

# Influence of Re-growth Interval on Chemical Composition, Herbage Yield, Digestibility and Digestion Kinetics of *Setaria sphacelata* and *Cenchrus ciliaris* in Buffaloes

Mahr-un-Nisa, M. Ajmal Khan<sup>1</sup>, M. Sarwar\*, M. Mushtaque<sup>2</sup>, G. Murtaza<sup>3</sup>, W. S. Lee<sup>1</sup> and H. S. Kim<sup>1</sup>

Institute of Animal Nutrition and Feed Technology, University of Agriculture, Faisalabad, Pakistan

**ABSTRACT :** This study examined the influence of re-growth periods on chemical composition, biomass production, nutritive value and digestion kinetics of *Setaria sphacelata* (SS) and *Cenchrus ciliaris* (CC) in ruminally cannulated buffalo bulls. Two re-growth intervals *i.e.* clipping every month (CI<sub>1</sub>) and clipping after every two months (CI<sub>2</sub>) were compared with the control (clipped after 4 months). Mean values of leaf to stem ratio in SS and CC grasses were decreased ( $p < 0.05$ ) with increasing re-growth interval. The lowest leaf to stem ratio was recorded in control plots of both grasses. In both grasses, increasing growth period increased the concentrations of dry matter (DM), neutral detergent fiber (NDF) and organic matter (OM) and decreased crude protein (CP). Mean dry herbage, OM and CP yields of SS and CC were increased ( $p < 0.05$ ) with increasing re-growth interval. Ruminal DM and NDF digestibilities of SS and CC were decreased ( $p < 0.05$ ) with increasing interval. Ruminal rate of DM and NDF disappearance was higher while the ruminal lag time of these nutrients was lower with monthly than with bi-monthly clipping interval. The results from present study imply that SS and CC clipped after every two months is more beneficial than when clipped every month or every four months in terms of optimal biomass with adequate nutritional value for buffaloes. (*Asian-Aust. J. Anim. Sci.* 2006. Vol 19, No. 3 : 381-385)

**Key Words :** Stapf. Grass, Buffel Grass, Grass Maturity, Grass Sustainability, Clipping Interval

## INTRODUCTION

Efficient defoliation regimens for range grasses are prerequisite for the sustainability of grass lands and animal agriculture (Sarwar et al., 2006). *Setaria sphacelata* (SS) is native to northern Rhodesia (Zambia) and has been developed for grazing and hay production in tropical regions. Plants of this grass species attain a height of 1 m at flowering. It is palatable and drought-resistant grass species and is better suited to the more shallow soils and lower rainfall situations. *Cenchrus ciliaris* (CC) is another aggressive perennial grass of arid tropical habitats around the globe. It is preferred in tropical range lands because of its better forage nutritive value for ruminants (Duke, 1983; Evtayan et al., 2004) and its ability to recover from grazing due to rapid formation of dense monocultures.

Grass clipped at optimum intervals had shown to increase herbage yields of grass species (Masters et al., 2005 and Svejcar and Rittenhouse, 1982). The concentrations of neutral detergent fibre (NDF) and acid detergent fibre (ADF) were increased in CC with increasing maturity (Gupta and Sagar, 1987; Sarwar et al., 2006).

Frequent clipping had provided ruminants with higher levels of digestible nutrients (Duke, 1983). However, it produced a cumulative destructive effect on forage yield because of rapid exhaustion of carbohydrate reserves in the stubbles and roots. Frequent clipping of crested wheatgrass and of rough fescue (McLean and Wikeem, 1985; Sarwar et al., 2006) resulted in low nutrient yields and had reduced the plant survival during summer season. Too frequent defoliation of range grasses resulted in weak plants with more susceptibility to drought, heat, cold, injury and prevalent diseases (Svejcar and Rittenhouse, 1982). This necessitates determination of an appropriate clipping regimen of range grasses.

*Setaria sphacelata* and CC grasses are preferred in tropical grass lands because of their better survivability and higher nutritive value for various livestock species (Elizalde et al., 1999). However, scientific evidence regarding the influence of re-growth periods on chemical composition, herbage yield, digestibility and digestion kinetics of SS and CC is limited. Thus, this study was conducted to determine the influence of re-growth periods on chemical composition, biomass production, nutritive value and digestion kinetics of SS and CC in ruminally cannulated buffalo bulls.

## MATERIALS AND METHODS

### Establishment of plots, treatments and sampling

Experiment was laid out in a completely randomized design with four replications at Punjab Forestry Research Institute, Faisalabad, Pakistan from April, 2004 to August,

\* Corresponding Author: Muhammad Sarwar. Tel: +92-41-9201088, E-mail: sarwar041@hotmail.com

<sup>1</sup> Dairy Science Division, National Livestock Research Institute, Korea (ROK).

<sup>2</sup> Punjab Forest Department, Pakistan.

<sup>3</sup> Institute of Soil and Environmental Sciences, University of Agriculture, Faisalabad, Pakistan.

Received April 11, 2005; Accepted August 25, 2005

**Table 1.** Influence of clipping intervals<sup>1</sup> on leaf to stem ratio, plant height, nutrient composition and yields of *Cenchrus ciliaris* and *Setaria sphacelata*

Parameters	Clipping intervals			SE
	CI <sub>1</sub>	CI <sub>2</sub>	Control	
<i>Cenchrus ciliaris</i>				
Leaf to stem ratio	1.04 <sup>a</sup>	0.63 <sup>b</sup>	0.5 <sup>b</sup>	0.04
Plant height	36.05 <sup>c</sup>	70.75 <sup>b</sup>	120.10 <sup>b</sup>	6.01
Dry matter (%)	23.38 <sup>b</sup>	29.74 <sup>b</sup>	37.69 <sup>a</sup>	1.54
Organic matter (%)	87.45	91.17	92.71	4.52
Crude protein (%)	6.42 <sup>a</sup>	6.27 <sup>a</sup>	4.52 <sup>b</sup>	0.29
Neutral detergent fibre (%)	69.6 <sup>b</sup>	75.0 <sup>b</sup>	78.35 <sup>a</sup>	4.10
Dry matter yield (Tons/ha)	0.23 <sup>c</sup>	4.18 <sup>b</sup>	14.85 <sup>a</sup>	0.20
Organic matter yield (Tons/ha)	0.20 <sup>c</sup>	3.69 <sup>b</sup>	13.23 <sup>a</sup>	0.22
Crude protein (Tons/ha)	0.015 <sup>c</sup>	0.26 <sup>b</sup>	0.67 <sup>a</sup>	0.08
<i>Setaria sphacelata</i>				
Leaf to stem ratio	0.84 <sup>a</sup>	0.22 <sup>b</sup>	0.18 <sup>b</sup>	0.03
Plant height	29.06 <sup>c</sup>	73.19 <sup>b</sup>	82.01 <sup>ab</sup>	6.79
Dry matter (%)	17.93 <sup>b</sup>	21.36 <sup>b</sup>	26.91 <sup>a</sup>	1.12
Organic matter (%)	84.75	89.26	93.62	4.46
Crude protein (%)	6.36 <sup>a</sup>	5.56 <sup>a</sup>	3.42 <sup>b</sup>	0.26
Neutral detergent fibre (%)	67.71 <sup>d</sup>	72.53 <sup>c</sup>	75.00 <sup>b</sup>	3.95
Dry matter yield (Tons/ha)	0.33 <sup>c</sup>	2.49 <sup>b</sup>	11.33 <sup>a</sup>	0.22
Organic matter yield (Tons/ha)	0.27 <sup>c</sup>	2.25 <sup>b</sup>	10.19 <sup>a</sup>	0.20
Crude protein (Tons/ha)	0.02 <sup>c</sup>	0.13 <sup>b</sup>	0.39 <sup>a</sup>	0.04

Means within a row bearing different superscripts differ significantly ( $p < 0.05$ ).

<sup>1</sup> CI<sub>1</sub> and CI<sub>2</sub> stand for monthly and bi-monthly clipping intervals, respectively and the control stands for plots harvested at 4 months.

SE is the standard error.

2004. Nursery of SS and CC grasses were separately raised through planting tuft splits in 1×3 m plots at 0.3×0.3 m spacing to maintain optimum plant density of 5 to 10 plants/m<sup>2</sup> (Butt and Ahmad, 1994). The soil was sandy loam and no fertilizer was applied during the experiment.

Two re-growth intervals *i.e.* clipping every month (CI<sub>1</sub>) and clipping after every two months (CI<sub>2</sub>) were compared with control (plots that were harvested after 4 months). Grass biomass was manually clipped with sickle at 5 cm stubble height. Leaf to stem ratio, dry matter (DM) and fresh biomass yield were determined at each defoliation date. On each clipping date, leaf to stem ratio were recorded. To determine leaf to stem ratio at each harvest, a sample (about 500 g) was removed from the innermost two rows of each sub-plot cut at a height of 5 cm. Tillers from this non-weed sample were divided into leaf blades and stem plus sheath fractions immediately after removal from the plot. The leaf and stem fractions were dried separately at 55°C to a constant weight. Leaf to stem ratio was calculated from the dry weights (Baron et al., 2000). Grass samples were chopped in a locally manufactured chopper and then were ground through a Wiley mill (2 mm screen) and preserved in plastic bags for chemical analysis. The samples of both grasses were analyzed for DM, crude protein (CP) and total ash by using AOAC (1990) method, NDF by method of Van Soest et al. (1991). The chemical composition and nutrient yield values of cutting interval after one and two months

were averaged for 4 and 2 time-harvesting, respectively.

#### *In situ* digestion kinetics

Nylon bags measuring 10×23 cm, with an average pore size of 50 µm were used to determine ruminal digestibility, rate of disappearance, extent of digestion and lag time of DM and NDF. The *in situ* bags each containing 10 g sample DM (*Setaria sphacelata* or *Cenchrus ciliaris*) were incubated in the rumen for 1, 3, 6, 12, 24, 36, 48 and 96 h in triplicate (Sarwar et al., 1995). The bags were closed and tied with nylon fishing line. After removal from the rumen, bags were washed in running tap water until the rinse was clear. The bags were then dried in a forced air oven at 55°C for 48 h. After equilibration, the bags were weighed back and the residues were transferred to 100-ml beakers for analysis as described previously. Digestibility of DM and NDF were calculated at 48 h of ruminal incubation. Rate of disappearance, lag time and extent of digestion of DM and NDF were determined by the methods described by Sarwar et al. (2004). The digestibility and digestion kinetics parameters of cutting interval after one and two months were averaged for 4 and 2 time-harvesting, respectively.

#### Statistical analysis

The data collected on different parameters were statistically analyzed by SAS (1988) using analysis of variance technique and comparison of means was done by

**Table 2.** Influence of clipping interval<sup>1</sup> on nutrient digestibility and digestion kinetics in *Setaria sphacelata*

Parameters	Clipping intervals			S.E
	CI <sub>1</sub>	CI <sub>2</sub>	Control	
Dry matter				
Digestibility (%)	62.1 <sup>a</sup>	58.5 <sup>a</sup>	41.0 <sup>b</sup>	2.73
Rate of disappearance (%/h)	4.2	4.1	3.5	0.2
Extent of digestion (%)	72.5	69.6	51.0	3.36
Lag time (h)	0.8 <sup>b</sup>	1.0 <sup>b</sup>	4.4 <sup>a</sup>	0.13
Neutral detergent fibre				
Digestibility (%)	60.9 <sup>a</sup>	56.4 <sup>a</sup>	39.2 <sup>b</sup>	2.65
Rate of disappearance (%/h)	4.0 <sup>a</sup>	3.9 <sup>a</sup>	1.2 <sup>b</sup>	0.16
Extent of digestion (%)	71.4	65.9	58.1	3.27
Lag time (h)	0.9 <sup>b</sup>	1.2 <sup>b</sup>	5.2 <sup>a</sup>	0.15

Means within a row bearing different superscripts differ significantly ( $p < 0.05$ ).

<sup>1</sup> CI<sub>1</sub> and CI<sub>2</sub> stand for monthly and bi-monthly clipping intervals, respectively and the Control stands for plots harvested at 4 months.

SE is the standard error.

Duncan's multiple range test (Steel and Torrie, 1981).

## RESULTS

Mean daily minimum temperature ranged from 15 to 31°C while corresponding maximum temperature was 32 to 48°C. Soil was sandy loam to loam.

Chemical composition, yield and leaf to stem ratio of SS and CC grasses are given in Table 1. Mean values of leaf to stem ratio in SS and CC grasses were decreased ( $p < 0.05$ ) with increasing re-growth interval. The lowest leaf to stem ratio was recorded in control plots (clipped at 4 month) of both grasses.

In both grasses, concentrations of DM, NDF and OM increased and CP decreased with increasing re-growth period. The DM, NDF and OM contents were the maximum in control plots. Mean dry herbage and CP yields of SS and CC were increased ( $p < 0.05$ ) with increasing re-growth interval.

Ruminal DM and NDF digestibilities of SS (Table 2) and CC (Table 3) were decreased ( $p < 0.05$ ) with increasing interval. Ruminal extent of DM and NDF digestion (calculated at 96 h ruminal incubation) were reduced in both SS and CC grasses with increasing re-growth interval. Ruminal rate of DM and NDF disappearance in both SS and CC grasses were higher while the lag time was lower with monthly than with bi-monthly clipping interval (Tables 2 and 3).

## DISCUSSION

Decreased leaf to stem ratio in SS and CC with increasing re-growth interval was because of increased plant age, advanced synthesis (Cuomo et al., 1996; Nguyen et al., 2004) and thus higher cell wall contents. Increased tiller density with increasing plant maturity of

**Table 3.** Influence of clipping interval<sup>1</sup> on nutrient digestibility and digestion kinetics of *Cenchrus ciliaris*

Parameters	Clipping interval			SE
	CI <sub>1</sub>	CI <sub>2</sub>	Control	
Dry matter				
Digestibility (%)	56.9 <sup>a</sup>	53.68 <sup>ab</sup>	43.68 <sup>b</sup>	2.58
Rate of disappearance (%/h)	4.3 <sup>a</sup>	4.0 <sup>a</sup>	3.0 <sup>b</sup>	0.19
Extent of digestion (%)	68.8 <sup>a</sup>	63.9 <sup>ab</sup>	54.0 <sup>b</sup>	3.13
Lag time (h)	0.7 <sup>c</sup>	1.8 <sup>b</sup>	4.6 <sup>a</sup>	0.14
Neutral detergent fibre				
Digestibility (%)	54.8 <sup>a</sup>	46.6 <sup>ab</sup>	39.9 <sup>b</sup>	2.37
Rate of disappearance (%/h)	3.6 <sup>a</sup>	2.9 <sup>b</sup>	2.3 <sup>b</sup>	0.15
Extent of digestion (%)	66.2	62.2	52.7	3.03
Lag time (h)	1.0 <sup>c</sup>	2.1 <sup>b</sup>	5.4 <sup>a</sup>	0.17

Means within a row bearing different superscripts differ significantly ( $p < 0.05$ ).

<sup>1</sup> CI<sub>1</sub> and CI<sub>2</sub> stand for monthly and bi-monthly clipping intervals, respectively and the Control stands for plots harvested at 4 months.

SE is the standard error.

switch grass (Madakadze et al., 1999) had reduced the leaf to stem ratio. Crowder and Chheda (1982) reported that a short vegetative period of 4 to 6 weeks in *Cenchrus ciliaris*, followed by stem elongation and floral parts, resulted in decreased leaf to stem ratio of this grass with maturity. Similarly, Chaparro and Sollenberger (1997) reported decreased leaf to stem ratio with frequent defoliations in Elephant grass.

Higher DM and OM of SS and CC grasses with increasing re-growth period may be because of reduced leaf to stem ratio with increasing clipping interval of Elephant grass (Chaparro and Sollenberger, 1997). Crowder and Chheda (1982) reported that with increasing clipping interval, older leaves contained higher cell wall constituents and thus, reduced intercellular spaces as well as condensed cellular inclusions. The midribs and leaf sheaths of grasses attained a greater percentage of fibre and lignin with increasing plant age (Chaparro and Sollenberger, 1997; Islam et al., 2004), older leaves senesced and lost water (Mero and Uden, 1998), stems elongated and were less succulent, resulting into increased DM contents (Fraser et al., 2001). Similar to present study, decreased CP concentrations with increasing maturity of CC (Mero and Uden, 1998) and *Brassica oleracea* (Fraser et al., 2001) were attributed to decrease leaf to stem ratio and accumulation of more cell wall constituents in mature grasses. Though in the present study, CP concentration decreased with increasing re-growth period, higher biomass yields with increasing re-growth interval of both grasses resulted in increased total protein yields.

Increased herbage and CP yields in SS and CC grasses with higher re-growth periods may be attributed to the increased basal area (Motazedian and Sharrow, 1986), number of tillers per plant (Adjei et al., 1989; Sarwar et al., 2006), more leaf elongation and stem development (Pitman and Holt, 1983; Nisa et al., 2005) with increasing grass

maturity. Pitman and Holt (1983) observed increased DM production in kleingrass (*Panicum coloratum* L.), green sprangletop (*Leptochloa dubia*) and plains bristle grass (*Setaria macrostachya*) with 8-week clipping frequency than with 2 and 4-week harvest frequencies. In present study, low herbage yield at shorter re-growth interval may also be attributed to the reduction in photosynthetic area to the extent that photosynthate was not adequately available for re-growth after clipping (Geber, 2002; Sarwar et al., 2005). Similarly, Mero and Uden, (1998) reported that grass DM and OM yields were more sensitive to the interval between defoliations than to the severity of defoliation.

Decreased ruminal DM and NDF digestibilities of SS and CC grasses with increasing re-growth interval may be because of increased fibre concentration in plant tissues, higher lignification and reduced leaf to stem ratio. Shorter ruminal lag time and faster rate of disappearance of DM and NDF in both grasses with monthly than with bi-monthly clipping might have resulted in higher digestibilities with more frequent clipping. Increased ruminal lag time with increasing clipping interval was because of more lignification (Mero and Uden, 1998) and less cell soluble material of the grasses at advanced maturity (Terrill et al., 2003; Sarwar et al., 2006).

## CONCLUSIONS

The results from present study imply that SS and CC clipped after every two 2 month is beneficial than those clipped at every month and at every four month to get optimum biomass with adequate nutritional value for buffaloes and to sustained grass vigor.

## REFERENCES

- Adjei, M. B., P. Mislevy, R. S. Kalmbacher and P. Busey. 1989. Production, quality and persistence of tropical grasses as influenced by grazing frequency. *Soil and Crop Sci. Soc. Fla. Proc.* 48:1.
- AOAC. 1990. Association of Official Analytical Chemists. Official Methods of Analysis 13 Ed. Association of Official Analytical Chemists, Washington, DC., USA.
- Baron, V. S., A. C. Dick and J. R. King. 2000. Leaf and stem mass characteristics of cool-season grasses grown in the Canadian Parkland. *Agron. J.* 92:54.
- Butt, N. M. and M. Ahmad. 1994. Production and management of Buffel grass pasture. *Progressive Farming* 14:30.
- Chaparro, C. J. and L. E. Sollenberger. 1997. Nutritive value of clipped 'Mott' Elephantgrass herbage. *Agron. J.* 89:789.
- Crowder, L. V. and H. R. Chheda. 1982. *Tropical Grassland Husbandry*. Longman, London and New York. p. 197.
- Cuomo, G. J., D. C. Blouin, D. L. Corkern, J. E. McCoy and R. Walz. 1996. Plant morphology and forage nutritive value of three bahiagrasses as affected by harvest frequency. *Agron. J.* 88:85.
- Duke, J. A. 1983. *Handbook of Energy Crops*. Purdue University, Center for New Crops and Plant Products.
- Elizalde, J. C., N. R. Merchen and D. B. Faulkner. 1999. *In situ* dry matter and crude protein degradation of fresh forages during the spring growth. *J. Dairy Sci.* 82:34.
- Evitayani, L., A. Warly, T. Fariani, T. Ichinohe and T. Fujihara. 2004. Seasonal Changes in Nutritive Value of Some Grass Species in West Sumatra, Indonesia. *Asian-Aust. J. Anim. Sci.* 17:1663-1668.
- Fraser, M. D., R. Fychan and R. Jones. 2001. The effect of harvest date and inoculation on the yield, fermentation characteristics and feeding value of forage pea and field bean silages. *Grass Forage Sci.* 56:218.
- Geber, U. 2002. Cutting frequency and stubble height of reed canary grass (*Phalaris arundinacea* L.): influence on quality and quantity of biomass for biogas production. *Grass Forage Sci.* 57:389.
- Gupta, P. C. and V. Sagar. 1987. Assessing the feeding value of tropical forages by direct and indirect methods. Technical Bulletin, Department of Animal Nutrition, Haryana Agricultural University, Hisar, India.
- Islam, M. R., M. Ishida, S. Ando, T. Nishida, N. Yoshida and M. Arakawa. 2004. Effect of Variety and Stage of Maturity on Nutritive Value of Whole Crop Rice, Yield, Botanical Fractions, Silage Fermentability and Chemical Composition. *Asian-Aust. J. Anim. Sci.* 17:183-192.
- Madakadze, I. C., K. Stewart, P. R. Peterson, B. E. Coulman and D. L. Smith. 1999. Switchgrass biomass and chemical composition for biofuel in Eastern Canada. *Agron. J.* 91:696.
- Masters, D. G., H. C. Norman and E. G. Barrett-Lennard. 2005. Agricultural Systems for Saline Soil: The Potential Role of Livestock. *Asian-Aust. J. Anim. Sci.* 18(2):296-300.
- McLean, A. and S. Wikeem. 1985. Rough fescue response to season and intensity of defoliation. *J. Range Management.* 38:100.
- Mero, R. N. and P. Uden. 1998. Promising tropical grasses and legumes as feed resources in central Tanzania. III. Effect of feeding level on digestibility and voluntary intake of four grasses by sheep. *Anim. Feed Sci. Technol.* 70:79.
- Motazedian, I. and S. H. Sharrow. 1986. Defoliation effects on forage dry matter production of a perennial ryegrass-subclover pasture. *Agron. J.* 78:581.
- Nisa, M., N. A. Touqir, M. Sarwar, M. A. Khan and M. Akhatar. 2005. Effect of additives and fermentation periods on chemical composition and *in situ* digestion kinetics of Mott grass (*Pennisetum purpureum*) silage. *Asian-Aust. J. Anim. Sci.* 18:812-815.
- Nguyen, H. V., M. Kawai, J. Takahashi and S. Matsuoka. 2004. Change in Nitrogen Fractions and Ruminal Nitrogen Degradability of Orchardgrass and Alfalfa during the Ensiling Process and the Subsequent Effects on Nitrogen Utilization by Sheep. *Asian-Aust. J. Anim. Sci.* 17:1663-1668.
- Pitman, W. D. and E. C. Holt. 1983. Herbage production and quality of grasses with livestock and wildlife value in Texas. *J. Range Management.* 36:52.
- Sarwar, M., M. Nisa, M. A. Khan and M. Mushtaque. 2006. Chemical Composition, Herbage Yield, and Nutritive Value of *Panicum antidotale* and *Pennisetum orientale* for Nili Buffaloes at Different Clipping Intervals. *Asian-Aust. J. Anim.*

- Sci. (In press).
- Sarwar, M., M. A. Khan, M. Nisa and N. A. Touqir. 2005. Influence of Berseem and Lucerne Silages on Feed Intake, Nutrient Digestibility and Milk Yield in Lactating *Nili* Buffaloes. Asian-Aust. J. Anim. Sci. 18:475-478.
- Sarwar, M., M. A. Sial, W. Abbas, S. Mahmood and S. A. Bhatti. 1995. Ruminant digestion kinetics of forages and feed by-products in Sahiwal calves. Indian J. Anim. Nutr. 12:141.
- Sarwar, M., M. A. Khan and M. Nisa. 2004. Effect of organic acids or fermentable carbohydrates on digestibility and nitrogen utilization of urea treated wheat straw in buffalo bulls. Austr. J. Agric. Research. 55:229.
- SAS. 1988. Statistical Analysis System. SAS user's guide: Statistics, SAS Inst. Inc., Carry, NC.
- Steel, R. G. D. and J. H. Torrie. 1981. Principles and procedures of statistics. Biometrical Approach. International Student Ed. McGraw Hills International Book Co. London.
- Svejcar, T. and L. R. Rittenhouse. 1982. Standing crop and vigor of defoliated Russian wildrye in southwestern Colorado. J. Range Management. 35:595.
- Terrill, T. H., S. Gelaye, S. Mahotiere, E. A. Amoah, S. Miller and W. R. Windham. 2003. Effect of clipping date and frequency on yield and quality of kudzu in the southern United States. Grass Forage Sci. 58:178.
- Van Soest P. J., H. B. Robertson and B. A. Lewis. 1991. Method of dietary fiber and non-starch polysaccharides in relation to animal material. J. Dairy Sci. 74:3583-3587.