RDF over wheat sown with 100% RDF with either seed rate remaining at par with 130% RDF during both the years of study (after fodder cut at 60 DAS) at 90 DAS and 120 DAS wheat. At 120 DAS, 30.24 and 30.28% higher leaf area index was observed in wheat sown at 125 kg/ha seed rate with 130% RDF over wheat sown at 100 kg/ha seed rate with 100% RDF during both the years. Wheat sown with higher seed rate recorded more leaf area during both years. The result collaboration with the finding of Guru *et al.* (1999) that the significant increase in leaf area was recorded which was found to be more responsive with the increase in the level of nitrogen. Somarin *et al.* (2009) also observed that with increasing nitrogen application number of leaf, tiller along with the leaf chlorophyll content were increased. Demari *et al.* (2018) also observed similar results.

Total number of tillers/m.r.l

The perusal data presented in Table 4 shows that among different cultivars, more number of tillers were observed in WH 1105 at 60 DAS as compared with C 306 cultivar during

both years. After cutting for fodder at 60 DAS, significantly more number of tillers were observed under no-cut plots with either wheat cultivar at 90, 120 DAS and at harvest during both years which might be due to the absence of cutting shock with no interruption in normal plant growth under no-cut situation. In case of cultivars, significantly more number of tillers were observed in WH 1105 cultivar as compared to C 306 throughout crop season before and after cut at 60 DAS during both years.

While comparing the seed rate and fertilizer combination treatments, significantly more number of tillers were observed in wheat sown with 115% RDF over wheat sown with 100% RDF at 60 DAS with either seed rate which was at par with 130% RDF during both the years of study. Ali *et al.* (2010) also observed that enhanced dose of nitrogen led to an increased number of productive tillers. Similar trend of significantly more number of tillers (after fodder cut at 60 DAS) at 90 DAS, 120 DAS and at harvest were observed in wheat sown with 115% RDF over wheat sown with 100% RDF with either seed rate remaining at par with 130% RDF during both the years of study. Higher seed rate of wheat recorded more number of tillers during both years because more number of seeds per unit area. Production of more total number of tillers per meter row length may be due to sufficient resources allocation in term of time and nutrients needed for development of secondary tillers. These results are in agreement with Khalil *et al.* (2011), Iqbal *et al.* (2012) and Naveed *et al.* (2014).

Grain yield (kg/ha)

Significantly higher grain yield of both the wheat cultivars was observed in no-cut plots with either seed rate during both the years of study (Table 5). Among varieties,

Table 4 Effect of different seed rate and fertilizer levels on total number of tillers /m.r.l. of dual-purpose wheat

Treatment	Number of tillers/m.r.l.							
	2017-18				2018-19			
	60 DAS	90 DAS	120 DAS	At harvest	60 DAS	90 DAS	120 DAS	At harvest
C 306 without cut	90.92	82.41	77.91	76.35	88.18	80.25	76.24	74.71
C 306 with cut at 60 DAS	87.94	79.72	75.36	73.86	85.30	77.62	73.74	72.27
WH 1105 without cut	109.62	102.65	97.04	95.10	106.33	99.95	94.95	93.05
WH 1105 with cut at 60 DAS	107.33	100.50	95.01	93.11	104.11	97.86	92.97	91.11
SEm ±	0.62	0.53	0.49	0.46	0.61	0.52	0.48	0.46
CD at 5%	2.01	1.70	1.58	1.51	1.95	1.66	1.55	1.48
100 kg/ha seed rate + 100% RDF	96.72	89.26	84.38	82.69	93.82	86.91	82.57	80.91
100 kg/ha seed rate + 115% RDF	98.98	91.34	86.35	84.63	96.00	88.94	84.49	82.80
100 kg/ha seed rate + 130% RDF	100.06	92.34	87.30	85.55	97.05	89.92	85.42	83.71
125 kg/ha seed rate + 100% RDF	97.71	90.17	85.24	83.54	94.77	87.80	83.41	81.74
125 kg/ha seed rate + 115% RDF	99.62	91.94	86.92	85.18	96.63	89.52	85.05	83.35
125 kg/ha seed rate + 130% RDF	100.63	92.87	87.80	86.04	97.60	90.43	85.91	84.19
SEm ±	0.45	0.38	0.35	0.34	0.44	0.37	0.35	0.33
CD at 5%	1.44	1.22	1.13	1.09	1.40	1.19	1.11	1.07

significantly higher grain yield was recorded in WH 1105 (79.3 and 79.4%) over C 306 during year 2017-18 and 2018-19, respectively, lower grain yield of C 306 may be attributed to the lodging problem of C 306 variety due to its tallness. In case of cultivars, more loss in crop yield, particularly grain yield, due to cut (for fodder) was observed in WH 1105 as compared with C 306 cultivar during both

years which might be due to poor regeneration growth of WH 1105 as compared to C 306. In case of seed rate and fertilizer combination treatments, significantly higher grain yield was observed in wheat sown with 115% RDF over wheat sown with 100% RDF with either seed rate which remained significantly lower than 130% RDF during both the years of study. Higher N has a positive effect on dry

Table 5 Effect of different seed rate and fertilizer levels on grain yield (kg/ha) of dual-purpose wheat

Variety	Cut	Seed rate (kg/ha)	Grain yield (kg/ha)							
			2017-18				2018-19			
			Fertilizer levels			Mean	Fertilizer levels			Mean
			RDF	115% RDF	130% RDF		RDF	115% RDF	130% RDF	
C 306	Without cut	100	3234	3199	2943	3126	2989	2929	2720	2879
		125	3250	3037	2878	3055	3004	2899	2660	2854
	With cut	100	2716	2910	3120	2916	2511	2690	2884	2695
		125	2749	2975	3169	2965	2541	2750	2929	2740
Mean			2987	3031	3028	3016	2761	2817	2798	2792
WH 1105	Without cut	100	6217	6405	6501	6375	5746	5976	6028	5917
		125	6403	6528	6590	6507	5918	6033	6091	6014
	With cut	100	3954	4352	4662	4323	3654	4022	4290	3989
		125	4010	4476	4809	4432	3716	4147	4472	4112
Mean			5146	5441	5641	5409	4759	5045	5220	5008
Overall mean			4067	4236	4334		3760	3931	4009	
			Factors			CD at 5%	Factors			CD at 5%
			Factor(A) (Variety and cut)			103	Factor(A) (Variety and cut)			97
			Factor(B) (Seed & fertilizer level)			85	Factor(B) (Seed & fertilizer level)			80
			Factor(B)at same level of A			125	Factor(B)at same level of A			118
			Factor(A)at same level of B			135	Factor(A)at same level of B			128

matter production of wheat crop. Higher seed rate of wheat had higher yield of wheat during both years.

In WH 1105 cultivar, the interaction effects also indicate that increase in fertilizer level increased the grain yield of WH 1105 with both cut management and seed rates during both the years of study (Table 5). The increase in grain yield with increasing level of fertilizer was more in cut-plots as compared with no-cut plots. Increase in fertilizer levels from 100 % RDF to 115% RDF had significant increase in grain yield with both cut and no-cut situations but increase in fertilizer levels from 115% RDF to 130% RDF had significant increase in grain yield with only cut condition. In case of C 306 cultivar, increase in fertilizer level decreased the grain yield under no-cut situation with either seed rate. The reason for this reduction in grain yield under without cut plot might be due to lodging of tall wheat which resulted in reduction of partitioning and decreased translocation of assimilates to sink (Sangwan 2018). Whereas, grain yield of C 306 increased significantly with increase in fertilizer level under cut situation with either seed rate. Increase in fertilizer levels from 100 % RDF to 115% RDF had significant increase in grain yield with both cut and no-cut situations but increase in fertilizer levels from 115% RDF to 130% RDF had significant increase in grain yield with only cut condition which might be due to reduced lodging of tall wheat after cut which resulted in production of partitioning and increased translocation of assimilates to sink. At 130% RDF, the grain yield of C 306 was more with cut situation as compared to no-cut situation during both years. Also, higher seed rate resulted into higher wheat yield with higher fertilizer levels during both the years. These findings are in collaboration with Afridi *et al.* (2010), Khalil *et al.* (2011), Choudhary and Suri (2014) and Atis and Akar (2018).

Conclusion

From the findings it can be concluded that cut management significantly reduced the grain yield of wheat. Production potential of tall wheat (C 306) is less than dwarf wheat (WH 1105). Whereas, among different seed rates and fertilizers levels, wheat sown at 100 kg/ha seed rate with 115% RDF gave statistically at par yield of wheat sown at 125 kg/ha seed rate with 130% RDF under either cut management.

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REFERENCES

- Abedi T, Alemzadeh A and Kazemeini S A. 2011. Wheat yield and grain protein response to nitrogen amount and timing. *Australian Journal of Crop Science* **5**(3): 330-336.
- Afridi M Z, Tariq jan M, Arif M and Jan, A. 2010. Wheat yielding components response to different levels of fertilizer N application time and decapitation stress. *Sarhad Journal of Agriculture* **26** (4): 499-507.
- Agropedia.iitk.ac, 2015.
- Ali M A, Ali M, Sattar M and Ali, L. 2010. Sowing date effect on yield of different wheat varieties. *Journal of Agricultural Research* **48**(2): 157-162.
- Atis I and Akar M. 2018. Grain yield, forage yield and forage quality of dual purpose wheat as affected by cutting heights and sowing date. *Turkish Journal of Field Crops* **23**(1): 38-48.
- Choudhary A K and Suri V K. 2014. On-farm participatory technology development on forage cutting and nitrogen management in dual-purpose wheat (*Triticum aestivum* L.) in North-Western Himalayas. *Communications in Soil Science and Plant Analysis* **45**: 741-750.
- Demari G H, Carvalho I R, Szareski V J, Nardino M, de Pelegrin A J, da Rosa T C, Martins T DS, Santos N LD, Barbosa M H, Souza V Q D, Pedó T, Zimmer P D and Zanatta A T. 2018. Leaf area response in dual purpose wheat submitted to different defoliation managements and seeding densities. *Australian Journal of Crop Science* **12**(10): 1552-1560.
- Devi S, Hooda V S, Singh J and Kumar A. 2017. Effect of planting techniques and weed control treatments on growth and yield of wheat. *Journal of Applied and Natural Science* **9**(3): 1534-1539.
- FAO STAT 2017-18. <http://www.fao.org>.
- Fisher J C. 1948. The fracture of liquids. *Journal of applied Physics* **19**(11): 1062-1067.
- Guru S K, Jain V, Pal M and Abrol Y P. 1999. Relationship between specific leaf weight and photosynthetic rate in two wheat genotypes. *Indian Journal of Plant Physics* **4**(2): 117-120.
- Iqbal J, Hayat K, Hussain S, Ali A and Bakhsh M A A H A. 2012. Effect of seeding rates and nitrogen levels on yield and yield components of wheat (*Triticum aestivum* L.). *Pakistan Journal of Nutrition* **11**: 531-536.
- Jackson M L. 1973. *Soil Chemical Analysis*, pp 183-192. Prentice Hall of India Pvt. Ltd, New Delhi.
- Jackson M L. 1958. *Soil Chemical Analysis*, p 187. Prentice Hall of India Pvt. Ltd, New Delhi.
- Jan M T, Shah M and Khan S. 2002. Type of N fertilizer rate and timing effect on wheat production. *Sarhad Journal of Agriculture* **18**: 405-410.
- Khalil K, Khan F, Rehman A, Muhammad F, Khan A Z, Wahab S, Akhtar S, Zubair M, Khalil I H, Shah M K and Khan, H. 2011. Dual purpose wheat for forage and grain yield in response to cutting, seed rate and nitrogen. *Pakistan Journal of Botany* **43**(2): 937-947.
- Naveed K, Khan M A, Baloch M S, Ali, Nadim M A, Khan E A, Shah S and Arif A. 2014. Effect of different seeding rates on yield attributes of dual-purpose wheat. *Sarhad Journal of Agriculture* **30**(1): 83-91.
- Olsen S R, Cole C V, Watanabe F S and Dean L A. 1954. Estimation of available phosphorus in soils by extraction with sodium bicarbonate. USDA Circulation, 939.
- Pandey A K. 2005. Effect of agronomic practices on green fodder, grain yield and economics of dual purpose wheat (*Triticum aestivum* L.). *Indian Journal of Agricultural Sciences* **75**(1): 27-29.
- Panse V S and Sukhatme P V. 1985. *Statistical Methods for Agricultural Workers*, 4th Edn. ICAR, New Delhi.
- Piper C S. 1966. *Soil and Plant Analysis*. Hans Publishers, Bombay.
- Sangwan M. 2018. Evaluation of tall wheat (*Triticum aestivum* L.)

- for dual purpose under cutting, nitrogen and weed management practices. Ph.D dissertation, CCSHAU, Hisar.
- Somarin A K, Kissin S A, Heerema D D and Bihari D J. 2009. Hydrothermal alteration, fluid inclusion and stable isotope studies of the North Roby zone, Lac des Iles PGE mine, Ontario, Canada. *Resource Geology* **59**(2), 107-120.
- Subbiah B V and Asija A K. 1956. A rapid procedure for the estimation of available nitrogen in soil. *Current Sciences* **24**: 259-260.
- Walkley A J and Black C A. 1934. Estimation of soil organic carbon by the chromic acid titration method. *Soil Science* **37**: 29-38.
- Watson D J. 1952. The physiological basis of variation in yield. *Advances in Agronomy* **4**: 101-145.
- Yousaf M, Shaaban M, Suliman A, Ali I, Fahad S and Khan M J. 2015. The effect of nitrogen application rates and timings of first irrigation on wheat growth and yield. *International Journal of Agriculture Innovations and Research* **2**(4): 645-653