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DUAL PURPOSE WHEAT FOR FORAGE AND GRAIN YIELD IN RESPONSE TO CUTTING, SEED RATE AND NITROGEN

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Abstract

Availability of green fodder is one of the most serious problems for livestock particularly in winter season. The aim of this research was to evaluate dual purpose wheat utilized for forage and grain yield grown under different seed rate (S) and nitrogen (N) levels. Wheat variety Bakhtawar-92 was sown at Agricultural University, Peshawar for forage and grain production using 3 N rates (80, 120, 160 kg ha^{-1}), 2 S rates (100, 150 kg ha^{-1}) and 3 cuttings (no cut, cut 75 days after planting, cut 90 days after planting). Forage dry matter yield increased with delay in cutting from 75 days to 90 days after sowing and delayed days to heading, whereas grain yield decreased with delayed cutting. No cut produced tallest plants with highest grain yield. Seed rate of 150 kg ha^{-1} and maximum N (160 kg ha^{-1}) produced tallest plants, maximum forage dry matter and biological yield, however, days to heading was delayed. Grain yield was higher from 100 kg ha^{-1} seed rate and 120 kg N ha^{-1}. Similar trend was observed in productive tillers m^{-2}, number of grains spike^{-1} and 1000-grains weight and perform better in the no cut plots, 100 kg ha^{-1} seed rate and 120 kg N ha^{-1}. It may be concluded that seed rate of 100 kg ha^{-1} and 120 kg N ha^{-1} and no cut appeared to be optimum for grain yield of wheat. Dry forage yield of 204 kg roughly equal to 800 kg^{-1} green forage may be obtained with a reduction of 300 kg in grain and 440 kg in biological yield ha^{-1}.

Introduction

Wheat (*Triticum aestivum*) ranks first among the cereals on the basis of production. It is a valuable source of high quality forage, rich in protein, energy, nutrients and low in fiber (Hossain *et al.*, 2003). Wheat was planted on 8.6 million (m) ha, producing 23.3 m tons (MINFAL, 2008). Pakistan is facing food and feed shortages due to the alarming increasing rate in population. To overcome food and feed shortage, there is an urgent need to increase the yield of wheat by bringing more area under cultivation or increasing yield per unit area. Wheat has the potential to meet the food and feed requirements of the rapidly growing human and livestock population from the same piece of land under optimum management practices.

N application, seed rate and cutting are important management inputs, which influence forage and grain production of wheat. It is reported that different seed rate and N application significantly effected yield and yield components of wheat (Dean & Munford 2004; Singh *et al.*, 2000; Tripathi & Chauhan, 2000). Seed rate strongly influence the use of environmental resources by changing relative importance of intra and interplant competition for light, water and nutrients during crop development (Gooding *et al.*, 2002). Low seed rate decrease interplant competition especially during vegetative growth but increase intraplant competitions during grain fill because plants tend to produce more spike bearing tillers. Thus low seed rate increase number of spikes and grains spike^{-1} by each plant, but decrease number of spike unit^{-1} area whereas the opposite occurs at high seed rate (Ozturk *et al.*, 2006; Arduini *et al.*, 2006; Larson *et al.*, 2005; Whaly *et al.*, 2000). Arduini *et al.*, (2006) reported higher yield of wheat at higher seed. Higher seed rate suppressed weeds biomass in addition to yield and yield components of wheat (Armin *et al.*, 2007). Higher seed rate of 150 to 200 kg ha^{-1} increased grain yield compared with low seed rate of 100 kg ha^{-1}. However, Carr *et al.*, (2003), Wood *et al.*, (2003) concluded that grain yield was higher with low seed rate compared with higher seed rate.

Wheat yield and yield components increased with N application up to 150 kg N ha^{-1} compared with control (Waraich *et al.*, 2007; Ahmad *et al.*, 2007). Fluegel & Johnson (2001) reported that higher N had a positive effect on plant height and dry matter. Higher N resulted in increased spikes m^{-2} (Iqtidar *et al. 2006)*. Ram *et al*., (2002) reported significant increase in grain yield up to 120 kg N ha^{-1}. Therefore, this study was designed to determine the effect of cutting, seed and nitrogen rates on the forage and grain yield of wheat.

Material and Methods

A three factor factorial experiment was conducted during 2001-2002 at New Developmental Farm, Khyber Pakhtunkhwa Agricultural University, Peshawar to study the effect of seed rate (S), nitrogen levels (N) and cutting (C) on forage and grain yield of wheat. The experiment was conducted according to randomized complete block (RCB) design with split plot arrangement. Combination of seed rate and N levels were allotted to main plots, while cutting were maintained in sub plots. Wheat variety Bakhtawar 92 was sown @ 100 and 150 kg ha^{-1} on November 06, 2001. N was applied @ 80, 120 and 160 kg ha^{-1} in a single dose in the form of urea at the time of sowing. Cuttings consisted of no cut, complete cut 75 and 90 days after sowing. Combination of seed rate and N were applied to main plot while cutting were allotted to subplot. Each subplot consisted of 10.5 m^2 having 7 rows 5 meter long and 30 cm apart. A basic dose of 60 kg phosphorous ha^{-1} was applied in the form of diammonium phosphate before sowing. All the standard agronomic cultural practices including irrigation, hoeing, weed management were uniformly adopted for the experiment. Data were recorded on forage dry matter production, days to heading, plant height, productive tillers m^{-2}, grain spike^{-1}, thousand grains weight, biological and grain yield.

Forage dry matter production was recorded by cutting the respective plots 75 or 90 days after sowing. In case of control, no cut was given. The samples were oven dried at 70^{o}C for 72 hours. Forage dry matter yield was recorded with an electronic balance and converted into dry matter production kg ha^{-1} by using following formula:

$$\text{Forage dry matter yield kg ha}^{-1} = \frac{\text{Yield in cut plot}}{\text{Plot area}} \times 10{,}000$$

Days to heading were counted from date of planting till 80% of spikes emerged in each subplot. For recording plant height, 5 tillers were randomly selected in each subplot and the height was measured with the help of a meter rod in centimeter.

Productive tillers were counted in 2 central rows of each subplot and converted into tillers m^{-2}. For grains spike data, grains of 5 randomly selected spikes in each subplot were counted and average number of grains spike^{-1} was calculated. Thousand grains were randomly picked from each subplot and weighed with a digital balance in gram.

For biological yield 3 central rows of each subplot were harvested when the crop reached harvest maturity, tied into bundles and sun dried for 6 days. The bundles were weighed and yield was converted into biological yield kg ha^{-1} by following formula:

$$\text{Biological yield kg ha}^{-1} = \frac{\text{Biological yield of harvested area}}{\text{Harvested area}} \times 10{,}000$$

The 3 central rows harvested were threshed with small wheat thresher. After threshing and cleaning the grains were weighed with an electronic balance and converted into grain yield kg $ha\text{-}^{1}$ by the above mentioned formula. The data was statistically analyzed according to RCB with split plot arrangement and least significant difference (LSD) test was applied where significant differences between treatment means were found (Steel *et al*., 1997).

Results

Forage dry matter yield: It is evident from the data in Table 1 that cutting (C), seed rate (S) and nitrogen (N), C x S x N showed significant effect on forage dry matter yield, while effects of C x S, C x N and S x N were non significant. Maximum forage dry matter yield of 353.46 kg ha^{-1} was recorded in plots given cut 90 days after sowing while plots cut 75 days after sowing produced minimum dry matter yield (207.75 kg ha^{-1}). Plots with seed rate of 150 kg ha^{-1} gave maximum dry matter yield of 292.38 kg ha^{-1} while minimum dry matter (268.83 kg ha^{-1}) was obtained from plots of 100 kg ha^{-1} seed rate. The lowest N (80 kg ha^{-1}) gave minimum forage dry matter yield of 267.13 kg ha^{-1} which increased with each increment of N and maximum forage yield (292.81 kg ha^{-1}) was given by high N (160 kg ha^{-1}). Maximum forage yield of 387.50 kg ha^{-1} was obtained from plots cut 90 days after sowing seeded at 150 kg ha^{-1} with 160 kg N ha^{-1}. However this yield was not significantly different from plots cut 90 days after sowing seeded at 150 kg ha^{-1} receiving 120 kg N ha^{-1}. Minimum forage yield (180 kg ha^{-1}) was produced from earlier cut plots (75 days after sowing) at 100 kg ha^{-1} seed rate receiving 80 kg N ha^{-1}.

Days to heading: Cut, seed rate and N significantly affected days to heading, while none of the interactions was significant (Table 2.) Maximum days to heading (133) were taken by plots cut 90 days after sowing, while minimum days to heading (120.5) were taken by no cut plots but not significantly different from plots given cut 75 days after sowing. Higher seed rate (150 kg ha^{-1} took more days to heading (127.4) as compared to low seed rate (100 kg ha^{-1}). Earliest heading (122.8 days) was recorded in plots with 80 kg Nha^{-1}.Each increment of N delayed heading and plots with highest N (160 kg ha^{-1}) took more days (126.8) to heading.

Plant height: Plant height was significantly affected by Cut, seed rate and N, while all the interaction showed non-significant effect (Table 3). Tallest plants (83.2 cm) were recorded from control, cut 90 days after sowing gave the lowest plant height of 73.3 cm. High seed rate of 150 kg ha^{-1} gave maximum plant height of 80.6 cm as compared to 100 kg ha^{-1} of seed rate. N at 160 kg ha^{-1} and 80 kg ha^{-1} gave plant heights of 81.9 cm and 76.2 cm respectively.

Table 1. Forage dry matter production (kg ha^{-1}) of wheat as affected by cutting, seed rate and nitrogen levels.

Seed rate	Nitrogen	Cut after sowing (days)		Mean
(kg ha^{-1})		75	90	
100	080	180.00 f	343.25 b	261.63
100	120	193.00 ef	345.00 b	269.00
100	160	208.50 de	343.25 b	275.88
150	080	217.25 cd	328.00 b	272.63
150	120	215.75 cd	373.75 a	294.75
150	160	232.00 c	387.50 a	309.75
100		193.83	343.83	268.83 b
150		221.67	363.08	292.38 a
	080	198.63	335.63	267.13 b
	120	204.38	359.38	281.88 a
	160	220.25	365.38	292.81 a
Mean		207.75b	353.46a	

LSD value at (0.05) for
Seed rate = 9.41, N = 11.52, Cutting = 8.48, SxNxCN = 20.76
Means followed by the same letters within the same treatment are non-significant at alpha 0.05 level of probability using LSD test.

Table 2. Days to heading of wheat as affected by cutting, seed rate and nitrogen levels.

Seed rate	Nitrogen	Cut after sowing (days)			Mean
(kg ha^{-1})		0	75	90	
100	080	114.00	114.75	130.25	119.67
100	120	118.50	119.50	130.25	122.75
100	160	121.50	122.25	130.75	124.83
150	080	121.75	122.75	133.50	126.00
150	120	123.00	123.25	136.00	127.42
150	160	124.50	124.25	137.75	128.83
100		118.00	118.83	130.42	122.42 b
150		123.08	123.42	135.75	127.42 a
	080	117.88	118.75	131.88	122.83 c
	120	120.75	121.38	133.13	125.08 b
	160	123.00	123.25	134.25	126.83 a
Mean		120.54 b	121.13 b	133.08 a	

LSD value at (0.05) for
Seed rate = 0.86, N = 1.05, Cutting = 1.99
Means followed by the same letters within the same treatment are non-significant at alpha 0.05 level of probability using LSD test.

Productive tiller m^{-2}: Cut, seed rate, N, and S x N significantly affected productive tillers, while rests of interactions were non-significant (Table 4). The lowest productive tillers (262.25 m^{-2}) were recorded from plots cut 90 days after sowing, whereas no cut and cut 75 days after sowing were not significantly different from each other. Seed rate of 100 kg ha^{-1} produced maximum productive tillers (361.92 m^{-2}) as compared to higher seed rate (150 kg ha^{-1}) which produced 326.06 tillers m^{-2}. Maximum productive tillers

(359.21 m^{-2}) were produced by 120 kg N ha^{-1}, while minimum productive tillers (332.92 m^{-2}) were produced by 80 kg N ha^{-1}. In interaction, maximum tillers of 397.42 m^{-2} produced by 100 kg ha^{-1} seed rate receiving 120 kg N ha^{-1} and lowest productive tillers (321 m^{-2}) were produced by 150 kg ha^{-1} of seed rate receiving 120 kg N ha^{-1}.

Grains spike^{-1}: Effects of cut, seed rate, N and C x N were significant on grains $spike^{-1}$, while rest of the interactions were non-significant (Table 5). Control and cut 75 days after sowing produced 52.71 and 51.25 grains $spike^{-1}$ respectively, while cut 90 days after sowing produced lowest grains $spike^{-1}$ (36). Lowest seed rate (100 kg ha^{-1}) produced more grains $spike^{-1}$ (49.19) as compared higher seed rate (150 kg) producing 44.14 grains $spike^{-1}$. N at 120 kg ha^{-1} produced more grains $spike^{-1}$ (52.58) compared with 60 N kg ha^{-1}. The C x N interaction showed that maximum grains $spike^{-1}$ (61.38) were obtained from control receiving 120 kg N ha^{-1}, whereas lowest number of 33.13 grains $spike^{-1}$ were produced by the inter action of cut 90 days after sowing receiving 160 N kg ha^{-1}.

Thousand grains weight: Thousand grains weight was significantly affected by cut, seed rate and N, while all interactions were found non-significant (Table 6). No cut produced heavier grains (37.93 g), while cut 90 days after sowing produced lowest 1000 grain weight of 25.09 g. Low seed rate (100 kg ha^{-1}) produced heavier grains (33.37 g), whereas higher seed rate (150 kg ha^{-1}) produced lighter grains (31.06 g). N at 120 kg ha^{-1} resulted in more 1000 grain weight of 33.86 g as compared to 80 kg or 160 kg N ha^{-1}.

Biological yield: Cut, seed rate and N and all interaction except S x N significantly affected biological yield (Table 7). No cut produced maximum biological yield of 11185 kg ha^{-1} followed by cut 75 days after sowing, which produced 10736 kg ha^{-1}., while cut 90 days after sowing produced lowest biological yield of 8175 kg ha^{-1}. Higher seed rate (150 kg ha^{-1}) produced maximum biological yield (10421 kg ha^{-1}, while lower seed rate (100 kg ha^{-1}) produced lower yield (9643 kg ha^{-1}). Low N (80 kg ha^{-1}) produced minimum biological yield (9953 kg ha^{-1}). Each increment of N increased biological yield and maximum yield (10095 kg ha^{-1}) was recorded at 160 kg N ha^{-1} however, it was not significantly different from yield produced by 120 kg N ha^{-1}. In the S x C interaction maximum biological yield of 11459 kg ha^{-1} was obtained from interaction of 150 kg ha^{-1} seed rate and no cut, while lowest biological yield (7493 kg ha^{-1}) was obtained from 100 kg seed rate and cut 90 days after sowing. In N x C interaction, 120 or 160 kg N ha^{-1} with no cut produced maximum biological yield, while lowest biological yield of 7689 kg ha^{-1} was obtained from 120 kg N ha^{-1} and cut 90 days after sowing. The S x N x C interaction revealed that maximum biological yield of 11947 kg ha^{-1} was recorded from 150 kg S x 120 kg N ha^{-1} with no cut, whereas lowest biological yield of 7457 kg ha^{-1} was recorded at 150 kg S x 120 kg N ha^{-1} cut 75 days after sowing.

Grain yield: Cut, seed rate and N significantly affected grain yield, while none of the interaction was significant (Table 8). Maximum grain yield of 3861 kg ha^{-1} was produced by no cut, followed by cut 75 days after sowing which produced 3456 kg ha^{-1} grain yield. The lowest grain yield of 1951 kg ha^{-1} was obtained from cut 90 days after sowing. Lower seed rate (100 kg ha^{-1}) produced higher grain yield of 3444 kg ha^{-1} as compared with higher seed rate (150 kg ha^{-1}) which produced 2735 kg grain ha^{-1}. Lowest grain yield (2891 kg ha^{-1}) was recorded at 80 kg N ha^{-1}. Grain yield increased with application of up to 120 kg ha^{-1}. Thereafter the grain yield decreased.

Table 3. Plant height (cm) of wheat as affected by cutting, seed rate and nitrogen levels.

Seed rate	Nitrogen	Cut after sowing (days)			Mean
(kg ha^{-1})		0	75	90	
100	080	78.00	77.00	69.75	74.92
100	120	80.75	80.50	72.00	77.75
100	160	83.75	81.00	73.75	79.50
150	080	82.25	77.75	72.50	77.50
150	120	86.50	82.00	71.75	80.08
150	160	88.00	84.75	80.00	84.25
100		80.83	79.50	71.83	77.39 b
150		85.58	81.50	74.75	80.61 a
	080	80.13	77.38	71.13	76.21 c
	120	83.63	81.25	71.88	78.92 b
	160	85.88	82.88	76.88	81.88 a
Mean		83.21 a	80.50 b	73.29 c	

LSD value at (0.05) for

Seed rate = 2.19, N = 2.69, Cutting = 2.61

Means followed by the same letters within the same treatment are non-significant at alpha 0.05 level of probability using LSD test.

Table 4. Productive tillers m^{-2} of wheat as affected by cutting, seed rate and nitrogen levels.

Seed rate	Nitrogen	Cut after sowing (days)			Mean
(kg ha^{-1})		0	75	90	
100	080	381.75	371.25	263.50	338.83 bc
100	120	439.50	437.75	315.00	397.42 a
100	160	392.75	395.00	260.75	349.50 b
150	080	362.50	360.00	258.50	327.00 cd
150	120	374.00	359.25	229.75	321.00 d
150	160	376.25	368.25	246.00	330.17 cd
100		404.67	401.33	279.75	361.92 a
150		370.92	362.50	244.75	326.06 b
	080	372.13	365.63	261.00	332.92 b
	120	406.75	398.50	272.38	359.21 a
	160	384.50	381.63	253.38	339.83 b
Mean		387.79 a	381.92 a	262.25 b	

LSD value at (0.05) for

Seed rate = 8.67, N = 10.62, Cutting=8.42, SxN=15.01

Means followed by the same letters within the same treatment are non-significant at alpha 0.05 level of probability using LSD test.

Table 5. Grains spike^{-1} of wheat as affected by cutting, seed rate and nitrogen levels.

Seed rate	Nitrogen	Cut after sowing (days)			Mean
(kg ha^{-1})		0	75	90	
100	080	46.50	37.50	43.58	46.75
100	120	60.50	41.75	56.00	65.75
100	160	52.25	38.75	48.00	53.00
150	080	43.50	36.00	41.00	43.50
150	120	56.00	34.50	49.17	57.00
150	160	49.00	27.50	42.25	50.25
100		55.17	53.08	39.33	49.19 a
150		50.25	49.50	32.67	44.14 b
	080	45.13 c	45.00 c	36.75 de	42.29 b
	120	61.38 a	58.25 a	38.13 d	52.58 a
	160	51.63 b	50.63 b	33.13 e	45.13 b
Mean		52.71 a	51.29 a	36.00 b	

LSD value at (0.05) for
Seed rate = 2.36, N = 2.89, Cutting = 2.54, NxC = 4.41
Means followed by the same letters within the same treatment are non-significant at alpha 0.05 level of probability using LSD test.

Table 6. Thousands grains weight (g) of wheat as affected by cutting, seed rate and nitrogen levels.

Seed rate	Nitrogen	Cut after sowing (days)			Mean
(kg ha^{-1})		0	75	90	
100	080	35.50	33.31	26.69	31.83
100	120	43.50	38.56	27.45	36.50
100	160	37.92	33.25	24.18	31.78
150	080	35.00	32.56	22.22	29.93
150	120	37.08	31.33	25.24	31.21
150	160	38.56	32.81	24.77	32.05
100		38.97	35.04	26.10	33.37 a
150		36.88	32.23	24.08	31.06 b
	080	35.25	32.93	24.45	30.88 b
	120	40.29	34.94	26.34	33.86 a
	160	38.24	33.03	24.48	31.91 b
Mean		37.93 a	33.63 b	25.09 c	

LSD value at (0.05) for
Seed rate = 1.08, N = 1.32, Cutting = 1.62
Means followed by the same letters within the same treatment are non-significant at alpha 0.05 level of probability using LSD test.

Table 7. Biological yield (kg ha^{-1}) of wheat as affected by cutting, seed rate and nitrogen levels.

Seed rate	Nitrogen	Cut after sowing (days)			Mean
(kg ha^{-1})		0	75	90	
100	080	10687 de	10447 e	7561 i	9565
100	120	10868 d	10590 de	7462 i	9640
100	160	11180 c	10539 e	7457 i	9725
150	080	10866 d	10477 e	9681 f	10341
150	120	11947 a	11507 b	7917 h	10457
150	160	11563 b	10858 d	8972 g	10464
100		10911 b	10525 c	7493 e	9643 b
150		11459 a	10947 b	8856 d	10421 a
	080	10776 c	10462 d	8621 e	9953 b
	120	11408 a	11048 b	7689 g	10048 a
	160	11371 a	10699 c	8215 f	10095 a
Mean		11185 a	10736 b	8175 c	

LSD value at (0.05) for
Seed rate = 68.66, N = 84.09, Cutting = 123.49, SC = 174.64, NC = 213.89, SNC = 302.48
Means followed by the same letters within the same treatment are non-significant at alpha 0.05 level of probability using LSD test.

Table 8. Grain yield (kg ha^{-1}) of wheat as affected by cutting, seed rate and nitrogen levels.

Seed rate	Nitrogen	Cut after sowing (days)			Mean
(kg ha^{-1})		0	75	90	
100	080	3875	3550	2433	3286
100	120	4988	4476	2194	3886
100	160	4000	3611	1870	3160
150	080	3250	2792	1444	2495
150	120	3639	3306	1889	2944
150	160	3416	3000	1876	2764
100		4288	3879	2166	3444 a
150		3435	3032	1737	2735 b
	080	3563	3171	1939	2891 b
	120	4313	3891	2042	3415 a
	160	3708	3306	1873	2962 b
Mean		3861 a	3456 b	1951 c	

LSD value at (0.05) for
Seed rate = 209.66, N = 256.78, Cutting = 204.79
Means followed by the same letters within the same treatment are non-significant at alpha 0.05 level of probability using LSD test.

Discussion

Early cut 75 days after sowing resulted in lower forage dry matter compared with late cut (90 days after sowing). This was due to increase in biomass in 90 days as compared to 75 days. Higher see rate (150 kg ha^{-1}) produced more forage dry matter than lower seed rate (100 kg ha^{-1}). This higher forage dry matter production was due to greater plants m^{-2} in case of higher seed rate. Similarly dry matter yield increased with increasing N. Highest N (160 kg N ha^{-1}) produced maximum dry matter yield compared to lower N (80 kg N ha^{-1}). It may be due the fact that plant growth under N stressed conditions was reduced (Noy-Meir & Brisbe, 2002). Higher N had a positive effect on growth and dry matter production (Fluegel & Johnson, 2001).

Days to heading increased as cutting after emergence was delayed. It may be due to the fact that cutting delayed growth and thus took longer time to heading compared with no cut. Higher seed delayed heading due to competition for solar radiation. Similarly N also has a positive effect on the vegetative growth and delayed maturity. Cutting had a significant effect on plant height. Tallest plants were observed where no cut was done compared to cut 75 or 90 days after planting. The reduction in plant height may be due to the fact that cutting imposed stress causing termination of growth and the new growth of shoot could not attain the same plant height due to shorter growth duration. In case of no cut there was no interruption in the plant growth and thus resulted in tallest plants (Noy-Meir & Briske, 2002). Lower seed rate produced shorter plants. Plant height increased with increasing seed rate. The increase in plant height in case of high seed rate may be due to dense population which increased competition among plants for air and solar radiation which led to increased plant height. Plant height showed direct relation with N and height increased with each increment of N and maximum plant height was recorded with highest N level (Fluegel & Johnson, 2001).

Productive tillers in the no cut or plots cut 75 days after of sowing were higher than cut 90 days after sowing. Production of less tillers due to late cut in season (90 days after planting) may be due to insufficient resources allocation in term of time and nutrients needed for development of secondary tillers (Noy-Meir & Briske, 2002). Higher seed rate decreased productive tillers. These results are in line with findings of Singh *et al.,* (2000) who reported that higher seed rate produced less productive tillers m^{-2}. The effect of N on productive tillers was quadratic. The productive tillers m^{-2} significantly increased up to 120 kg N ha^{-1}. These results agree with Waraich *et al.,* (2007) who reported that number of spikes m^{-2} increased with increased N.

Grains $spike^{-1}$ showed similar trend like productive tillers. Late cut (90 days after sowing) produced less grains $spike^{-1}$ compared to no cut or early cut. These results agreed with Noy-Meir & Briske (2002) who reported increased number of grains $spike^{-1}$ from control compared with grazing late in the season. Effect of seed rate on grains $spike^{-1}$ was similar to productive tillers m^{-2}. Lower seed rate produced more grains $spike^{-1}$ than higher seed rate. These results coincide with Ozturk *et al.*, (2006), Singh *et al.*, (2000) and Whaley *et al.,* (2000) who reported more grains $spike^{-1}$ at lower seed rate than higher seed rate. N application increased grains $spike^{-1}$ up to 120 kg ha^{-1}, thereafter grains $spike^{-1}$ decreased.

No cut produced heaviest grains compared to cut 75 or 90 days after sowing. Reduction in 1000 grain weight was also recorded when all or 2 top leaves were removed 100 days after planting (Hulmel *et al.,* 2005). Lower seed rate (100 kg ha^{-1}) produced heavier grains compared to higher seed rate (150 kg ha^{-1}). Low seed rate provided enough space, moisture, solar radiation and nutrients to the plants (Gooding *et al*., 2002). Grains weight significantly increased up to 120 kg N ha^{-1}. Thereafter further increase in N level did not increase grain weight (Iqtidar *et al.*, 2006).

No cut produced maximum biological yield followed by cut 75 and 90 days after sowing. This is obvious that in the no cut all biomass produced were intact whereas, cut 75 or 90 days after sowing removed the whole biomass and secondary growth could not make up the deficiency, possibly due to shortage of time and nutrients. Noy-Meir & Briske (2002) also reported reduced vegetative and reproductive biomass production with a single severs clopping of wheat. Similarly, seed rate increased biological yield up to 150 kg ha^{-1}. Higher seed rate resulted in more plants m^{-2} and thus resulted in more biological yield (Alvarez *et al.,* 2004). N application increased biological yield up to 160 kg N ha^{-1}. N limitation may contribute to growth suppression and reduction in biomass production (Noy-Meir & Briske, 2002). No cut produced more grain yield compared to cut 75 or 90 days after planting. Removal of leaves significantly reduced grain yield of wheat (Hulmel *et al.,* 2005). Lower seed rate (100 kg ha^{-1}) gave maximum yield compared to higher seed rate of 150 kg ha^{-1}which may be due to the fact that wheat have the potential to compensate for low seed rate if the environmental conditions are favorable (Carr *et al.*, 2003; Wood *et al*., 2003). N levels increased grain yield up to 120 kg N ha^{-1}, thereafter yield decreased. This may be due to the optimum requirements of wheat crop in the present study (Ram *et al*., 2002). It may be concluded that seed rate of 100 kg ha^{-1} and 120 kg N ha^{-1} and no cut appeared to be optimum for grain yield of wheat. Dry forage yield of 204 kg roughly equal to 800 kg ha^{-1} green forage may be obtained with a reduction of 300 kg in grain and 440 kg in biological yield ha^{-1}.

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