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Cutting Durations Influency on Wheat Crop Dry Matter Production and Yield Components

[1]Muhammad Owais Iqbal, [1]Muhammad Zahir Afridi, [2]Kashif Akhtar, [1]Fazal Munsif, [3]Vu Ngoc Ha, [1]Kamran Khan and [1]Muhammad Mehran Anjum

[1]Department of Agronomy, Amir Muhammad Khan Campus, Mardan, The University of Agriculture Peshawar, KPK, Pakistan
[2]College of Agronomy, Northwest A & F University, Yangling, Shaanxi, China
[3]College of Forestry, Northwest A & F University, Yangling, Shaanxi, China

Abstract: Green fodder accessibility is a serious issue for livestock in rabi season, especially in crop land areas where fodder crops cannot be sown due to competition with staple food crops like wheat. The aim of the study was to estimate dual purpose wheat utilized for forage and grain production grown under different cutting durations. Wheat variety Atta-Habib was sown at Palatoo Research Farm (PRF), Amir Muhammad Campus Mardan, The University of Agriculture Peshawar, during 2014-15, for fodder and grain production. The five treatments were consisting of no-cut and one cut i.e. at Zadok growth stage 12 or 14 or 16 or 18. The experiment was laid out in randomized complete block design with four replications having plot size 3 x 3 m^2. Results showed that fodder production was increased from 130 to 3500 kg ha^{-1} with delaying cutting from ZGS-12 to ZGS-18, whereas grain yield was decreased from 4400to 2750 kg ha^{-1} with delayed cutting. No cut produced tallest plants (88 cm) as compared to cut at ZGS 18 (76 cm). Similar inclination was observed in productive tillers m^{-2} (from 388 to 357), grains $spike^{-1}$ (from 62 to 48) and 1000-grains weight (from 49 g to 33 g) which perform better in the no cut plots. Similarly days to heading (122), anthesis (125) and maturity (162) were also delayed with cutting. From all findings it may be concluded that no cut is optimum to obtain higher grain yield (4400 kg ha^{-1}) and cut at ZGS-18 is optimum for forage production (3500 kg ha^{-1}). Green fodder production of 3500 kg ha^{-1} may be obtained with a reduction of 1650 kg ha^{-1} in grain yield and 2450 kg ha^{-1} in biological yield.

Key words: Dual purpose wheat · Zadok growth stage · Forage and fodder production

INTRODUCTION

Wheat (*Triticum aestivum*) is most important among the cereals on the basis of production. In Pakistan it occupies about 66% of the annual food cropped area MINFAL, 2008 [1]. It is a rich source of quality forage, protein, energy, nutrients and low in fiber (Hossain *et al*., [2]. Wheat was planted on 9.18 million ha, producing 25.48 million tons in year 2014-15 PBS 2015 [3]. Pakistan is facing food and feed shortages due to the increasing rate in population. Similarly livestock population increase as about one million each year, while area under fodder production is decreasing. 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 Khalil *et al*., [4].

Wheat can be grown non-traditionally to attain maximum benefit for both grains and feed Shuja *et al*. [5] to diminish fodder shortage during winter. Wheat has the great potential to re-grow and set seed for their dual-purpose cultivation Francia *et al*. [6]. 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 for grain production Arzadun *et al*. [7]. The fodder scarcity in winter is one of the main warning factors for livestock production. About six million acres wheat in Mexico is cultivated for dual-

Corresponding Author: Muhammad Owais Iqbal, Department of Agronomy, Amir Muhammad Khan Campus, Mardan, The University of Agriculture Peshawar, KPK, Pakistan.

purpose to nourish three million stocker cattle in fall Zhang *et al*. [8]. However, many reports suggested that dual purpose wheat crop produce lower grain production. For example, Borman *et al*. [9] reported that yield reduction depends on a combination of timing, intensity and extent of grazing.

Therefore, keeping in view the current demand of both grain and fodder production, this experiment was conducted to determine optimum cutting duration suitable for dual purpose wheat. The objectives of the study were to determine the optimal cutting duration for dual-purpose wheat and to evaluate the response of important characteristics of wheat to different cutting duration. These characteristics were spikes m^{-2}, grains $spike^{-1}$, thousand grains weight (g), green fodder yield (kg ha^{-1}), grain yield (kg ha^{-1}), biological yield (kg ha^{-1}) and harvest index (%).

METERIALS AND METHODS

The experiment was conducted during winter season 2014-15 at Palatoo Research Farm (PRF), Amir Muhammad Khan Campus Mardan, the University of Agriculture Peshawar. The five treatments were consisting of no-cut and one cut i.e. at Zadok growth stage 12, 14, 16 or 18. The experiment was laid out in Randomized Complete Block Design (RCBD) having four replications. The plot size was 3 × 3 m^2. The soil was ploughed up to 30 cm depth twice by using common cultivator followed by planking to break the clods. The wheat variety Atta-Habib was sown at the rate of 120 kg ha^{-1} manually in each plot. Nitrogen and phosphorus were applied at the rate of 120 and 60 kg ha^{-1} using urea and diammonium phosphate (DAP), respectively. All phosphorus was applied at the time of sowing. Half nitrogen was applied at tillering stage, while the remaining half of the nitrogen was applied before boot stage. Chemical herbicide, Bromoxynil + MCPA was sprayed to control weeds. The cutting of fodder carried out with the help of sickle along with the ground level at each specific duration.

The data was recorded on different parameter that is numbers of tillers m^{-2} were measured by selecting plants randomly in one square meter area using a quadrate. The tillers inside the quadrate were counted. While data on Productive tillers m^{-2} was observed physically by pressing the spikes of randomly selected plants in one square meter area using a quadrate. The productive tillers inside the quadrate were counted.

Days to heading were noted as days from sowing date to the date when spikes arise completely from flag leaf and days to anthesis were noted as days from sowing date to the date when 75% anthers were extruded from spikelets and were seen with naked eye.

The duration of maturity were counted as days from sowing date to the day when spikes turned yellow. Whereas plant height was recorded by measuring height (from the soil surface to the end of the spike) of ten randomly selected plants from each plot and then average. The spike length was measured from base of the spike to the tip of the last spikelet apart from awns and the data on spikelets $spike^{-1}$ was taken by ten randomly selecting spikes from each plot and then counted the number of spikelets on each spike. Then its average was taken. Therefore the grains $spikelets^{-1}$, ten spikes randomly selected from each plot. Spikes were then crushed into spikelets and grains in each spikelet were computed. Then its average was taken. The counting of number of grains $spike^{-1}$, ten spikes from each plot were selected and threshed. The number of grains were counted and then averaged. Thousand grains weight was recorded by taking random samples from threshed grains of each plot, computed and weighted by electric balance. The biological yield, central rows were harvested, dried in sun for seven days and then weighted by digital balance. The yield was then converted to kg ha^{-1}. The wheat grain yield after threshing were collected and weighted to record grain yield in kg m^{-2}. Then it was converted to kg ha^{-1} and after threshing, straw of each plot was collected and weighted to record straw yield in kg m^{-2}. Then it was converted to kg ha^{-1} after conversion the harvest index was determined as the ratio of grain yield kg $ha^{-1}$to biological yield kg ha^{-1}. The Green fodder yield was determined by weighting fresh fodder when it was harvested. Then fodder yield in kg m^{-2} was converted to kg ha^{-1}. Data collected were analyzed statistically according to procedure relevant to RCB design. Upon significant F-Test, least significance difference (LSD) test was used for mean comparisons.

$$\text{Harvest Index (\%)} = \frac{\text{Grain yield (kg ha}^{-1})}{\text{Biological yield (kg ha}^{-1})} \times 100$$

RESULTS AND DISCUSSION

Number of Tillers m^{-2}: Planting density at time of harvesting is central yield determining factor for each crop. The data regarding number of tillers m^{-2} is represented in Fig. 1. Numbers of tillers m^{-2} were significantly affected by cutting duration. Higher tillers m^{-2} (430) were observed in no cut plots whereas lower tillers m^{-2} (370) were observed with delaying the cutting duration (to ZGS-18). The cutting duration decreased the tillers m^{-2} as D0=430 >D1=410 > D2=399 > D3=380 > D4=370 pattern. The results also are in agreement with the earlier findings of Naveed *et al*. [10], who reported that cutting at 60 days after sowing negatively affect tillers m^{-2}.

Productive Tillers m^{-2}: The data regarding productive tillers m^{-2} is represented in Fig. 2. The productive tillers m^{-2} was significantly decreased affected by cutting durations. Higher numbers of productive tillers m^{-2} (388) were observed in no-cut plots whereas lower productive tillers m^{-2} (357) were observed with delaying the cutting duration (to ZGS-18). The cutting duration decreased productive tillers m^{-2} in the pattern as D0=388 >D1=381 > D2=375 > D3=367 > D4=357. Similar results were also reported by Khalil *et al*. [4]. Production of fewer tillers may be due to insufficient resources allocation needed for development of secondary tillers Noy-Meir & Briske, 2002 [11].

Plant Height (cm): Plant height is important component of straw yield and may also affect grain yield due to partitioning of dry matter to vegetative portion. The data regarding plant height is presented in Fig. 3. Plant height was significantly affected by cutting durations. Tallest plants (88 cm) were observed in no-cut plots, whereas shorter plant (76 cm) were observed with delaying the cutting duration (to ZGS-18). The cutting duration decreased the plant height in the pattern as D0=88 >D1=85 > D2=82 > D3=80 > D4=76 cm. The decrease in plant height is due to the fact that cutting imposed stress and terminates the growth; therefore new shoot cannot attain the same plant height due to shorter growth duration. In case of no cut there was no disturbance in the plant growth and thus resulted in tallest plants Noy- Meir & Briske, 2002 [11]. The present results confirmed the earlier findings of Munsif *et al*. [12], Khaleel *et al*. [4] and Naveed *et al*. [13].

Spike Length (cm): Spike is main reproductive part of wheat. It length is also an important yield determining factor that can directly effects number of grains $spike^{-1}$ and grain yield. The data regarding spike length is represented in Fig. 4. Spike length was significantly affected by cutting durations. The longest spikes (12 cm) were observed in no-cut plots, whereas the shortest spikes (8.5cm) were observed with delaying the cutting duration (to ZGS-18). The cutting duration decreased the plant height in the pattern as D0=12 >D1=11.5 > D2=10.5 > D3=9 > D4=8.5.

Grains $Spikelet^{-1}$: The data regarding grains $spikelet^{-1}$ is represented in Fig. 5. Grains $spikelet^{-1}$ was significantly affected by cutting durations. The highest grains $spikelets^{-1}$ (3.5) were observed in no-cut plots, whereas the least number of grains $spikelets^{-1}$ (2) were observed with delaying the cutting duration (to ZGS-18). The cutting duration decreased grains $spikelet^{-1}$ in the pattern as D0=3.5 >D1=3 > D2=2.75 > D3=2.5 > D4=2, Similar results were also reported by Hastenpflug *et al*. [14].

Spikelet's $Spike^{-1}$: Spikelets $spike^{-1}$ also directly affects number of grains $spike^{-1}$ and grain yield. The data about spikelets $spike^{-1}$ is represented in Fig. 6. Spikelets $spike^{-1}$ was significantly affected by cutting durations. The highest spikelets $spike^{-1}$ (25) were observed in no-cut plots, whereas the lowest number of spikelets $spike^{-1}$ (17) were observed with delaying the cutting duration (to ZGS-18). The cutting duration decreased grains $spikelet^{-1}$in the pattern as D0=25 >D1=23 > D2=21 > D3=.

Grains $Spike^{-1}$: Number of grains $spike^{-1}$ is an essential yield component that directly affects grain yield and harvest index. The data about grains $spike^{-1}$ is represented in Fig. 7. Grains $spike^{-1}$ was significantly affected by cutting durations. The highest grains $spike^{-1}$ (62) was observed in no-cut plots, whereas the lowest number of grains $spike^{-1}$ (48) was observed with delaying the cutting duration (to ZGS-18). The cutting duration decreased grains $spike^{-1}$ in the pattern as D0=62 >D1=59 > D2=56 > D3=52 > D4=48. Afridi *et al*. [16] stated that decapitation stress significantly reduce grains $spike^{-1}$. Similar results were found by Noy-Meir & Briske, [11], who reported the increased number of grains $spike^{-1}$ in control plots as compared to late grazing in the season. Similar results were also reported by the findings of Naveed *et al*. [13] and Khalil *et al*. [4].

Days to Heading: The data about days to heading is represented in Fig. 8. Days to heading were significantly affected by cutting durations. Fewer days to heading (122) were observed in no cut plots whereas more days to heading (127) were observed with delaying cutting duration (to ZGS-18). Days to heading were delayed in the

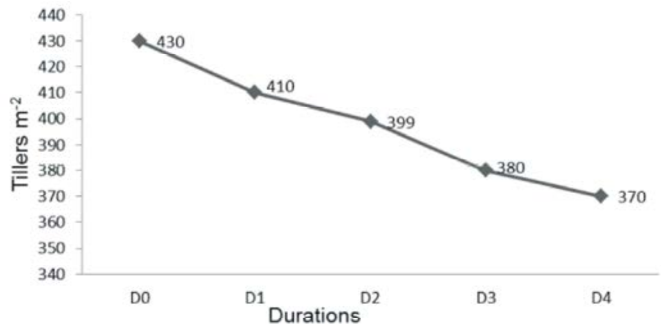

Fig. 1: Impact of cutting durations on number of tillers m^{-2} of dual purpose wheat

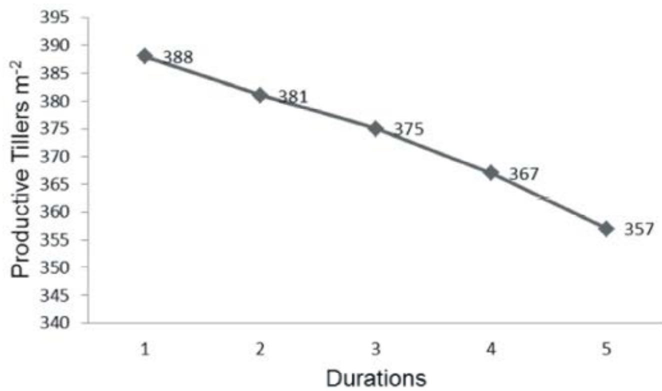

Fig. 2: Impact of cutting durations on productive tillers m^{-2} of dual purpose wheat

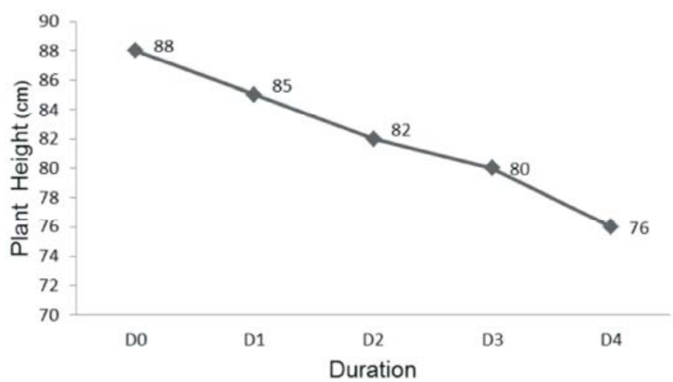

Fig. 3: Impact of cutting durations on plant height of dual purpose wheat

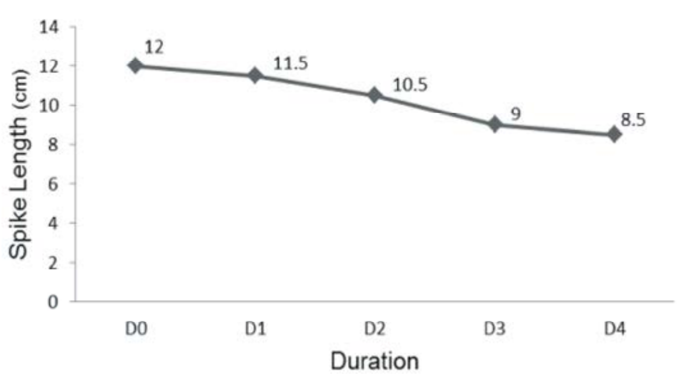

Fig. 4: Impact of cutting durations on spike length of dual purpose wheat

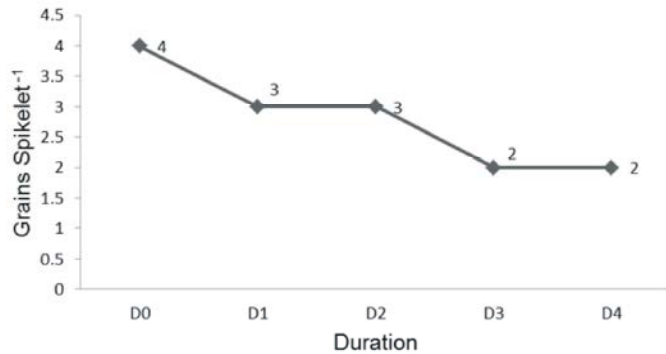

Fig. 5: Impact of cutting durations on number of grains spikelet^{-1} of dual purpose wheat

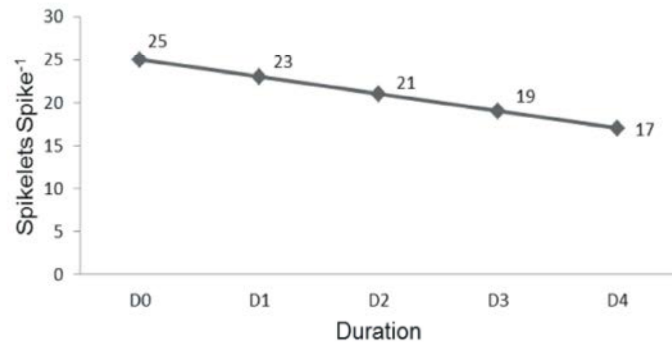

Fig. 6: Impact of cutting durations on spikelet's spike^{-1} of dual purpose wheat

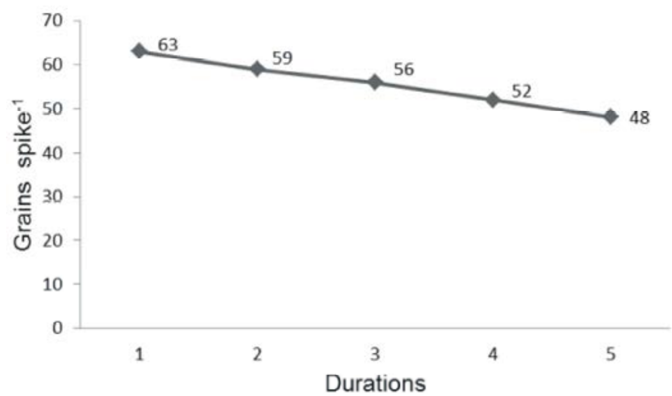

Fig. 7: Impact of cutting durations on grains spike^{-1} of dual purpose wheat

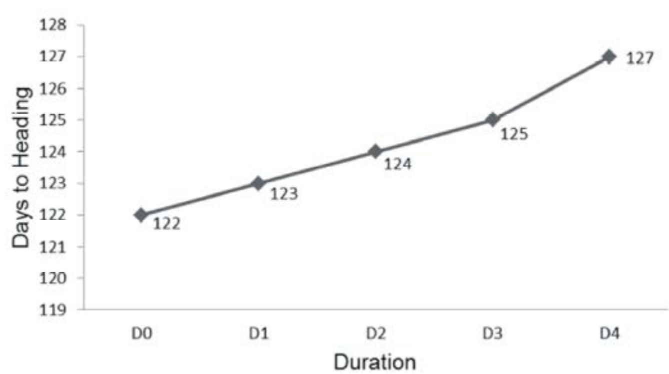

Fig. 8: Impact of cutting durations on days to heading of dual purpose wheat

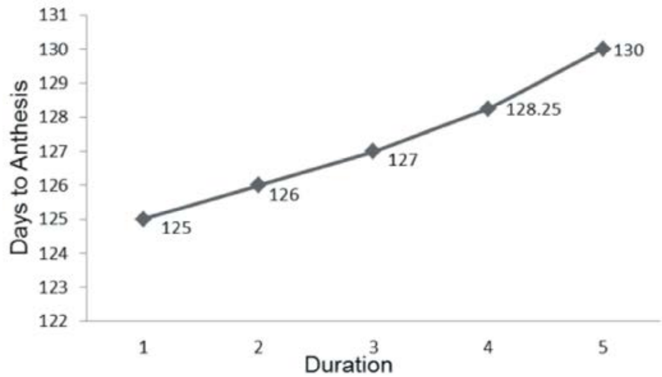

Fig. 9: Impact of cutting durations on days to anthesis of dual purpose wheat

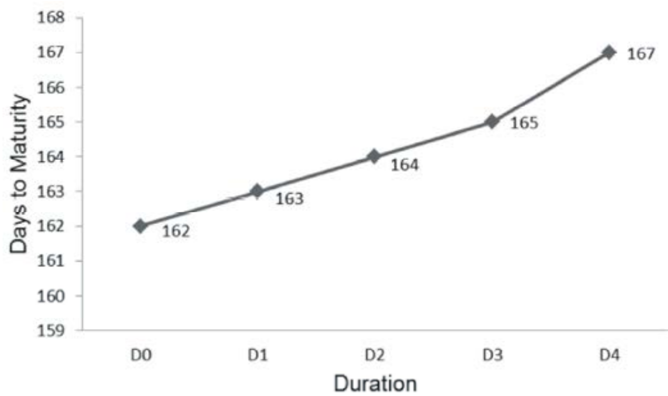

Fig. 10: Impact of cutting durations on days to maturity of dual purpose wheat

pattern in the pattern as D0=122 < D1=123 < D2=124 < D3=125 < D4=127. The present results confirmed the earlier findings of Munsif *et al*. [12] and Khalil *et al*. [4], who reported that booting, heading, anthesis and maturity considerably delayed with cutting. Days to heading delayed as cutting durations were deferred, because cutting delayed growth and took longer time to heading.

Days to Anthesis: The data about days to anthesis is represented in Fig. 9. Days to anthesis were significantly affected by cutting durations. Fewer days to anthesis (125) were observed in no cut plots whereas more days to anthesis (130) were observed with delaying cutting duration (to ZGS-18). Days to anthesis were delayed in the pattern as D0=125 < D1=126 < D2=127 < D3=128 < D4=130. The present results confirmed the earlier findings of Munsif *et al*. [12].

Days to Maturity: The data about days to maturity is represented in Fig. 10. Days to anthesis were significantly affected by cutting durations. Fewer days to maturity (162) were observed in no cut plots, whereas more days to maturity (167) were observed with delaying cutting duration (to ZGS-18). Days to maturity were delayed in the pattern as D0=162 < D1=163 < D2=164 < D3=165 < D4=167. Gardner *et al.*, (2010) reported that grazing significantly delayed maturity because flowering occurs later. Similar results were also found by Munsif *et al*. [12].

Biological Yield (kg ha^{-1}): The data about biological yield is represented in Fig. 11. Biological yield was significantly affected by cutting durations. The highest biological yield (11500 kg ha^{-1}) was observed in no-cut plots, whereas lowest biological yield (9050 kg ha^{-1}) was observed with delaying the cutting duration (to ZGS-18). The cutting duration decreased biological yield in the pattern as D0=11500 > D1=10700 > D2=10150 > D3=9525 > D4=9050. This reduction is due to removal of whole biomass during cut at ZGS-12, 14, 16 or 18, due to which secondary growth could not face the deficiency, due to shortage of time and nutrients. Afridi *et al*. [16] also reported reduced vegetative and reproductive biomass production with removal of flag leaf from wheat. The present results confirmed the earlier findings of Naveed *et al*. [13], Khalil *et al*. [4] and Abdoli *et al*. [17].

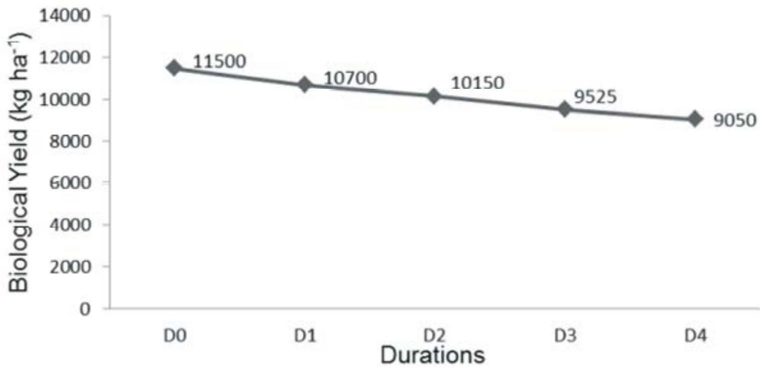

Fig. 11: Impact of cutting durations on biological yield of dual purpose wheat

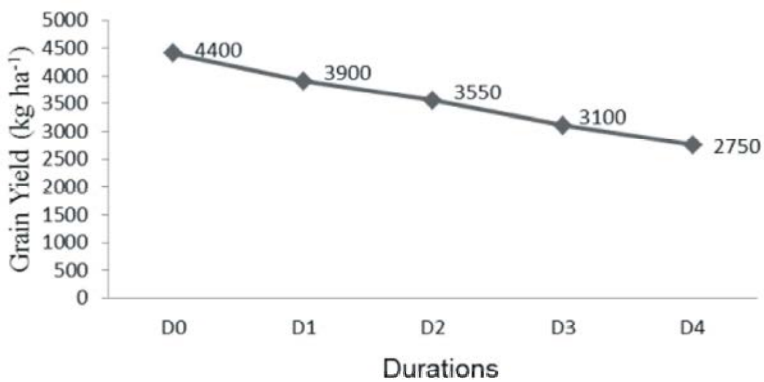

Fig. 12: Impact of cutting durations on grain yield of dual purpose wheat

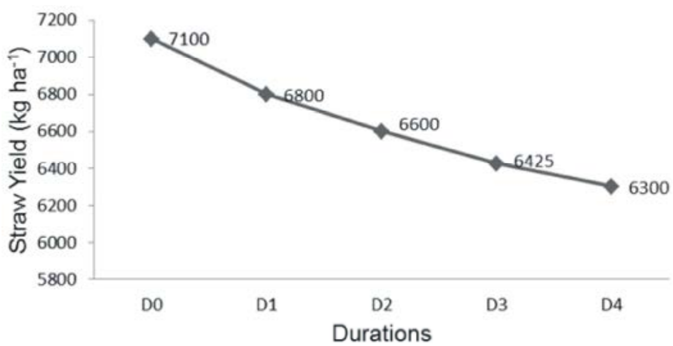

Fig. 13: Impact of cutting durations on straw yield of dual purpose wheat

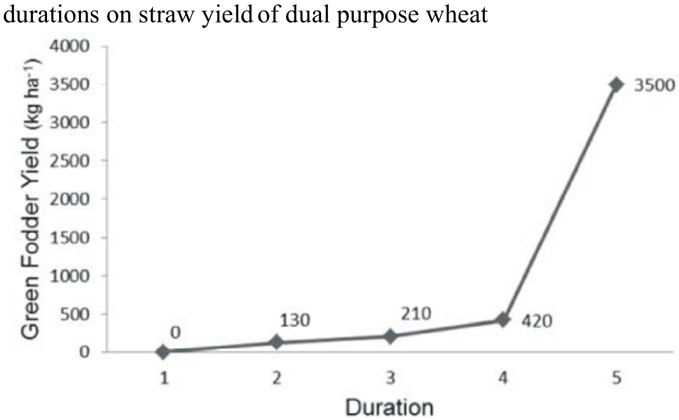

Fig. 14: Impact of cutting durations on green fodder yield of dual purpose wheat

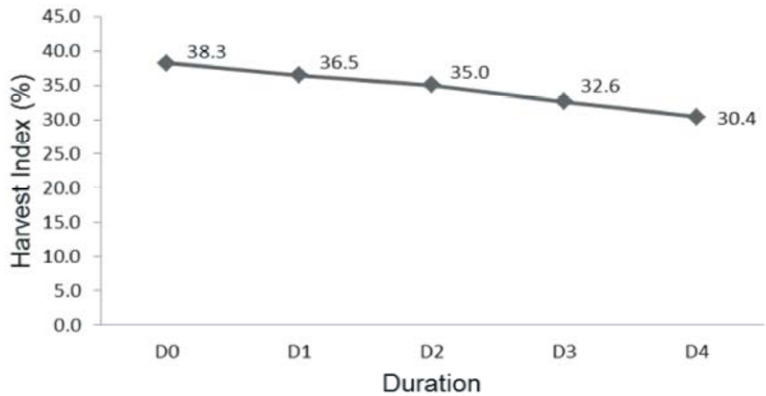

Fig. 15: Impact of cutting durations on harvest index of dual purpose wheat

Grain Yield (kg ha^{-1}): The data about grain yield is represented in Fig. 12. Grain yield was significantly affected by cutting durations. The highest grain yield (4400 kg ha^{-1}) was observed in no-cut plots, whereas the lowest grain yield (2750 kg ha^{-1}) was observed with delaying the cutting duration (to ZGS-18). The cutting duration decreased biological yield in the pattern as D0=4400 > D1=3900 > D2=3550 > D3=3100 > D4=2750. Removal of leaves considerably reduced grain yield of wheat (17). Similar results were also reported by Hastenpflug *et al*., (2007), Shuja *et al*., (2010), Gardner *et al*., (2010) Freebairn *et al*., (2002) Khaleel *et al*., (2011) and Larson *et al*., (2005) [14, 17, 18, 19, 4].

Straw Yield (kg ha^{-1}): The data about straw yield is represented in Fig. 13. Straw yield was non-significantly affected by cutting durations. The highest straw yield (7100 kg ha^{-1}) was observed in no-cut plots, whereas the least straw yield (6300 kg ha^{-1}) was observed with delaying the cutting duration (to ZGS-18). The cutting duration decreased straw yield in the pattern as D0=7100 > D1=6800 > D2=6600 > D3=6425 > D4=6300.

Green Fodder Yield (kg ha^{-1}): The data about green fodder yield is represented in Fig. 14. Green fodder yield was significantly affected by cutting durations. The lowest green fodder yield (210 kg ha^{-1}) was observed in cut at ZGS-12, whereas the highest green fodder yield (3500 kg ha^{-1}) was observed with delaying the cutting duration (to ZGS-18). The cutting duration decreased biological yield in the pattern as D0=0 < D1=130 < D2=210 < D3=420 < D4=3500. Early cut resulted in lower forage dry matter as compared to late cut. It is due to increase in biomass in growing days in between ZGS-12 and ZGS-18. Khaleel *et al*. [4] also reported the same results.

Harvest Index (%): The data about harvest index is represented in Fig. 15. Harvest index was significantly affected by cutting durations. The maximum harvest index (38 %) was observed in no-cut plots, whereas the minimum harvest index (30%) was observed with delaying the cutting duration (to ZGS-18). The cutting duration decreased harvest index in the pattern as D0=38 > D1=36 > D2=35 > D3=33 > D4=30 [16]. Also revealed the same results from his findings.

CONCLUSION AND RECOMMENDATION

The performance of dual purpose wheat was highly significant. The maximum grain yield 4400 kg ha^{-1} was observed in no cut plots. Similarly the highest biological yield (11500 kg ha^{-1}), while the maximum 1000-grains weight (50 g) and the maximum harvest index (38%) were also observed in no cut plots. But heading, anthesis and maturity were significantly delayed due to cutting. Likewise the highest green fodder yield (3500 Kg/ha) was given by plots having cutting duration at Zadok Growth Stage-18. Keeping in view the above conclusion the following recommendations are made that no cut wheat crop is recommended on the basis grain yield, biological yield, grains spike^{-1} and 1000-grains weight, while on the basis of green fodder production, cut at ZGS-18 is recommended.

REFERENCES

1. Minfal, 2008. Agricultural Statistics of Pakistan. Ministry of Food, Agriculture and Livestock, Islamabad.
2. Hossain, I., F.M. Epplin and E. Krenzer, Jr. 2003. Winter wheat winter forage yield and grain yield response to planting date in a dual-purpose system. Agricultural Systems, 63: 161-173.

3. Pakistan Bureau of Statistics and Ministry of National Food Security & Research Report 2014-15.
4. Khalil, S.K, F. Khan, A. Rahman, F. Muhammad, Amanullah, A.Z. Khan, S. Wahab, S. Akhtar, M. Zubair, I.H. Khalil, M.K. Shah and H. Khan, 2011. Dual purpose wheat for forage and grain yield in response to cutting, seed rate and nitrogen levels. Pak. J. Bot., 43(2): 937-947.
5. Shuja, M.N., A.M. Dure-Nayab, A. Iqbal and I.H. Khalil, 2010. Evaluating the response of Wheat Genotypes to Forage Clipping. Int. J. Agric. Biol., 12: 111-114.
6. Francia, E., N. Pecchioni, O.L.D. Nicosia, G. Paogetta, L. Taibi, V. Franco, M. Odoardi, A.M. Stanca and G. Delogu, 2006. Dual-purpose barley and oat in a Mediterranean. Env. J. Field Crops Res., 99(2-3): 158-166.
7. Arzadun, M.J., J.I. Arroquy, H.E. Laborde and R.E. Brevedan, 2006. Effect of planting date, clipping height and cultivar on forage and grain yield of winter wheat in Argentinean pampas. Agron. J. 98: 1274-1279.
8. Zhang, X.C., W.A. Phillips, J.D. Garbrecht, J.L. Steiner and L.A. Hunt, 2008. A wheat-grazing model for simulating grain and beef production. Agron. J., 100: 1242-1247.
9. Borman, M.M., M. Louhaichi, D.E. Johnson, W.C. Krueger, R.S. Karow and D.R. Thomas, 1997. Yield mapping to document goose grazing impact on winter wheat. Agron. J., 94(5): 1087-1093.
10. Naveed, K., M.A. Khan, M.S. Baloch, K. Ali, M.A. Nadim, E.A. Khan, S. Shah and M. Arif, 2014. Effect of different seed rates on yield attributes of dual-purpose wheat. Sarhad J. Agric., 30(1): 83-91.
11. Noy-Meir, I. and D.D. Briske, 2002. Response of wild wheat populations to grazing in Mediterranean grasslands: the relative influence of defoliation, competition, mulch and genotype. J. Appl. Ecol., 39(2): 259-278.
12. Munsif, F., M. Arif, M. Tariq Jan and M.J. Khan, 2013. Phenology of dual purpose wheat cultivars as influenced by planting dates. Scholarly Journal of Agricultural Science, 3(9): 340-350.
13. Naveed, K., M.A. Khan, M.S. Baloch, N. Khan and M.A. Nadim, 2013. Effect of time of nitrogen application on morphological and physiological attributes of dual -purpose wheat. Pak. J. Bot., 45(4): 1299-1305.
14. Hastenpflug, M., T.N. Martin, J.A. Braida, D.K. Barbosa, R.P. Zielinski and R. Refatti, 2007. Grain yield of dual-purpose wheat cultivars as affected by nitrogen and cuttings. Bragantia Campinas, 70(4): 819-824.
15. Gardner, M. and G. McMullen, 2010. Grazing wheat and barley - impacts on crop canopy management, lodging and grain yield. NSW Department of Primary Industries, Tamworth, matthew.gardner@dpi.nsw.gov.au.
16. Afridi, M.Z., M.T. Jan, M. Arif and A. Jan, 2010. Wheat yielding components response to different levels of fertilizer-N application time and decapitation stress. Sarhad J. Agric., 26(4): 499-506.
17. Abdoli, M., M. Saeid, S.J. Honarmand, M.E. Ghobadi and K.C. MIRZA, 2013. Effect of source and sink limitation on yield and some agronomic characteristics in modern bread wheat cultivars under post anthesis water deficiency. Acta agriculturae Slovenica, 101(2): 173-182.
18. Freebairn, B., L. Ayres, S. Kleven, F. McRae and F. Ellison, 2002. Productive dual purpose winter wheats. New South Wales Department of Primary Industries.
19. Larson, K., E. Krenzer and R. Kochenower, 2005. Irrigated dual purpose wheat planting dates, seeding rates, varieties in Southeastern Colorado. http://www. Colostate.edu/Depts/prc/pubs/wtwifortex.05-1.pdf.