

## CROP PRODUCTION

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### Yield and quality of fodder oat (*Avena sativa*) and barley (*Hordeum vulgare*) at various stages of harvesting

ASHIQ HUSSAIN<sup>1</sup>, SARTAJ KHAN<sup>2</sup>, DOST MOHAMMAD<sup>3</sup>, M BANARAS BIHATTI<sup>4</sup> and M USMAN MUFTI<sup>5</sup>

National Agricultural Research Centre, Pakistan Agricultural Research Council,  
Islamabad 45 500, Pakistan

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#### ABSTRACT

An experiment was conducted during 1990 and 1991 to evaluate yield and quality of fodder for various harvesting stages in oat (*Avena sativa* L.) and barley (*Hordeum vulgare* L. sensu lato). The stages of harvesting were: repeated cutting of plants at 4-leaf, tillering, jointing and booting stages, and harvesting of plant once at ear emergence, 50% flowering, 100% flowering, early milk and early dough stages. Oat harvested at booting stage and barley at 100% flowering stage gave the maximum green-fodder yields (79.45 and 63.10 tonnes/ha respectively). In oat and barley crops, the highest dry-matter yield (15.54 and 13.75 tonnes/ha respectively) was recorded at early dough stage. In both the crops crude protein contents decreased with the advancement in crop maturity. The maximum crude protein content (14.93 and 14.37% in oat and barley respectively) was observed when the crops were cut repeatedly at 4-leaf stage, whereas the minimum at early dough stage in both the crops. Oat and barley harvested at booting stage proved better for reasonable green-fodder yield (67.32 tonnes/ha), dry-matter yield (11.66 tonnes/ha) and fodder quality (crude protein 10.33%). At this stage sufficient quantity of fodder yield with moderate quality was obtained in both the crops.

The ideal oat (*Avena sativa* L.) and barley (*Hordeum vulgare* L. sensu lato) crops should be high in crude protein and digestibility and low in crude fibre content. The quantity and quality of both crops are greatly influenced by plant age. The crude protein content and *in-vitro* dry-matter digestibility decrease with the increase in plant age. However, dry-matter yield increases with plant age (Singh *et al.* 1973, Gupta and Pradhan 1974).

Generally, the farmers harvest oat and barley crops at 50% flowering stage or at some later stages to get maximum quantity of green fodder without keeping in view the fodder quality. A meagre information is available on fodder yield and quality in oat and barley at various cutting stages. It is therefore essential to determine an appropriate cutting stage in oat and barley for green-fodder yield, dry-matter yield and quality fodder.

#### MATERIALS AND METHODS

The field experiment was conducted during 1990 and 1991 at the National Agricul-

<sup>1,2,3</sup>Senior Scientific Officer, <sup>4</sup>Principal Scientific Officer, <sup>5</sup>Scientific Officer, Fodder Programme

tural Research Centre, Islamabad. There were 9 cutting treatments, viz CS<sub>1</sub>, repeated cutting at 4-leaf; CS<sub>2</sub>, tillering; CS<sub>3</sub>, jointing; CS<sub>4</sub>, booting stages; and CS<sub>5</sub>, harvesting the plant once at ear-emergence; CS<sub>6</sub>, 50% flowering; CS<sub>7</sub>, 100% flowering; CS<sub>8</sub>, early milk; and CS<sub>9</sub>, early dough stages. The crops were sown during the third week of October in each of the 2 years. A randomized complete block design was used with 3 factor factorial, replicated thrice. The gross plot sown and net harvested plots were 3 m x 6 m and 1.8 m x 6 m respectively for estimation of green-fodder and dry-matter yields. The plants were cut to a height of 7–8 cm. The rows were spaced 30 cm apart. The crops were fertilized uniformly @ 75 kg N/ha and 50 kg P/ha before planting. On 5 random plants from each plot data were recorded on plant height, tillers/plant, green leaves/tiller, leaf area (length x breadth), green-fodder yield, dry-matter yield and crude protein content.

Analysis of variance was performed for the combined data of 2 years for all the characters except crude protein content. The representative green-fodder samples from each plot were collected at random and dried in an oven at 60°C. After drying, the samples were weighed to calculate dry-matter yield. The dried samples were ground using a Wiley mill and passed through a 1-mm sieve. The crude protein (N% x 6.25) was estimated by the method of Reardon *et al.* (1966) for only 1 year and replication.

#### RESULTS AND DISCUSSION

Combined analysis of variance of 2 years data for different characters indicated significant differences between years, cutting stages and year x cutting stage for all the characters. There were significant differences between crops for all other characters except number of tillers and leaves. Significant year x crop interaction was recorded only for plant

height and green leaves/tiller. Crop x cutting stage interaction was significant for all the characters except tillers/plant, green-fodder and dry-matter yields. Significant differences were also observed among year x crop x cutting stage interaction for plant height, green-fodder and dry-matter yields.

The oat harvested at early milk and dough stages gave maximum plant height. These 2 stages also produced the tallest plants in barley (Table 1). Significantly lowest plant height was observed in oat and barley when cut at 4-leaf and tillering stages. The plant height was also maximum at early milk and early dough stages and minimum at 4-leaf and tillering stages.

Maximum tillers/plant were recorded in barley when cut at 4-leaf, tillering, jointing, booting, 50% flowering and early milk stages, whereas in oat at booting, ear emergence and 50% flowering stages. Cuttings at tillering and jointing stages in oat were at par for tillers/plant with those of above cutting stages in oat and barley except 50% flowering in barley. The minimum tillers/plant were observed in barley harvested at early dough stage. The maximum tillers/plant were recorded at the 50% flowering, booting and tillering stages and minimum at early dough stage. Dunphy *et al.* (1982) also reported that delaying the final forage harvest in wheat (*Triticum aestivum* L. emend. Fiori & Paol.) generally results in reduced survival of tillers.

The highest green leaves/tiller were recorded when the plant was cut at jointing, booting, ear emergence and 50% flowering stages in barley. Cutting at 100% flowering in oat and barley and that at jointing and booting stages in oat were significantly at par with the cutting at jointing, ear emergence and 50% flowering stages for production of green leaves/tiller. The minimum green leaves/tiller were recorded in barley harvested at early

Table 1 Plant height, tillers/plant and green leaves/tiller of oat and barley as affected by cutting at different stages (pooled data of 2 years)

Cutting stage	Plant height (cm)			Tillers/plant			Green leaves/tiller		
	Oat	Barley	Mean	Oat	Barley	Mean	Oat	Barley	Mean
CS <sub>1</sub>	33.67	30.92	34.29	5.00	6.50	5.75	4.33	4.17	4.25
CS <sub>2</sub>	38.58	31.08	34.79	6.17	7.33	6.75	5.00	5.33	5.17
CS <sub>3</sub>	50.33	46.67	48.50	6.17	7.17	6.67	5.67	6.33	6.00
CS <sub>4</sub>	95.50	86.33	90.92	7.33	7.67	7.50	5.67	6.67	6.17
CS <sub>5</sub>	101.33	97.83	99.58	6.50	5.33	5.92	6.00	6.00	6.00
CS <sub>6</sub>	101.33	99.83	100.58	7.67	7.83	7.75	5.17	6.17	5.67
CS <sub>7</sub>	93.50	96.00	94.75	5.33	5.17	5.25	5.50	5.50	5.50
CS <sub>8</sub>	125.28	108.17	116.67	4.83	6.50	5.67	5.83	4.83	5.33
CS <sub>9</sub>	129.33	114.67	122.00	5.00	4.00	4.50	5.00	3.33	4.17
LSD (P = 0.05)		8.15	5.76		1.50	1.06		0.91	0.64

CS<sub>1</sub>, Repeated cutting at 4-leaf; CS<sub>2</sub>, tillering; CS<sub>3</sub>, jointing; CS<sub>4</sub>, booting stages; CS<sub>5</sub>, harvesting the plant once at ear-emergence; CS<sub>6</sub>, 50% flowering; CS<sub>7</sub>, 100% flowering; CS<sub>8</sub>, early milk; and CS<sub>9</sub>, early dough stage

dough stage. The maximum mean green leaves/tiller were observed at jointing, ear emergence, 50% flowering and 100% flowering stages and minimum at 4-leaf and early dough stages.

Maximum leaf area in oat was recorded when the plant was harvested at early milk and early dough stages, followed by booting stage which was statistically at par with early dough stage (Table 2). The ear emergence and 100% flowering stages in oat were at par with booting stage for leaf area. Significantly lowest leaf area was observed in barley at 4-leaf and tillering stages. The mean maximum leaf area was recorded at early milk and early dough stages, whereas the minimum at 4-leaf and tillering stages. Bhatti *et al.* (1992) and Hussain *et al.* (1993) reported similar results in oat harvested at various intervals.

The highest green-fodder yield was obtained in oat when the plant was cut at jointing, booting, ear emergence, 50% flowering, 100% flowering and early milk stages.

Barley harvested at 100% flowering stage gave similar quantity of green fodder as observed in oat cut at jointing, booting, ear emergence, 50% flowering, 100% flowering and early milk stages. Barley cut at booting, 50% flowering and early milk stages gave green-fodder yield at par with 100% flowering stage. The mean maximum green-fodder yield was recorded at booting, 100% flowering and early milk stages and minimum at 4-leaf, tillering and early dough stages. These findings are in accordance with those of Bhatti *et al.* (1992) and Hussain *et al.* (1993), who reported maximum green-fodder yields at the 50% flowering stage in oat.

The highest dry-matter yields were at par at all the cutting stages except cutting at 4-leaf, tillering and 50% flowering stages in oat and at early dough stage in barley. In oat, 50% flowering stage was at par with jointing, booting, ear emergence, 100% flowering and early milk stages for dry-matter yield. The minimum dry-matter yield was recorded in

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Table 2 Leaf area, green-fodder and dry-matter yields and crude protein of oat and barley as affected by cutting at different stages (pooled data of 2 years)

Cutting stage	Leaf area (cm) <sup>2</sup>			Green-fodder yield (tonnes/ha)			Dry-matter yield (tonnes/ha)			Crude protein (%) <sup>†</sup>		
	Oat	Barley	Mean	Oat	Barley	Mean	Oat	Barley	Mean	Oat	Barley	Mean
CS <sub>1</sub>	27.42	19.60	23.51	46.02	39.63	42.82	7.40	5.58	6.49	14.93	13.47	14.20
CS <sub>2</sub>	36.03	26.15	31.09	51.39	42.04	46.71	9.23	6.91	8.07	14.07	12.78	13.43
CS <sub>3</sub>	59.91	59.82	59.86	69.35	48.68	59.02	12.63	8.26	10.45	12.65	11.70	12.18
CS <sub>4</sub>	118.28	57.27	87.78	79.45	55.19	67.32	13.96	9.37	11.66	10.80	9.85	10.33
CS <sub>5</sub>	113.39	60.47	86.93	72.69	51.16	61.92	12.66	7.39	10.02	8.75	8.42	8.59
CS <sub>6</sub>	94.99	52.15	73.57	70.98	54.95	62.96	11.48	10.00	10.74	8.10	7.72	7.91
CS <sub>7</sub>	109.95	50.05	80.00	77.78	63.10	70.44	14.18	11.12	12.65	7.63	7.54	7.59
CS <sub>8</sub>	139.32	56.57	97.94	73.26	58.22	65.74	14.09	11.70	12.90	7.50	7.02	7.26
CS <sub>9</sub>	136.70	69.63	103.16	51.97	45.72	48.84	15.54	13.75	14.64	7.15	6.85	7.00
LSD (P = 0.05)	20.50		14.50	10.47		7.40	2.94		2.08			

Details of treatments are given under Table 1

<sup>†</sup> 1-year data

barley when it was cut at 4-leaf, tillering and jointing stages, whereas it was minimum in oat at 4-leaf stage. The highest dry-matter yield was observed at 100% flowering, early milk and early dough stages and the lowest at 4-leaf stage.

Crude protein content decreased with the age of crops. Maximum crude protein content was recorded at very early vegetative cutting stage (4-leaf stage) and minimum at early dough stage. High crude protein content at early vegetative stage was owing to more leafy and succulent nature of plant at this stage. Singh *et al.* (1973) and Gupta and Pradhan (1974) also reported similar results for dry-matter and crude protein yields.

It was concluded that oat and barley produced plants of medium height, maximum number of tillers and green leaves, moderate leaf area, good green-fodder and dry-matter yields and crude protein contents at the booting stage. Thus oat and barley crops may be harvested at booting stage for obtaining

reasonable quantity of fodder with moderate quality.

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