WHEAT YIELDING COMPONENTS RESPONSE TO DIFFERENT LEVELS OF FERTILIZER-N APPLICATION TIME AND DECAPITATION STRESS

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ABSTRACT

Wheat (Triticum aestivum L.) if cut before boot stage can be used for both forage and grain purposes, however, it needs better nutrient management along with other agronomic practices to reduce the possible loss in grain yield. A field experiment was conducted on imposing decapitation stress in wheat as compare to no cut under different N levels and its application time to assess the response of yield crop and yield components. The decapitation stress was imposed through cutting of foliage at 60 d after wheat sowing. Three levels of nitrogen (100, 150 and 200 kg ha^{-1}) were applied as full dose at sowing (M_1), full dose at 2nd irrigation (M_2) and split (M_3) as half each at sowing and with 2nd irrigation to cut (C_1) or no cut (C_0) wheat. Treatments were arranged in randomized complete block (RCB) design with four replications having a plot size of 3 m x 5 m. Wheat cultivar Fakhre Sarhad was planted on 1st November 2004 with seed rate of 120 kg ha^{-1}. The experiment was conducted on well developed, deep silty clay loam alkaline soil (pH = 7.7-8.2) at Agricultural Research Farm (Malakandher), KP Agricultural University Peshawar during 2004-05. Compared to control, fertilizer-N supplementation produced more spikes m^{-2} (349), grains spike^{-1} (44), thousand grains weight (37.21 g), grain yield (2985 kg ha^{-1}), biological yield (10039 kg ha^{-1}) and harvest index (37 %) as compare to control. Whereas the decapitation stress decreased spikes m^{-2} (316), grains spike^{-1} (42), thousand grains weight (35.92 g), grain yield (2601 kg ha^{-1}), biological yield (9176 kg ha^{-1}) and harvest index by 35 % as compare to no-cut plots. Compared to control fertilizer-N levels increased spikes m^{-2} (368), grains spike^{-1} (46), thousand grains weight (37.89 g), grain yield (3213 kg ha^{-1}) and biological yield (10923 kg ha^{-1}. Similarly, the split application of fertilizer-N improved spikes m^{-2} (353), grain spike^{-1} (45), grain yield (3165 kg ha^{-1}) and biological yield (10527 kg ha^{-1}) as compared to control, whereas thousand grains weight and harvest index were not affected by fertilizer-N application time. Based on the findings of this study wheat can be grown as dual purpose crop and the reduction in yielding component can be managed through increase in fertilizer-N level, through split application, half at sowing and half with 2nd irrigation.

Key Words: **Nitrogen, Wheat, spike m^{-2}, Grains spike^{-1}, grain weight, grain yield, harvest index, Decapitation.**

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INTRODUCTION

Wheat is an important cereal crop of Pakistan and it occupies about 66% of the annual food cropped area with an average production of 2716 kg ha^{-1} during 2007-08 (MINFAL, 2008). It supplies the major dietary requirements, 60% of the calories and protein of the average human diet (Khalil and Jan, 2002). Agricultural scientists are continuously studying different aspects of wheat production such as soil properties fertilizer application, different wheat varieties and other crop management practices to make Pakistan self sufficient in wheat grains. However, of late the use of wheat as dual-purpose (DP) crop (forage and grain production) is aimed at increasing area devoted to wheat grain production which can also produce forage.

Forage availability is reduced during the winter period, therefore cereals as dual purpose crop can be used to provide good quality forage and also increases the area devoted to grain production (Arzadun *et al*., 2003). However, many reports suggested that dual purpose wheat crop produce lower grain production. For example, Borman *et al*. (2002) reported that yield reduction depends on a combination of timing, intensity, and extent of grazing. Similarly, delayed cutting or many cuttings may cause substantial reduction in grain yield (Winter and Musick, 1991). In the same way, late defoliation increased forage production, but reduces grain yield (Zhu *et al*., 2006). However, Khalil *et al*. (2002) reported that grazing had negative effects on the grain yield. Similar findings were also reported by Buntin (1994) and Cosser *et. al.* (1997) who found that flag leaf defoliation decreases yield. In contrast, Chaudhary *et. al.* (1994) reported that seedling defoliation generally had little adverse effect on grain yield and test weight. Similar results were also reported by Baron *et al*. (1993) who concluded that the yield does not change and rather an increase in tiller per m^2 was reported. Lyon *et al*. (2001) observed that decapitation before boot stage is advantageous to late cutting both in providing grain plus forage from same crop.

Between winter and spring cereals, Juskiw (2000) observed that winter cereals were better than spring cereals in terms of forage production. Wheat crop reduced the grain yield when cut in the spring, while grazing during winter had no impact on grain yield (Weller *et al*. 1995). Similarly early grazing of wheat resulted in greater tillers than late or no grazing (Hendrickson *et al*., 2005).

Proper nutrient management and particularly N fertilizer play an important role in crop production. Although it is proved that recently developed wheat cultivars require high N and P for more production. But it has been reported that wheat yield can be limited by both inadequate and excessive N availability (Bundy and Andraski, 2004). Highest yield obtained with urea when applied at tillering, while late fertilization increased N recovery (Melaj *et al*., 2003).

The injudicious use of nitrogen sometimes causes increase in plant height which ultimately causes crop logging and decrease the yield. To avoid such and other problems associated with injudicious use of nitrogen such as logging, grain crop need defoliation at a specific growth stage, which will not only increase total income by efficient utilization of nitrogen, but will also safeguard the environment. However, dual purpose wheat production is a complicated process due to complex interaction of forage and grain yield from the same crop. Therefore to get higher grain yield as well as forage from the same wheat crop, longer period of growth and development is required. This may be accomplished by early sowing as suggested by Hossain *et al*. (2003). Some studies also suggested that urea increases autumn forage production and N content by prolonging the vegetative stage and thereby the grazing season (Rao and Popham, 1999). Others reported that the timing and rate of N application had profound effects on protein quality of the grains and forage (Farrer *et al*., 2006) and hence on dual purpose wheat production. For example, Brown and Petrie (2006) reported that late season N increase protein without decreasing yield losses from excessive N during vegetative growth. Similarly, Sieling and Beims (2007) found that early N application was not as good as late, split applied at stem elongation, ear emergence or bud formation.

Efficient utilization of nitrogen would be achieved in wheat crop production by introducing artificial stress by giving a cut to the standing crop aiming to provide dry matter on one hand and safe guarding environmental on other hand. However, in Pakistan, research on wheat as dual purpose crop (forage as well as grain crop) is limited. The objectives of our research were to evaluate the different levels of fertilizer-N, application time impact and decapitation stress on some of the important characteristics of wheat under decapitation stress. These characteristics were spikes m^{-2}, grains $spike^{-1}$, thousand grains weight (g), grain yield (kg ha^{-1}), biological yield (kg ha^{-1}) and harvest index (%).

MATERIALS AND METHODS

The experiment was conducted to evaluate the "wheat yielding components response to different levels of fertilizer-N, its application time and decapitation stress" at Agricultural Research Farm, KP, Agricultural University Peshawar during 2004-05. The environmental conditions of research farm are semi-arid subtropical with a mean annual rainfall less than 360 mm. Depending upon the amount of annual rainfall and soil type, wheat fields are generally irrigated 3-5 times during entire growing season.

The soil used for this experiment was well develop, deep silty clay loam. The nature of soil was alkaline with pH 7.7 – 8.2. The soil was deficient in total N (<0.5 g kg^{-1}). The field was ploughed thoroughly using mould board plough. Triple super phosphate and muriate of potash were used at rate of 50 kg ha^{-1} as P and K source, respectively and applied at sowing time. Urea was used as N source and applied according to the treatment mentioned below. Each plot size was 3 m x 5 m having 10 rows 30 cm apart and 5 m long. All the other agronomic practices were applied uniformly to each plot.

The experimental variables were (a) decapitation stress, which was induced through hand cutting of wheat foliage (C_1) at Zadok growth stage 29 (Zadoks *et al*., 1974) compare to no-cut (C_0), where (b) N levels were 100(N_1), 150(N_2) and 200(N_3) kg ha^{-1} and (c) three application time as full dose at sowing (M_1), full dose at 2^{nd} irrigation (M_2) and split application (M_3) as half at sowing and half with 2^{nd} irrigation. A control plot was also included in each replication. Wheat variety Fakhre Sarhad was planted on 1^{st} November, 2004 and harvested at 2^{nd} May, 2005. A total of 19 (2x3x3+1) treatments including one control were laid out in randomized complete block (RCB) design and replicated four times.

For spike m^{-2}, the numbers of spikes were counted in one meter row at three different places randomly selected in each plot. Numbers of spikes m^{-2} were calculated using formula:

$$\text{Spike } m^{-2} = \frac{\text{Number of spikes counted}}{\text{R - R} \times \text{Number of rows} \times \text{row lenght}} \times 1m \times 1m$$

Ten representative spikes were randomly selected in each plot. The grains were threshed, counted and averaged to record the data on grains $spike^{-1}$.

Thousand grains were randomly taken from the lot of sun dried grain of each plot and weighed to record grain weight for each treatment.

Biological yield was recorded by harvesting central six rows in each plot. Bundles were made after harvest and air-dried. The air-dried bundles weight was recorded with a spring balance and converted to kg ha^{-1} with following formula.

$$\text{Biological yield (kg ha}^{-1}) = \frac{\text{Plant aerial components (kg)}}{\text{R - R} \times \text{No. rows} \times \text{row lenght}} \times 10000$$

The harvested central six rows after sun drying were threshed with wheat thresher to record grain yield. The grains were cleaned and weighed, and converted to kg ha^{-1} using the following formula:

$$\text{Grain yield (kg ha}^{-1}) = \frac{\text{Grain yield in six row (kg)}}{\text{R - R} \times \text{No. rows} \times \text{row lenght}} \times 10000$$

Harvest index was calculated as economic yield divided by biological yield and multiplied by 100 to express the data as percentage.

$$Harvest\,index = \frac{Eonomic\ yield\ (grain)}{Bio\log ical\ yield} x100$$

The data was statistically analyzed using analysis of variance appropriate for randomized complete block design. The mean comparison was done to explain significant variation among the treatments. For such purpose, the sum of square of treatments was further partitioned to answer specific and important questions about the treatment effects (Jan *et al.*, 2009). Main effects were compared using least significance different (LSD) test at 0.05 level of probability, when the F-values were significant (Gomez and Gomez, 1980).

RESULTS AND DISCUSSION

The spikes m^{-2} of wheat significantly increased with fertilizer-N treatments (349) as compare to 272 from control (Table I). The decapitation stress significantly decreased (316) spike m^{-2}. The fertilizer-N significantly increased spikes m^{-2} (368) in a linear fashion with increase in fertilizer-N rate up to 200 kg ha^{-1}. The split application of fertilizer-N in case of M_3 significantly improved spikes m^{-2} (353). The interaction among CxN showed significant variation for spikes m^{-2}. Spikes m^{-2} increased with N levels up to 150 kg ha^{-1} with no cut imposition but further increase in N (200 kg ha^{-1}) did not improve it further, but spikes m^{-2} increased linearly with increase in N level when cut was applied. Nitrogen supplementation had positive effects on crop productivity, and therefore higher spikes m^{-2} were observed in plots where N was applied. The increase in spikes m^{-2} with N rate is in the agreement with the findings of Melaj *et al*. (2003) and was further confirmed by Mandal *et al*. (2005). When N was applied as splits doses, it increased the spike m^{-2} compared to single dose of N application either earlier or late. It might reflect the better synchronization between N availability and plant demand. Decapitation of wheat in the study presented here has reduced the spike m^{-2} (Table I). Similar finding were also reported by Malinowski *et al.* (2003) who observed that wheat grass can survive after frequent defoliation due to lower temperature at night but may decrease the number of tiller. Our results contradict the findings of Hendrickson *et al.* (2005) more tiller recruitment in few wheat cultivars under grazing.

Table-I *Spikes m^{-2} of wheat as affected by fertilizer-N, decapitation stress and its application time.*

Decapitation treatment	N levels (kg N ha^{-1})	N application time M1	M2	M3	C x N
No-Cut	100	367	376	368	371
No-Cut	150	381	398	385	388
No-Cut	200	399	374	388	387
Cut	100	280	274	296	283
Cut	150	294	321	333	316
Cut	200	343	354	348	348
			C x M		
No-Cut		382	382	380	382
Cut		306	316	326	316
			N x M		
100		324	325	332	327
150		338	359	359	352
200		371	364	368	368
Mean		344	349	353	
Control		272			
Rest		349			

$LSD_{(0.05)}$ for N=14.9, M=14.9, Cut=**, Control vs. Rest=**
Interactions: CxN= **, CxM= ns, NxM= ns and CxNxM = ns,
ns, *, ** = Non-significant, significant at 0.05 and 0.01 level of probability, respectively.

Number of grains $spike^{-1}$ of wheat significantly improved with fertilizer-N (44) treatments as compare to 38 grains $spike^{-1}$ from control (Table II). The decapitation stress significantly reduced grains $spike^{-1}$(42) compare to no cut (46). The fertilizer-N significantly enhanced grains $spike^{-1}$ (46) linearly with respect to increase in fertilizer-N rate. The full dose of fertilizer-N application at sowing or two equal split application of fertilizer-N (i.e. M_3) significantly improved grains $spike^{-1}$(45). The interactions were non-significant for grain $spike^{-1}$. Shorter life cycle of crop might be the possible reasons for lesser grains in decapitated plots compared to no cut plots. The grains $spike^{-1}$ plays a vital role in grain yield (Abbate *et al*., 1998; Guarda *et al*., 2004). Our results suggest that applied N has increased grains $spike^{-1}$ compared to control plots. The increases in grains $spike^{-1}$ are in line with the findings of Mandal *et al*. (2005). The full dose of fertilizer-N application at sowing or split application of fertilizer-N (M_3) improved grains $spike^{-1}$. The grains $spike^{-1}$ production depends upon the nutrient deficiency duration (Jeuffroy and Bouchard, 1999), which means that nutrient availability/unavailability directly effects grains $spike^{-1}$. Thus split application had greater nutrients availability time than single application and has thus increased the grains $spike^{-1}$ as a consequence of the better crop growth. The decapitation stress reduced grains $spike^{-1}$, the possible reason for this may be the stress condition produced due to cutting and the limited time to complete it re-growth and development.

Table-II *Grains $spike^{-1}$ of wheat as affected by fertilizer-N, decapitation stress and its application time.*

Decapitation treatment	N levels (kg N ha^{-1})	N application time M1	M2	M3	C x N
No-Cut	100	45	44	47	45
No-Cut	150	45	43	45	45
No-Cut	200	45	46	50	47
Cut	100	38	39	41	40
Cut	150	43	41	42	42
Cut	200	46	43	45	44
			C x M		
No-Cut		45	45	47	46
Cut		42	41	43	42
			N x M		
	100	41	42	44	42
	150	44	42	43	43
	200	45	44	48	46
Mean		44	43	45	
Control		38			
Rest		44			

$LSD_{(0.05)}$ for N=1.3, M=1.3, No-cut vs. Cut=**, Control vs. Rest=**
Interactions: CxN= **, CxM= ns, NxM= ns and CxNxM = ns,
ns, *, ** = Non-significant, significant at 0.05 and 0.01 level of probability, respectively.

Compare to control (35.06 g) thousand grains weight (g) of wheat significantly enhanced with fertilizer-N (37.21 g) treatments (Table III). The decapitation stress significantly reduced (35.92 g) thousand grains weight as compare to no-cut (38.51 g). Whereas the fertilizer-N levels significantly enhanced thousand grains weight (37.89 g) with increase in fertilizer-N rate up to 150 kg N ha^{-1} but further increase in N reduced grain weight (Table 3). However, the fertilizer-N application time showed no significant variation in thousand grains weight.

The interaction of CxN was significant for thousand grains weight (Table III). Thousand grains weight increased (39.70 g) with N levels up to 150 kg ha^{-1} with no cut imposition and further increase in N (200 kg ha^{-1}) decreased to 36.42 g, but thousand grains weight enhanced (36.08 g) with increase in N level (up to 150 kg ha^{-1}) and further increase in N (200 kg ha^{-1}) decrease to 35.74 g when cut was applied. Our results indicate that grain weight of wheat enhanced with fertilizer-N, which could be associated with optimum availability of nutrients for translocation of photo-assimilate to the grains. Similar results were also reported by Mandal *et al*. (2005), who observed more grains weight with better nutrient management. However, excessive use of fertilizer-N was not beneficial as observed by Brown and Petrie, (2006) who reported that it causes more vegetative growth and reduced kernel weight. Brancourt-Hulmel *et al*. (2003) also attributed and highlighted the importance of grain weight toward grain yield. The decapitation stress reduced grains weight, could be due to delay in completing growth and development stage as stated by Gibson and Paulsen, (1999). The high temperature after anthesis reduces kernel weight, and so lighter grains were obtained.

Table-III ***Thousand grains weight (g) of wheat as affected by fertilizer-N, decapitation stress and its application time.***

Decapitation treatment	N levels (kg N ha^{-1})	N application time M1	M2	M3	C x N
No-Cut	100	40.35	38.51	39.34	39.40
No-Cut	150	39.62	39.02	40.47	39.70
No-Cut	200	36.92	37.16	35.18	36.42
Cut	100	35.31	36.63	35.93	35.95
Cut	150	36.81	36.15	35.29	36.08
Cut	200	35.21	36.03	35.98	35.74
			C x M		
No-Cut		38.96	38.23	38.33	38.51
Cut		35.77	36.27	35.73	35.92
			N x M		
	100	37.83	37.57	37.63	37.67
	150	38.21	37.58	37.88	37.89
	200	36.06	36.59	35.58	36.08
Mean		37.37	37.25	37.03	
Control		35.06			
Rest		37.21			

LSD $_{(0.05)}$ for N=0.69, M=ns, No-cut vs. Cut=**, Control vs. Rest=**
Interactions: CxN= **, CxM= ns, NxM= ns and CxNxM = ns,
ns, *, ** = Non-significant, significant at 0.05 and 0.01 level of probability, respectively.

Grain yield (kg ha^{-1}) of wheat significantly increased with fertilizer-N treatments (2985 kg ha^{-1}) as compared to control (1908 kg ha^{-1})(Table IV). Whereas the decapitation stress significantly reduced (2601 kg ha^{-1}) grain yield compared to no cut 3370 kg ha^{-1}. The fertilizer-N significantly enhanced grain yield (3213 kg ha^{-1}) linearly with increase in fertilizer-N (up to 200 kg N ha^{-1}). Also the full dose of fertilizer-N application at sowing time (2952 kg ha^{-1}) or two equal split application of fertilizer-N (M3) improved (3165 kg ha^{-1}) grain yield.

The interaction between CxN was significant for grain yield (Table IV). In case of no cut grains yield increased (3416 kg ha^{-1}) with N levels up to 150 kg ha^{-1}, but further increase in N (200 kg ha^{-1}) did not improved the grain yield. However, in case of cut imposition, higher grain yield was obtained from the highest dose of 200 kg N ha^{-1}. These results are in line with the findings of Khalil *et al*. (2002) who reported that grazing of wheat decrease grain yield and further confirmed by Arzadun *et al*. (2006). However, Borman *et al*. (2002) suggested that grazing can reduce or cause no difference or may increase grain yield depending on a combination of timing, intensity, and extent of grazing. The full dose of fertilizer-N application at sowing time or two equal split applications of fertilizer-N improved grain yield (Table IV). The nitrogen applied before or at tillering improved grain yield more than after tillering stage, this suggest that the time of fertilizer-N application play a vital role (Melaj *et al*., 2003) in grain yield improvement.

Table-IV *Grain yield (kg ha^{-1}) of wheat as affected by fertilizer-N, decapitation stress and its application time.*

Decapitation treatment	N levels (kg N ha^{-1})	N application time M1	M2	M3	C x N
No-Cut	100	2896	2913	3180	2996
No-Cut	150	3430	3253	3565	3416
No-Cut	200	3710	3663	3718	3697
Cut	100	2410	2291	2656	2452
Cut	150	2585	2373	2903	2620
Cut	200	2683	2535	2970	2729
			C x M		
No-Cut		3345	3276	3488	3370
Cut		2559	2400	2843	2601
			N x M		
	100	2653	2602	2918	2724
	150	3007	2813	3234	3018
	200	3197	3099	3344	3213
Mean		2952	2838	3165	
Control		1908			
Rest		2985			

$LSD_{(0.05)}$ for N=123.8, M=123.8, No-cut vs. Cut=**, Control vs. Rest=**
Interactions: CxN= **, CxM= ns, NxM= ns and CxNxM = ns,
ns, *, ** = Non-significant, significant at 0.05 and 0.01 level of probability, respectively.

Biological yield of wheat significantly improved (10039 kg ha^{-1}) with fertilizer-N treatments as compare to 6697 kg ha^{-1} from control (Table V). Whereas the decapitation stress significantly reduced biological yield (9176 kg ha^{-1}) as compare to no-cut (10902 kg ha^{-1}). The fertilizer-N levels significantly enhanced biological yield (10923 kg ha^{-1}) in linear fashion with increase in fertilizer-N levels. The full dose of fertilizer-N application with 2nd irrigation or two equal split application of fertilizer-N (M3) significantly improved biological yield.

The interaction CxN was significant for biological yield (Table V). Biological yield increased with N levels up to 150 kg ha^{-1} when no cut was imposed but further increase in N (200 kg ha^{-1}) did not show any increase in biological yield in same manner and rather showed a decreasing trend. Biological yield increased with N application when compare with control which might be due to increase in N application as suggested by Rao and Popham, (1999) and attributed to urea application. Similar findings were also reported by Gibson *et al.* (2007) who reported that the fertilizer-N enhanced biological yield.

Table-V *Biological yield (kg ha^{-1}) of wheat as affected by fertilizer-N, decapitation stress and its application time.*

Decapitation treatment	N levels (kg N ha^{-1})	N application time M1	M2	M3	C x N
No-Cut	100	9249	8194	9911	9118
No-Cut	150	10750	11375	12619	11581
No-Cut	200	11961	12083	11972	12005
Cut	100	8137	8833	8056	8342
Cut	150	9113	9306	9620	9346
Cut	200	8902	9634	10984	9840
			C x M		
No-Cut		10653	10551	11501	10902
Cut		8717	9258	9553	9176
			N x M		
	100	8693	8514	8983	8730
	150	9931	10340	11120	10464
	200	10431	10859	11478	10923
Mean		9685	9904	10527	
Control		6697			
Rest		10039			

$LSD_{(0.05)}$ for N=642, M=642, No-cut vs. Cut=**, Control vs. Rest=**
Interactions: CxN= **, CxM= ns, NxM= ns and CxNxM = ns,
ns, *, ** = Non-significant, significant at 0.05 and 0.01 level of probability, respectively.

As can be noted in Table 5, our results showed reduction in biological yield with decapitation stress, which is in contradiction with the findings of Hopkins *et al.* (2003) who reported that orchard grass and pubescent wheatgrass grazing increased dry matter yield. However, our results are in line with the findings of Borman *et al.*

(2002), that timing and intensity of grazing affect grain and biological yield, heavy or delayed grazing reduces the final product, while early grazing had no impact on biological or grain yield and this suggests that decapitation before tillering completion (Zadok growth stage 29) of wheat is manageable. The N fertilizer application at tillering stage enhanced tillers m^{-2}, leading to higher biological yield (Melaj *et al.*, 2003). Similarly, the split applications prolong the N availability (Brown and Petrie, 2006) and enhanced vegetative growth, which in turn produced more biological yield (Table V).

The harvest index of wheat significantly increased with fertilizer-N (37 %) treatments as compare to 33 % from control (Table VI). Whereas the decapitation stress significantly decreased harvest index (35 %) as compare to 39 % from no cut plots. The fertilizer-N level (100 kg ha^{-1}) significantly enhanced harvest index (39 %) as compare to 36 % from 150 and 200 kg N ha^{-1}. No significant interaction among the variables was observed for harvest index. According to Andersson and Johansson, (2006) harvest index is related to the above ground dry matter, and depends upon environment and genotype interaction. The variation in harvest index could be related to the relative increase in both grain and biological yield due to N application. These findings are in agreement with Guarda *et al.* (2004) who observed higher harvest index with N application. Our results indicated that lower N dose had higher harvest index compared to increased N rates (Table VI), which could be possibly explained by higher biological yield as a result of increased N levels. These results are in line with the results of Baker *et al.* (2004) who reported low harvest index with higher N fertilizer and were confirmed by Bundy and Andraski, (2004). The decapitation stress decreased harvest index, which are in accordance with findings of Brancourt-Hulmel *et al.* (2003) who reported a reduction in harvest index for cut plants. Similar findings were also reported by Borman *et al.* (2002) who stated that reduction in harvest index depends on cutting/grazing time and intensity as well as plant genetic makeup.

In the light of these findings, it can be concluded that decapitation stress reduces spike m^{-2}, grains $spike^{-1}$, thousand grain weight, grain yield and biological yield but it can be manageable through increase in fertilizer-N level and its split application.

Table-VI ***Harvest index (%) of wheat as affected by fertilizer-N, decapitation stress and its application time.***

Decapitation treatment	**N levels (kg N ha^{-1})**	**N application time**			**C x N**
		M1	**M2**	**M3**	
No-Cut	100	39	41	42	41
No-Cut	150	38	38	35	37
No-Cut	200	38	36	39	38
Cut	100	38	35	37	37
Cut	150	35	34	37	36
Cut	200	36	33	33	34
			C x M		
No-Cut		38	38	39	39
Cut		36	34	36	35
			N x M		
100		38	38	40	39
150		36	36	36	36
200		37	34	36	36
Mean		37	36	37	
Control		33			
Rest		37			

$LSD_{(0.05)}$ for N=1.9, M=ns, No-cut vs. Cut=**, Control vs. Rest=**
Interactions: CxN= **, CxM= ns, NxM= ns and CxNxM = ns,
ns, *, ** = Non-significant, significant at 0.05 and 0.01 level of probability, respectively.

CONCLUSION AND RECOMMENDATIONS

In the light of these findings, it can be concluded that decapitation stress reduces spike m^{-2}, grains $spike^{-1}$ thousand grain weight, grain yield and biological yield but it can be manageable through increase in fertilizer-N level and its split application.

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