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Suitability of wheat (*Triticum aestivum*) varieties for dual purpose under varying seed rate and fertilizer levels

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ABSTRACT

To meet the demand of grain and fodder, dual purpose crops can be a good alternative that can also reduce burden on the land. A field study was carried out during two consecutive *rabi* seasons of 2017–18 and 2018–19 on research farm of Agronomy, CCS HAU, Hisar, Haryana, to evaluate the performance of dual purpose wheat (*Triticum aestivum* L.). The experiment was laid out in split plot design with three replications. It comprised two varieties (C 306 and WH 1105) along with cut management in main plots, and two seed rates (100 kg/ha and 125 kg/ha) with three levels of fertilizer, viz. RDF, 115% of RDF and 130% of RDF in sub-plots. The findings revealed that significantly higher crop growth rate (CGR) up to 60 DAS was observed in C 306 over WH 1105, whereas, after 60 DAS, higher CGR was observed in WH 1105 over C 306. Maximum tillers/m^2, dry matter accumulation, effective tillers, grain and biological yield, crude protein were obtained in WH 1105 without cut, closely followed by C 306 without cut. Among, seed and fertilizer rate combinations, significantly higher CGR, protein and crude protein content other growth parameters were observed in 125 kg/ha seed rate +130% RDF and 100 kg/ha seed rate + 130% RDF. It was concluded that C 306 may be a good choice for dual purpose wheat which can provide fodder in lean period without affecting its yield if supplied with slightly higher dose of fertilizers.

Keywords: Crude protein, Cut management, Seed rate, Wheat

At present, India faces a net deficit of 35.6% green fodder, 10.9% dry crop residue and 44% feed (Vision 2013). To mitigate the shortage of green fodder, conventional cereal crops need to be grown as dual purpose for fodder and grain under irrigated farming (Jarial 2014, Dove and Kirkegaard 2014). Dual purpose crops also increase the profitability of farmers by overcoming the grain yield losses through the income generated from forage production.

Among cereals, wheat (*Triticum aestivum* L.) is world's largest food grain crop having 223.8 mha area under cultivation with production of 733.1 million tonnes (MT) and productivity of 3280 kg/ha. It is an important staple food crop of India also (Devi *et al.* 2017), it is grown on 31.3 mha area with total production of 107.8 MT and productivity of 3440 kg/ha during 2019–20 in the country (FAO, 2020). In Haryana, wheat was grown on 2.53 mha area with a total production of 11.9 MT and productivity of 4687 kg/ha during 2019–20 (Tanwar *et al.* 2021). Dual purpose wheat has great potential to make available high-quality forage to livestock population of country in order to fill the gap in forage demand and supply (Harender *et al.* 2020).

Wheat is highly responsive to fertilizer and plant population (Khalil *et al.* 2011). It responses to higher dose of fertilizers particularly nitrogen (N) in form of plant height, number of leaves and tillers etc. Production potential of tall wheat is less because it is less responsive to inputs like fertilizer, irrigation etc. due to lodging. Growing tall wheat for dual purpose is one of the options to avoid lodging and harvest wheat for fodder in early winter months of fodder scarcity. Thus, knowledge of appropriate genotype, seed rate and nitrogen doses are necessary not only to save the investment of costly inputs, but also to enhance the crop productivity through efficient utilization of inputs. Different yield attributing characters are closely related to various yield and quality traits, faulty cut management and fertilization practices can impede development by reducing the product's desired qualitative characteristics. In order to to understand these relationships and evaluate the performance of dual purpose wheat, the experiment was conducted.

MATERIALS AND METHODS

This field study was carried out at Agronomy Research Farm of CCS Haryana Agricultural University, Hisar, during *rabi* season of 2017–18 and 2018–19. The experiment

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was laid out in split plot design with three replications. It comprised four treatments, viz. C 306 without cut (M_1), C 306 with cut at 60 days after sowing (DAS) (M_2), WH 1105 without cut (M_3), WH 1105 with cut at 60 DAS (M_4) in main-plot and six seed rate and fertilizer level combinations, viz. 100 kg/ha seed rate + 100% RDF (S_1), 100 kg/ha seed rate + 115% RDF (S_2), 100 kg/ha seed rate + 130% RDF (S_3), 125 kg/ha seed rate + 100% RDF (S_4), 125 kg/ha seed rate + 115% RDF (S_5) and125 kg/ha seed rate + 130% RDF (S_6) in sub-plots. The gross and net plot sizes were 10.0 m × 2.0 m and 10.0 m × 1.8 m, respectively, with 20 cm spacing in N-S row orientation. The recommended doses of NPK were applied through urea, diammonium phosphate and muriate of potash, respectively. N fertilizer was applied in two splits in without cut i.e. half at the time of sowing and rest half at the time of first irrigation, whereas, in cut management nitrogen was applied in three splits i.e. half as basal dose, one fourth after first irrigation and remaining one fourth after cut. The crop growth rate (CGR) was calculated according to Watson (1952). The crude protein content in grain was calculated by multiplying 5.83 to nitrogen content of the grain. The data recorded during study for various parameters was statistically analyzed with the help of OPSTAT available at CCS HAU, Hisar.

RESULTS AND DISCUSSION

Dry matter accumulation: Before cutting at 60 DAS, significantly higher dry matter accumulation was observed in no-cut plots as compared to cut-plots with either wheat variety (Table 1). Higher dry matter accumulation was observed in C 306 at 30 and 60 DAS as compared to WH 1105. After cut, significantly higher dry matter accumulation was observed in WH 1105 over C 306, this may be due to fast growth in WH 1105 to overcome the cutting shock. At maturity, 45% higher dry matter accumulation was observed in WH 1105 over C 306 in no-cut condition, whereas in cut condition, 21% higher dry matter accumulated in WH 1105 over C 306. Among seed rates and fertilizer combinations, significantly higher dry matter accumulation was recorded in S_6 (125 kg/ha +130% of RDF) from 30 DAS to at harvest, as compared to S_1 and S_4, this was statistically at par with rest of the combinations. This might be due to higher plant population per unit area due to higher seed rate and fertilizer dose. Abedi *et al.* (2011) also reported that application of higher dose of nitrogen fertilizer increased the growth parameters of wheat.

Crop growth rate (CGR): Significantly higher CGR of 2.01 and 8.62 g/m^2/day was observed in C 306 over WH 1105 during 0–30 and 31–60 DAS (before cut management), respectively (Table 1). Whereas, significantly higher CGR of 11.63, 27.46 and 13.48 g/m^2/day was observed in dwarf wheat variety WH 1105 over tall wheat variety C 306 during 61–90, 91–120 and 121-at harvest (after cut management), respectively. Among seed rate and fertilizer combinations, significantly higher CGR of 1.93, 8.49, 8.40, 19.81 and 9.95 g/m^2/day during 0-30, 31–60, 61–90, 91–120 DAS and 121 DAS–at harvest, respectively, was observed with 125 kg/ha seed rate + 130% RDF over rest of the combinations. It was statistically at par with S_5 (125 kg/ha + 115% RDF) and S_3 (100 kg/ha + 130% RDF). Significantly lowest CGR of 1.87, 8.14, 7.53, 18.49 and 8.06 g/m^2/day during 0–30, 31–60, 61–90, 91–120 DAS and 121 DAS–at harvest, respectively, was observed in wheat sown at S_1 (100 kg/ha + 100% RDF) over rest of the combinations. It may be possible due to lesser competition amongst crop plant with improvement in availability of nutrients.

Table 1 Effect of various seed rates and fertilizer levels on dry matter accumulation (g/m^2) and crop growth rate (g/m^2/day) in wheat

Treatment	Dry matter accumulation (g/m^2)					Crop growth rate (g/m^2/day)				
	30 DAS	60 DAS	90 DAS	120 DAS	At harvest	0–30 DAS	31–60 DAS	61–90 DAS	91–120 DAS	121– at harvest
M_1	60.4	318.7	587.2	1090.2	1380.8	2.01	8.62	8.95	16.77	7.55
M_2	58.6	304.1	495.9	920.9	1135.7	1.95	8.19	6.39	14.16	5.58
M_3	55.5	312.1	660.8	1484.6	2003.8	1.85	8.55	11.63	27.46	13.48
M_4	53.8	294.1	443.5	996.5	1374.5	1.80	8.01	4.98	18.43	9.82
SEm ±	0.40	2.13	4.93	9.13	15.60	0.01	0.06	0.10	0.15	0.17
CD @5%	1.23	6.83	17.8	30.58	52.21	0.04	0.19	0.37	0.43	0.56
S_1	56.2	300.4	526.2	1080.8	1391.0	1.87	8.14	7.53	18.49	8.06
S_2	57.2	307.3	547.3	1124.0	1476.3	1.91	8.34	8.00	19.22	9.15
S_3	57.6	310.7	556.7	1143.3	1521.3	1.92	8.44	8.21	19.55	9.81
S_4	56.2	303.5	532.7	1094.2	1418.2	1.88	8.25	7.64	18.72	8.41
S_5	57.3	309.3	553.8	1137.1	1493.4	1.91	8.40	8.15	19.44	9.25
S_6	57.8	312.4	564.4	1158.7	1541.9	1.93	8.49	8.40	19.81	9.95
SEm ±	0.30	1.53	3.35	7.83	13.38	0.01	0.04	0.06	0.15	0.15
CD @5%	0.90	4.90	11.15	24.10	41.18	0.03	0.14	0.21	0.44	0.44

Treatment details given in Materials and Methods.
Pooled data of two years.

Table 2 Effect of various seed rates and fertilizer levels on tillers/m^2, crude protein in grain, effective tillers/m^2, harvest index, grain and biological production in wheat

Treatment	Tillers/m^2				Crude protein (%)	Effective tillers/m^2	Harvest index (%)	Yield (q/ha)	
	60 DAS	90 DAS	120 DAS	At harvest				Grain	Biological
M_1	441	401 (9.0)	388 (3.3)	379 (2.4)	10.59	379	27.8	29.79	107.13
M_2	427	384 (9.9)	369 (4.0)	365 (0.9)	10.04	367	32.1	28.29	88.11
M_3	532	489 (8.1)	475 (2.9)	469 (1.3)	11.14	471	39.9	62.03	155.46
M_4	518	479 (7.4)	465 (3.0)	457 (1.6)	10.18	460	39.5	42.14	106.64
SEm ±	3.05	2.60	2.40	2.30	0.05	2.30	0.72	3.29	1.28
CD @5%	9.75	8.30	7.75	7.40	0.18	7.40	2.53	1.03	4.27
S_1	465	432 (7.2)	413 (4.3)	403 (2.3)	10.37	406	35.3	38.78	107.92
S_2	472	445 (5.8)	422 (5.0)	408 (3.4)	10.52	415	34.5	40.61	114.54
S_3	479	448 (6.6)	427 (4.6)	422 (1.2)	10.75	427	34.3	41.44	118.03
S_4	469	433 (7.6)	417 (3.7)	405 (2.8)	10.31	411	35.3	39.49	110.03
S_5	475	442 (7.1)	425 (3.7)	417 (1.9)	10.49	425	34.3	41.06	115.87
S_6	481	449 (6.6)	430 (4.4)	427 (0.7)	10.61	431	34.3	42.00	119.63
SEm ±	2.20	1.85	1.75	1.65	0.01	1.65	0.62	2.76	1.10
CD @5%	7.00	5.95	5.55	5.35	0.03	5.35	NS	4.52	3.37

Treatment details given in Materials and Methods.
Pooled data of two years; *values of tiller extinction rate are given in parenthesis.

These results are in confirmatory with the findings of Rai *et al.* (2018) and Demari *et al.* (2018).

Tillers/m^2: Maximum number of tillers m^2 were observed in M_3 (WH 1105 no-cut at 60 DAS) followed by M_4 (WH1105 cut at 60 DAS) at 60 DAS to till harvest. C 306 produced lesser number of tillers as compared to WH 1105 irrespective of management; this might be due to difference in varietal characteristics (Table 2). Maximum extinction rate in tillers was observed at 90 DAS, this may be due higher competition for resources. The dying of tillers continues till harvest. In varieties, maximum tiller extinction rate was observed in M_2 (9.94% at 90 DAS, 4.01% at 120 DAS and 0.93% at harvest). Among seed rates and fertilizer rate combinations, maximum number of tillers were recorded in S_6 (481/m^2 at 60 DAS, 449/m^2 at 90 DAS, 430/m^2 at 120 DAS and 427/m^2 at harvest) and minimum in S_1 (465/m^2 at 60 DAS, 432/m^2 at 90 DAS, 413/m^2 at 120 DAS and 403/m^2 at harvest). Maximum tillers extinction rate was obtained in S_4 (7.65% at 90 DAS), this might be due to more competition among plants for nutrients. Ali *et al.* (2010) also observed that enhanced dose of nitrogen led to an increased number of productive tillers. At harvest, maximum number of tillers was retained in S_6 and S_3. These results are supported by the finding of Naveed *et al.* (2014).

Crude protein content: Significantly higher crude protein content in grain was obtained in WH 1105 as compared to C 306. It decreased in grain after cut in both varieties due to cutting shock, wheat crop becomes source limited crop by interruption in normal growth and development. Similar results were observed by Atis and Akar (2018). Among seed rate and fertilizer combinations, significantly crude protein content in grains was recorded in S_6 (125 kg/ha+130% RDF) as compared to other combinations (Table 2). Increasing level of fertilizer recorded higher crude protein in wheat while increasing seed rate recorded lower crude protein due to competition among plants and direct relationship between nitrogen and protein content. These results are supported by the finding of Waheddullah *et al.* (2018).

Effective tillers/m^2: Significantly higher number of effective tillers/m^2 was observed in no-cut WH 1105 as compared to other treatments (Table 2). These results are in agreement with Khalil *et al.* (2011). Among seed rates and fertilizer combinations, significantly more number of effective tillers/m^2 was observed in S_6 (431/m^2) and S_3 (427/m^2) as compared to other combinations. It may be due to the concept that higher seed rate results in more plants per unit area. These findings are in collaboration with finding of Ahmad *et al.* (2007).

Harvest Index (HI): Significantly higher harvest index was observed in WH 1105 as compared to C 306 (Table 2). In case of cut and no cut treatments, higher HI was observed in cut plots, this may be attributed to lower biological yield. Maximum HI was observed in S_1 (35.3%) and S_4 (35.3%) and minimum in S_2 (34.5%). The variation in harvest index could be related to the relative increase in both grain and biological yield due to nitrogen application. These results are in collaboration with the results of Choudhary and Suri (2014).

Grain and biological yield: Significantly higher grain and biological yield was obtained in no-cut plots as compared cut-plots in both varieties (Table 2). It may be due to higher value of plant CGR, tillers and dry matter accumulation in no-cut treatments. In case of varieties, more loss in grain and biological yield due to cut (for fodder) was observed in WH 1105 as compared to C 306. Among seed rates and fertilizer combinations, significantly higher yield (grain and biological) was observed in S_6 (42.0 q/ha and 119.6 q/ha, respectively) and S_3 (41.4 q/ha and 118.0 q/ha) as compared to other combinations. Higher nitrogen content has a positive effect on dry matter production of wheat crop. Similarly, higher seed rate of wheat also resulted in greater yield of wheat (Khalil *et al.* 2011).

From the results of this experiment, it can be concluded that cut management practices had some adverse effect on grain production and it significantly reduced the grain production along with reduction in protein and crude protein in wheat crop but not too much as it is providing nutritional fodder to livestock at the same time in lean period. It was also observed that the production potential i.e. crop growth rate of tall wheat (C 306) is less than dwarf wheat (WH 1105) and it is mainly due to the less responsive nature of C 306 towards inputs like fertilizer due to lodging problem. Among different seed rates and fertilizer levels, it was concluded that protein and crude protein content in grain, higher production of grain and biological yield can be obtained in wheat sown with 130% RDF over wheat sown with 115% and 100% RDF with either seed rates.

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