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INTERACTIVE EFFECTS OF CUTTING MANAGEMENT AND NITROGEN SCHEDULING ON GROWTH AND YIELD ATTRIBUTES OF DUAL-PURPOSE WHEAT

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ABSTRACT

Wheat (*Triticum aestivum* L.), a globally important cereal crop, plays a pivotal role in food security and agricultural sustainability. The dual-purpose wheat system, offering both forage and grain, provides a viable strategy for improving farm profitability in light of land constraints and increasing production demands. This study was conducted at the Research Farm, School of Agriculture, M.V.N. University, Palwal, India, to assess the effects of cutting and nitrogen scheduling on growth, yield attributes, and productivity of dual-purpose wheat (variety WH 1105). The experiment was laid out in a split-plot design with three cutting schedules (at 40, 50 and 60 DAS) as main plots and six nitrogen schedules as subplots. Results indicated that plant population at 25 DAS remained unaffected by treatments. However, cutting at 40 DAS consistently led to superior plant height, tiller number, dry matter accumulation (DMA), biological yield (167.94 q/ha), and grain yield (64.61 q/ha), while delayed cutting reduced both biomass and grain output. Among nitrogen treatments, the split application of nitrogen (½ basal + ½ after cut) significantly enhanced DMA (383.6 g/mrl), tiller number and grain yield (59.89 q/ha), outperforming schedules with nitrogen applied only before or at irrigation. The highest harvest index (43.80%) was observed with the latest cutting (60 DAS), while N2 (½ basal + ½ at irrigation) achieved the highest index among nitrogen treatments. The interaction of early cutting and appropriate nitrogen scheduling (particularly three split applications) significantly improved yield components. The findings underscore the importance of timely forage harvesting and post-cut nitrogen management in maximizing the productivity of dual-purpose wheat systems. Adoption of a 40 DAS cutting regime combined with nitrogen application split between basal and post-cut stages emerges as the most effective strategy to balance forage and grain yield.

Key words : Dual-purpose wheat, Cutting schedule, Nitrogen management, Grain yield, Dry matter accumulation.

Introduction

Wheat (*Triticum aestivum* L.), the "King of Cereals," is the world's leading grain crop and a cornerstone of the global agricultural economy. Among cereals, it occupies the largest share of cultivated land worldwide, covering 223.8 million hectares with a production of 733.1 million tonnes and an average productivity of 3,280 kg/ha (Harender *et al*., 2022). Wheat is highly adaptable, thriving from below sea level to altitudes of 5,000 m, and in regions receiving annual precipitation between 300 mm and 1,130 mm. It is the most important source of calories (20%) and protein in the human diet, surpassing all other food crops in nutritional contribution. Notably, per capita wheat availability has increased from 79 g/day to over 185 g/day despite a doubling of the global population since 1961 (Bhardwaj *et al*., 2010). Dual-purpose wheat, which produces both forage and grain, offers a valuable management strategy for farmers. The forage is rich in nutrients, promoting livestock weight gain, while providing feed during lean periods. Additionally, reduced stubble loads improve sowing operations for subsequent crops, and the combined returns from grain and livestock enhance farm profitability compared to grain-only systems (Harrison *et al.*, 2011). Cutting management is therefore crucial for optimizing both green fodder and grain yield. While the practice of grazing winter cereals before the jointing stage followed by grain harvest has long been adopted in some parts of the world (Bisht *et al*., 2008), it has gained renewed importance in the context of shrinking cultivable land and rising production demands. Achieving maximum returns from a dual-purpose wheat system requires precise management, with an optimal balance between cutting schedules and nutrient application. Proper nitrogen scheduling, in conjunction with well-timed cutting, is key to sustaining growth and maximizing productivity in dual-purpose wheat.

Materials and Methods

The experiment was conducted at Research Farm, of School of Agriculture, M.V.N. University, Palwal (India), which is situated at an elevation of 215.2 m above mean sea level in the subtropics at 28º 01” North latitude and at 77º 33” in the East longitude. Palwal is located on the outer margins of the south-west monsoon region. The average annual rainfall is 545 mm, out of which, 70-80 per cent is received during monsoon period. The soil of the field was having 64.9% sand, 19.6% silt and 16.5% clay; classified as loamy in texture having slightly alkaline pH, low in organic carbon and available nitrogen, medium in available phosphorus and high in available potassium. The field experiment was conducted on wheat (*Triticum aestivum* L.) variety WH 1105 to study the effect of cutting and nitrogen scheduling on growth parameters under a dual-purpose wheat system. The experiment was laid out in a split-plot design with three replications. The recommended nitrogen dose was applied as per treatment combinations using urea as the nitrogen source. The basal dose was applied at the time of sowing, the “first irrigation” application was given at the crown root initiation stage, and the “after cut” application was given immediately after forage removal as per treatment schedule. All other agronomic practices were followed uniformly across treatments to ensure optimal crop growth. Data on growth parameters were recorded at specified crop growth stages and statistically analyzed following the appropriate analysis of variance (ANOVA) technique for a split-plot design.

Results and Discussion

Plant population

Cutting and nitrogen schedules did not significantly influence plant population at 25 days after sowing (DAS), as no treatments had been imposed up to this stage (Table 1). However, minor numerical differences were observed among treatments.

Table 1 : Effect of cuttings and nitrogen schedule on plant population/mrl length at 25 DAS of dual-purpose wheat.

Treatments	**Plant population at 25 DAS**
Cutting schedule	
C_1 (40 days after sowing)	44.4
C_2 (50 days after sowing)	44.8
C_3 (60 days after sowing)	44.6
SEm±	0.9
CD at 5%	**NS**
Nutrient schedule	
N_1 (1/3 basal dose + 1/3 at first irrigation and 1/3 after cut)	44.0
N_2 (½ basal dose + ½ at first irrigation)	44.9
N_3 (½ basal dose and ½ after cut)	44.6
N_4 (¼ basal dose + ½ at first irrigation and ¼ after cut)	43.5
N_5 (½ basal dose + ¼ at first irrigation and ¼ after cut)	45.1
N_6 (¼ basal dose + ¼ at first irrigation and ½ after cut)	45.1
SEm ±	1.3
CD at 5%	**NS**

Plant height (cm)

At 25 DAS, plant height was not significantly influenced by cutting schedules (Table 2). At the time of cutting, however, the tallest plants (69.08 cm) were observed when the crop was cut for green fodder at 60 DAS, which was significantly higher than cutting at 50 DAS and 40 DAS. In contrast, at 25 days after cutting (DAC), the highest plant height (69.18 cm) was recorded with cutting at 40 DAS, which was significantly superior to all other cutting schedules. This trend continued at 55 DAC and at maturity, where cutting at 40 DAS resulted in significantly taller plants than cutting at either 50 or 60 DAS. Delaying cutting to 50 DAS and 60 DAS reduced plant height at maturity by 5.59% and 15.97%, respectively, compared to cutting at 40 DAS. The reduction in plant height with delayed forage harvest may be attributed to slower internode elongation and reduced assimilate transfer from leaves to roots following cutting, as suggested by Gill *et al.* (2017). Similar results were reported by Malik *et al.* (2015), who found maximum plant height when the crop was cut at 70 DAS (65.9 cm), followed by 60 DAS (53.8 cm) and 50 DAS (45.9 cm).

Nitrogen schedules did not significantly affect plant height at 25 DAS. At the time of cutting, maximum height (56.12 cm) was recorded with N_2 (½ basal + ½ at first irrigation), which was significantly higher than all treatments except N_4 (57.76 cm). At 25 DAC, N_3 (½ basal + ½ after cut) produced significantly taller plants (63.71 cm) than N_2, but remained statistically at par with other nitrogen treatments. Similar trends were observed at 55 DAC and at maturity, where N_3 outperformed N_5 and N_2 at 55 DAC and only N_2 at maturity, while being statistically comparable to the rest of the nitrogen schedules. The higher crop growth rate in treatments receiving greater nitrogen after cutting can be explained by improved post-cut nutrient availability, which enhances photosynthetic activity and growth (Naveed *et al*., 2013). Alipatra *et al.* (2012) also reported that the highest plant height was achieved with 90 kg N ha^{-1} applied in three splits (½ basal + ¼ at 20 DAS + ¼ at 40 DAS).

Dry Matter accumulation (g/mrl)

Dry matter accumulation (DMA) increased steadily with crop age, with the maximum increment occurring between post-cutting and maturity (Table 3). At 25 DAS, neither cutting nor nitrogen schedules significantly influenced DMA. At the time of cutting, however, the highest DMA was observed when cutting was delayed to 60 DAS, which was significantly greater than cutting at 50 DAS and 40 DAS. By maturity, this trend reversed—cutting at 40 DAS produced the highest DMA (437.0 g/mrl), which was 15.9% and 30.8% greater than cutting at 50 DAS and 60 DAS, respectively. These results indicate that although late cutting enhances biomass at the forage harvest stage, early cutting promotes greater recovery and total biomass production at maturity. Similar findings were reported by Khalil *et al*. (2011), who observed that early forage cuts in wheat (75 DAS) resulted in lower forage biomass compared to late cuts (90 DAS). The progressive increase in DMA reflects improved photosynthetic efficiency and assimilates partitioning during crop development.

Nitrogen schedules also influenced DMA at different stages. At the time of cutting, N_2 (½ basal + ½ at first irrigation) produced significantly higher DMA (66.4 g/mrl) than N_5, N_6 and N_3, while remaining statistically similar to N_4 and N_1. By maturity, the highest DMA was recorded with N_3 (½ basal + ½ after cut), which was significantly higher than N_2, but comparable to treatments involving three splits. At maturity, N_3 exceeded N_1, N_4, N_6, N_5 and N_2 by 0.35%, 2.77%, 4.25%, 6.12% and 9.94%, respectively. The improved DMA in N_3 may be attributed to greater nitrogen availability during the post-cut regrowth phase, enhancing cell expansion, elongation, and tissue regeneration (Naveed *et al*., 2013). Similarly, Kumar *et al.* (2010) reported that application of 150 kg N ha^{-1} in three splits significantly increased plant height, leaf area index and DMA in wheat.

Table 2 : Effect of cuttings and nitrogen schedule on plant height (cm) of dual purpose wheat.

Treatments	Plant height (cm)				
	25 DAS	At Cut	25 DAC	55 DAC	Maturity
Cutting schedule					
C_1	25.69	41.28	69.18	116.04	118.67
C_2	25.06	50.65	62.76	112.04	112.04
C_3	25.69	69.08	53.60	101.09	99.72
SEm±	0.39	0.32	0.42	0.63	1.47
CD at 5%	NS	1.25	1.53	2.45	5.27
Nitrogen schedule					
N_1	25.27	53.70	63.29	110.67	110.78
N_2	26.33	56.12	57.92	106.04	105.93
N_3	24.64	51.18	63.71	110.88	112.46
N_4	25.90	54.76	61.71	110.14	110.25
N_5	25.80	53.70	61.18	109.93	109.72
N_6	24.64	52.44	63.07	110.57	111.72
S Em±	0.52	0.66	0.90	0.92	1.11
CD at 5%	NS	1.88	2.57	2.60	3.15

Table 3 : Effect of cuttings and nitrogen schedule on Dry matter accumulation (g/mrl) of dual-purpose wheat.

Treatments	Dry matter accumulation (g/mrl)		
	25 DAS	At Cut	Maturity
Cutting schedule			
C_1	3.2	46.5	437.0
C_2	2.9	59.1	367.5
C_3	3.2	81.0	302.2
SEm±	0.1	0.8	5.60
CD at 5%	NS	2.78	19.76
Nitrogen schedule			
N_1	3.1	63.9	382.2
N_2	3.3	66.4	345.5
N_3	2.8	55.3	383.6
N_4	3.1	64.5	373.0
N_5	3.3	62.4	360.1
N_6	3.1	60.7	367.3
SEm±	0.1	1.2	8.6
CD at 5%	NS	3.43	24.71

Number of Tillers (mrl)

At 25 DAS, neither cutting nor nitrogen schedules had a significant effect on tiller number (Table 4). However, at 25 days after cutting (DAC) and at maturity, cutting at 40 DAS produced the highest number of tillers, significantly exceeding those recorded with cutting at 50 DAS and 60 DAS. At maturity, cutting at 40 DAS resulted in 4.81% and 13.63% more tillers compared to cutting at 50 DAS and 60 DAS, respectively. These results suggest that earlier cutting promotes greater post-harvest tiller regeneration and final tiller density. Meena *et al*. (2017) similarly reported that cutting schedules in barley did not cause notable variation in growth parameters at 35 DAS, but cutting at 60 DAS yielded the highest plant height, tiller number, dry matter and LAI compared to earlier cuts. Tiller number is an important growth index, directly contributing to dry matter production and ultimately influencing grain yield.

Among nitrogen schedules, at 30 DAC, the maximum number of tillers (167.0/mrl) was observed in N_3 (½ basal + ½ after cut), which was significantly higher than N_2 (½ basal + ½ at first irrigation), but statistically comparable with treatments involving three splits. At maturity, N_3 also produced significantly more tillers (114.8/mrl) than N_2, while remaining at par with other nitrogen treatments. Relative to N_1, N_4, N_6, N_5 and N_2, N_3 produced 1.83%, 2.39%, 4.40%, 3.67% and 8.07% more tillers, respectively.

The higher tiller number with N_3 can be attributed to improved nitrogen availability during the regrowth phase after cutting, which supports cell expansion, elongation, and tiller initiation (Naveed *et al*., 2013). Similar observations were made by Kumar *et al*. (1997), who noted that split nitrogen application enhances fertilizer use efficiency, resulting in improved plant growth and development. Bhagat *et al.* (1994) also reported that split application of nitrogen and potassium, in combination with appropriate cutting regimes, increased plant height, effective tiller number and leaf area index.

Biological Yield and grain yield

Biological yield was significantly influenced by cutting as well as nitrogen schedules (Table 5). Among different cutting schedules, early cutting at 40 DAS resulted in significantly higher biological yield (167.94 q/ha) as compared to cut at 50 DAS and 60 DAS. Reduction in biomass was in the tune of 12.43 and 29.50 per cent when cutting was delayed from 40 DAS to 50 DAS and 60 DAS, respectively. Shuja *et al*. (2010) also found significant effect of clipping on biological yield. The reason of maximum biological yield obtained was probably the optimum growth factors (temperature and time) available to crop which resulted in enhanced crop growth. The results obtained are in conformity with the findings of Arif *et al*. (2010). Among various nitrogen schedules, N_3 treatment recorded significantly higher biomass as compared to N_4, N_5 and N_2, but it was statistically at par with rest of the treatments. N_3 resulted in 0.42, 0.67, 2.27, 4.46 and 8.12 per cent higher biological yield than N_1, N_6, N_4, N_5 and N_2, respectively.

Grain yield was significantly affected by cutting and nitrogen schedules (Table 5). Among various cutting schedule, crop cut at 40 DAS for green fodder produced maximum grain yield (64.61 q/ha), which was significantly higher than cut at 50 DAS and 60 DAS. Whereas, minimum (49.93 q/ha) grain yield was recorded with cut at 60 DAS. The grain yield was decreased by 8.02 and 22.72 per cent by delay in cutting from 40 DAS to cut at 50 DAS and 60 DAS, respectively. With delay in cut for green fodder, grain and straw yields reduction might be due to shortening of vegetative and reproductive period. Shortening of grain filling period might have led to forced maturity thereby production of more shriveled grains and significant reduction in 1000-grain weight (Gill *et al*., 2017). Among different nitrogen schedules, maximum grain yield (59.89 q/ha) was recorded when half nitrogen dose was applied as basal and rest was applied after cut, which was significantly higher than treatment in N_2 and N_5 but it was at par with in N_1, N_4 and N_6. Whereas, minimum grain yield (55.10 q/ha) was recorded with N_2. N_3 resulted in 1.20, 2.29, 2.65, 4.91 and 8.0 per cent higher grain yield as compared to N_1, N_4, N_6, N_5 and N_2, respectively. The interaction effect of cuttings and nitrogen schedules was also found statistically (Table 5). The maximum grain yield (64.61 q/ha) was recorded when crop was cut for green fodder at 40 DAS and nitrogen was applied as ¼ basal + ½ at first irrigation and ¼ after cut. Singh *et al.* (2012) also revealed that the application of nitrogen in three splits (1/3 at basal+1/3 immediate after cut+1/3 at 100 DAS) recorded significantly highest grain yield compared to other schedules. The higher yield in three splits may be attributed to better availability of nitrogen to the crop during entire season. Kharub *et al*. (2013) also revealed that highest grain yield was obtained when nitrogen applied in three splits (1/3 at basal+1/3 immediate after cut+1/3 tillering stage after cut) closely followed by two splits (½ at basal+½ immediate after cut).

Harvest Index (%)

Harvest index (%) was influenced significantly by cutting and nitrogen schedules (Table 5). Among different cuttings, when crop was cut for green fodder at 60 DAS resulted in significantly higher harvest index (43.80%) as compared to cut at 50 DAS and 40 DAS cutting. The

Table 4 : Effect of cuttings and nitrogen schedule on Number of tillers/mrl of dual-purpose wheat.

Treatments	Number of tillers/mrl		
	25 DAS	At Cut	Maturity
Cutting schedule			
C_1	120.9	190.1	118.1
C_2	117.5	173.6	112.5
C_3	119.8	115.1	102.0
SEm±	3.2	2.3	0.7
CD at 5%	NS	8.42	2.63
Nitrogen schedule			
N_1	121.4	164.6	112.7
N_2	122.9	148.3	105.5
N_3	116.4	167.0	114.8
N_4	120.9	160.5	112.0
N_5	117.5	156.1	109.7
N_6	117.5	161.4	110.6
SEm±	4.3	3.8	1.9
CD at 5%	NS	11.06	5.37

Table 5 : Effect of cuttings and nitrogen schedule on yields (q ha^{-1}) and harvest index (%)of dual purpose wheat.

Treatments	Yields (q/ha)		
	Biological yield	Grain yield	Harvest Index (%)
Cutting schedule			
C_1	167.94	64.61	40.52
C_2	147.07	59.43	42.56
C_3	120.08	49.93	43.80
SEm±	1.42	0.57	0.15
CD at 5%	5.02	2.03	0.54
Nitrogen schedule			
N_1	148.22	59.18	41.98
N_2	136.76	55.10	42.65
N_3	148.85	59.89	42.55
N_4	145.47	58.53	42.49
N_5	142.21	56.96	42.40
N_6	147.85	58.30	41.70
SEm±	1.33	0.55	0.17
CD at 5%	3.81	1.55	0.48

increase in harvest index (%) was in the tune of 2.8 and 7.5 per cent when cutting was delayed from 40 DAS to 50 DAS and 60 DAS, respectively. Among different nitrogen schedules, N_2 being at par with all treatments which showed higher harvest index (%). The maximum (42.65%) and minimum (41.70%) harvest index was recorded with N_2 and N_6, respectively. Mathukia *et al.* (2014) also reported that maximum harvest index was recorded with the application of nitrogen in 3 splits with reduced basal dose in the ratio of 25: 50: 25 (basal + active tillering + booting). Higher harvest index with 3 splits of nitrogen application might be owing to more mobilization of assimilates from source to sink formation. These findings are in line with those of Samsujjaman *et al.* (2009).

Conclusion

This study emphasizes the importance of cutting time and nitrogen scheduling in dual-purpose wheat. Cutting at 40 DAS significantly enhanced plant height, tiller number, dry matter and yields (167.94 q/ha biological, 64.61 q/ha grain), proving early cutting's advantage. The nitrogen schedule with half applied at sowing and half after cutting (N_3) was most effective, promoting better regrowth and yield. While later cutting (50–60 DAS) increased initial biomass, it reduced recovery and final productivity. Overall, early forage harvest combined with split nitrogen especially post-cut application emerges as the most efficient strategy for maximizing both fodder and grain yield in wheat.

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