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HERBAGE YIELD AND NUTRIENT CONTENT OF STAMPEDE OAT UNDER DIFFERENT IRRIGATION INTERVALS

DORJI WANGMO[1]* AND REKHA CHHETRI[2]

[1]Dzongkhag Livestock Office, Department of Livestock, Punakha.
[2]College of Natural Resources, Royal University of Bhutan, Lobesa, Punakha.

*Author for correspondence: swangmo573@gmail.com

ABSTRACT: A study was conducted to assess herbage yield and nutrient content of oat cultivar Stampede under four different irrigation intervals. The trial was conducted at the Lobesa agricultural farm, College of Natural Resources (CNR), from 8th August, 2016 to 1st January 2017, over a period of 145 days, with 85 days to first cut and 60 days between first and second cut. Randomized complete block design was used as an experimental design with four replicates. The irrigation treatments were T1- rainfed as control, T2- irrigation after seven days, T3- irrigation after 14 days, and T4- irrigation after 21 days. Flooding method was used to irrigate the beds. In the first cut, the plants were significantly taller (87.45 cm) in T3 and the plants were shortest (69.41 cm) in T1. Maximum number of tillers (7.33) was observed in T2 and least number of tillers (3.43) was observed in T1. In the second cut, the plants were significantly taller (44.02 cm) in T3 and plants were shortest (35.25 cm) in T1. Tiller number was almost similar among irrigation treatments. It can be concluded that, under the existing environmental condition of Lobesa, T1 (irrigation at seven days interval) provides taller plants, more number of tillers per plant, high biomass yield and high crude protein content.

Keywords: Dry matter yield; forage oat; nutrient content; irrigation; stampede.

1. INTRODUCTION

Shortage of green forages during dry winter months and early spring is a major constraint affecting the productivity of livestock. Fodder scarcity problem is severe from January to April. The only fodder resources available during this period are wheat straw, paddy straw and grain products, which are almost devoid of nutritional values and biomass (Gyaltshen 2002).

Oat (*Avena sativa*) is an important forage crop introduced in Bhutan (Gyaltshen 2002). Many oat varieties were also introduced for grain production, but farmers adopted oats as fodder (RNRR-RC Jakar 2008). Traditionally, oat is grown after paddy harvest and is used as winter fodder. Among green winter fodders, oats are said to be more palatable than wheat. Oats is a multi-cut crop and green oats is reported to yield double than the green wheat (Gyaltshen et al. 2009). Oats can be intercropped with other agricultural crops. Among oat varieties tested in Bhutan, oat cultivar Stampede was found suitable for enhancing fodder production during lean season.

Water is an essential factor for every developmental phase, starting from seed germination to maturation of a crop. Availability of adequate amount of moisture at critical stages of plant determines the productivity of any crop (Jamal et al. 1996). Water stress during crop growth leads to reduction in total biomass. Therefore, the accurate evaluation of crop water requirement is

essential for increased oat production. Studies have investigated the effects of irrigation interval on yield performances of cereal crops (Khan 2000; Sasani et al. 2004) and irrigation interval was found to have a significant effect on yield components and qualitative traits of sorghum (Moosavi et al. 2011). However, irrigation is expensive and it is important to identify accurate irrigation interval that produces optimum forage yield and quality of oat. Although, oat is extensively used as winter forage in Bhutan, little is known on the effects of irrigation interval on oat yield and quality. Therefore, a study was conducted to evaluate the potential of oat variety Stampede to provide optimum forage yield and quality under different irrigation intervals.

2. MATERIALS AND METHODS

2.1 Study area

The agriculture farm of College of Natural Resources, Lobesa, Bhutan, was selected as a study site. It is situated at an altitude of 1,450 meters above sea level (masl). The area falls under dry sub-tropical climate, which experiences hot summer and cool winter. The mean maximum annual rainfall of 4490 mm is recorded in September and the mean minimum of 30 mm in November. The site experiences mean maximum temperature of 31.66ºC, minimum temperature of 6.31ºC and relative humidity of 81.50%. The soil is reddish clay, which is slightly acidic (pH=6.32) with low nitrogen content (0.03%), organic carbon (0.4%) and moisture content (4.17%).

2.2 Experimental design and treatment

The field experiment was carried out from 18th August 2016 to 1st January, 2017. Randomized complete block (RCB) was the experimental design and irrigation interval was the treatment. The four treatments were; T1- rainfed as control, T2- irrigation after seven days, T3- irrigation after 14 days, and T4- irrigation after 21 days. Each treatment was replicated four times. Individual plot size was 3.6 m^2 (3m×1.2m).

2.3 Management and treatment application

About 1.50 kg cow dung was applied to each plot. Seeds were sown in lines at the rate of 30 kg ac^{-1}. Spacings followed were: 20 cm between lines, 100 cm between replications and 50 cm between plots. The amount of water applied to each plot was 443.5 ml while the control plot (rain fed) did not receive any irrigation. Weeding of trial plots was done as and when required.

2.4 Field measurements

Plant height, number of tillers, plant density and biomass (BM) yield were measured at booting stage during first cutting (85 days). Similar measurements were carried out during the second cut i.e. 60 days after the first cut. Twenty plants were randomly selected and their heights and tiller number were measured. The plants were then harvested and fresh biomass was measured. A frame (0.50m×0.50m) was randomly placed four times per plot to obtain yield from 1 m^2. Plant materials inside the frames were harvested and bulked. The plant materials were then thoroughly mixed and a representative sample weighing 100 gm was collected for dry matter and nutrient analysis. Samples were analyzed for dry matter content, crude protein, crude fiber, moisture, ash and ether extract.

2.5 Data analysis

The data was entered in Microsoft Excel spreadsheet and exported to SPSS. Multivariate ANOVA was used to analyze the data. Difference between treatment means was considered significant when p value was less than 0.05. The entire dataset was analyzed with statistical software SPSS version 23.

3. RESULTS AND DISCUSSION

3.1 Plant growth

Plant height and tiller number

The mean plant height for first and second cut is presented in Table 1. The overall average plant height was 81.08 cm in the first cut and 40.70 cm in

Table 1: Mean plant height and tiller number in first and second cut under different irrigation treatment.

Irrigation treatment	Sample size	First Cut		Second Cut	
		Mean plant height (cm)	Number of tillers	Mean plant height (cm)	Number of tillers
a) Rain fed	80	69.41	3.43	35.25	2.30
b) Irrigation after 7 days	80	87.31	7.33	36.90	2.23
c) Irrigation after 14 days	80	87.45	5.43	44.02	2.33
d) Irrigation after 21 days	80	80.14	4.48	37.39	2.33
Total	320	324.31	5.16	38.39	2.29

the second cut. In the first cut, the tallest plant height (87.45 cm) was obtained from T3 plot (irrigation after 14 days), followed by T2 plot (87.31 cm) (irrigation after 7 days) and T4 plot (80.14 cm) (irrigation after 21 days). The shortest plant height was obtained from T1 plot (69.41 cm) (rainfed). Similarly, in the second cut, the tallest plant height (44.02 cm) was obtained from T3 plot and the shortest (35.24 cm) from T1 plot. The result agrees with the findings of Ahmad et al. (2014), who reported maximum plant height of 80.91 cm under irrigation at 20 days interval and the shortest plant height of 64.46 cm under irrigations at 40 and 60 days intervals.

The second cut result is in line with the findings of Gyaltshen (2002), who obtained maximum plant height of 46.35 cm (average of three cuts). The overall results are in agreement with the findings of Tahir et al. (2014) that plant height is significantly influenced by irrigation at different critical crop growth stages. The results suggest that long irrigation interval beyond three weeks is not favorable for plant growth.

The overall average number of tillers per clump was 5.16 in the first cut and 2.29 in the second cut. The maximum number of tillers per clump (7.33) was recorded in T2 and minimum number of tillers per clump (3.43) in T1. This result is similar to the findings of Mohammad et al. (2004) who obtained highest number of tillers per plant (7.17) after 85 days of sowing. The variation in the number of tillers per plant may be due to difference in irrigations intervals. The study revealed that water is very important for the development of tillers as the treatment with shorter irrigation interval had the maximum number of tillers in the first cut. Significant difference was observed in the number of tillers per clump during first cut, however, only small difference was observed in the second cut.

3.2 Forage yield

Plant density, biomass and dry matter

Table 2 presents the plant density, biomass and dry matter of oat under different irrigation treatments. The overall average plant density was 1445 in the first cut and 2846 in the second cut. In the first cut, the highest plant density (1701.5 plants m^{-2}) was observed in T3 and lowest in T1 (1418.3 plants m^{-2}). In the second cut, the highest plant density (3694.50 plants m^{-2}) was observed in T4 and lowest (2421 plants m^{-2}) in T1.

In the first cut, the overall average biomass yield obtained was 10.30 kg. In the second cut, the average biomass yield was 1.49 kg. Biomass yield was highest (11.97 kg) in T2 and lowest (6.54 kg) in T1. Among treatments, T2 gave the maximum biomass yield in the first cut. In the second cut, the highest biomass yield (1.97 kg) was obtained from T4.

The overall mean dry matter yield produced was 0.92 kg in the first cut and 1.74 kg in the second cut. In both the cuts, the highest dry matter yield was 0.27 kg and 2.19 kg produced from rain fed irrigation. The lowest dry matter yield was obtained from irrigation after 7 days (0.15 kg).

A significant difference among treatments in dry matter yeild was observed in both first and second cuts. However, the dry matter yeild increased during the second cut by 1.55 kg. The increase in dry matter yield was observed at different maturing stages. Kirilov (2004) and Mohammad et al. (2004) reported that dry matter yield increases with the advancing maturity.

3.3 Forage quality

Crude protein, ash and crude fiber

Table 3 presents the nutrient content of oat, mainly crude protein, ash and crude fiber, under different irrigation treatments. The overall average crude protein content was 9.38% in the first cut and 13.34% in the second cut. In the first cut, the highest crude protein content (9.99%) was observed in T3 and the lowest crude protein content (8.39%) in T2. On the contrary, in the second cut, the highest crude protein content (14.17%) was observed in T2 and the lowest crude protein content (12.19%) in T3. The result is in agreement with the findings of Tahir et al. (2014) that different levels of irrigation significantly affect crude protein content. Tahir et al. (2014) also reported maximum crude protein (9.13%) in plants that received single irrigation 21 days after sowing and minimum crude protein of 8.41% was observed in plants with no irrigation.

Table 2: Mean biomass yield from two cuts.

Irrigation method	First cut		Second cut	
	Mean Biomass	SD	Mean Biomass	SD
a) Rain fed	6.54	0.63	1.15	0.18
b) Irrigation after 7 days	11.97	0.38	1.26	0.13
c) Irrigation after 14 days	11.85	0.34	1.61	0.36
d) Irrigation after 21 days	10.84	0.84	1.96	0.38
Total	10.30	2.33	1.49	0.42

The average ash content was 9.83% in the first cut and 18.23% in the second cut. The highest ash content of 11.03% in the first cut was observed in T4 and the highest ash content of 21.25% in the second cut was in T3. The lowest ash content of 9.06% in the first cut was observed in T2 and the lowest ash content of 15.83% in the second cut was observed in T1. Similar results were obtained by Hussain et al. (2014) who reported the maximum total ash under frequent irrigation. Lack of irrigation during critical growth stage negatively influences the oat growth, which leads to decline in forage yield and quality.

In the first cut, the highest crude fiber content of 1.62% was observed in T4 and lowest of 0.92% in T3. In the second cut, the highest crude fiber content of 19.13% was observed in T2 and lowest fiber content of 18.79% in T3. The result showed that crude fiber increased during the second cut. The crude fiber content in plant increases with maturity. The results agree with the findings of Mohammad et al. (2004) who reported similar results for oat.

Table 3: Crude protein, ash and crude fiber content of oat for first and second cut under different irrigation treatment.

	First cut			Second cut		
Irrigation treatment	CP%	Ash%	CF%	CP%	Ash%	CF%
a) Rain fed	9.63	9.41	1.33	13.86	15.83	19.08
b) Irrigation after 7 days	8.39	9.06	1.24	14.17	19.25	19.13
c) Irrigation after 14 days	9.99	9.81	0.92	12.19	21.25	18.79
d) Irrigation after 21 days	9.52	11.03	1.62	13.13	16.62	18.87
Total	9.38	9.83	1.28	13.34	18.24	18.97

4. CONCLUSION

This study demonstrated that short irrigation interval provides better plant growth, high forage yield and better forage quality. No irrigation or long irrigation interval gives higher yield but of low forage quality.

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