Effects of Forage Utilization on Grain Yield of Naked and Malting Barley in Cheju Province

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濟州地方에 있어서 靑草利用이 쌀보리와 麥酒보리의 種實收量에 미치는 影響

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Summary

This study was conducted to determine the effects of forage utilization on the growth and yield of naked and malting barley in Cheju province. 'Saessalbori' (naked barley) and 'Doosan 22' (malting barley) were grown at three locations in grain-only and forage utilization systems. Barley for the grain-only system was seeded in early to mid-November and that for the forage utilization system, in mid-October.

Total fresh forage yields of naked barley harvested thrice at Cheju, Aeweol and Seogwi were 1247, 820 and 1327 ㎏/10a, respectively, and those of malting barley harvested twice were 1189, 515 and 930 ㎏/10a, respectively. Naked barley headed two days earlier in the forage utilization system, than in the grain-only ststem, averaging three locations. Forage utilization did not consistently affect heading date of malting barley grown at three locations. Forage utilization significantly reduced culm length, regardless of cultivars and locations, except that on malting barley at Seogwi. The number of spikes per ㎡ of two cultivars did not significantly differ in the two production systems, irrespective of location. The number of kernels per spike, 1000-kernel weight and test weight of two cultivars were not consistently influenced by the production system. The three-location average grain yields of naked barley did not significantly differ in two production systems. However, forage utilization significantly decreased grain yield of malting barley at Cheju and Aeweol. Straw yield of two cultivars was decreased by forage utilization.

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Introduction

In Cheju province, naked barley and malting barley are major winter cereals, and are grown solely for grain production. However, use of winter cereals for dual production of grain and forage is practiced to some extent in most areas of world with mild winters where winter cereals are grown (Baldridge et al., 1985; Dunphey et al., 1982; Hubbard and Harper, 1949; Morris and Gardner, 1958; Sharrow and Motazedian, 1987; Winter and Thompson, 1990). The general practice for dual production is to graze winter cereals planted earlier than the optimum date for sole grain production during vegetative growth and to remove cattle before the jointing stage (Dunphey et al., 1982; Winter and Thompson, 1990). The economic return from winter cereals includes both the value of the grain and forage. A substantial body of literature exists on the subject of forage utilization of winter cereals. Substantial variations in the reported impact of forage utilization on grain yield suggest that yield response interacts with environmental conditions, cultivars and management practices (Christiansen et al., 1989; Dunphey et al., 1982; Hubbard and Harper, 1949; Kang, 1989; Morris and Gardner, 1958; Sharrow and Motazedian, 1987; Winter and Thompson, 1990; Winter et al., 1990). Forage utilization normally reduced grain yield of winter cereals, although yield increases have been documented. When leaves of winter cereals producd during vegetative growth were harvested as forage, grain yield was limited by the potential of the plant to rapidly produce new leaves and prevent tiller senescence (Dunphy et al., 1984). Growing conditions were always good when grain yield increases were reported. Yield increases by forage utilization were usually attributed to reduced lodging, since clipping or grazing reduced plant height and lodging (Winter and Thompson, 1990; Winter et al., 1990).

This research was conducted to determine the effects of forage utilization on the growth and yield of naked and malting barley in Cheju province.

Maerials and Methods

A field experiment was conducted in the 1989 harvest year at Cheju (Cheju National University upland farm, altitude 277 m), Aeweol (Cheju Rural Development Administation upland farm, altitude 110*m*) and Seogwi (Research Institute for Subtropical Agriculture upland farm, altitude 95*m*). Chemical properties of surface soil for three locations are presented in table 1.

Table 1. Chemical properties of surface soil (0-30㎝) for the three trial locations

Location	pH (1 : 5)	Organic matter (%)	Available P_2O_5 (ppm)	Exchangeable cations (me/100*g*)			Cation exchage capacity (me/100*g*)
				K	Ca	Mg	
Cheju	5.4	6.3	44	2.4	1.6	1.1	13.7
Aeweol	6.7	1.3	25	0.3	5.2	1.1	19.4
Seogwi	5.2	9.3	11	1.2	0.4	0.4	14.8

'Saessalbori' (naked arley) and 'Doosan 22' (malting barley), which are recommending cultivars in Cheju province, were grown in grain-only and forage utilization systems. Barley for the grain-only system at Cheju, Aeweol and Seogwi was sown on November

Table 2. Normal mean air temperature and precipitation, and departures from normal for barley growing season in 1988 to 1989 at three locations

Month	Temperature		Precipitation	
	Normal a)	Departure	Normal	Departure
		Cheju		
October	16.3	+0.1	43.3	−30.4
November	11.0	−0.8	49.3	−26.8
December	6.3	+1.0	67.9	+16.4
January	2.7	+3.4	58.4	+64.1
February	3.5	+2.7	76.2	+57.8
March	6.8	+1.3	111.4	−59.9
April	12.3	+1.9	74.5	−36.0
May	16.6	+0.7	78.5	−39.5
June	20.9	−0.6	315.2	+213.8
		Aeweol		
October	16.9	+0.8	90.5	−81.0
November	11.4	−0.2	83.6	−66.1
December	7.5	−0.3	91.2	−53.7
January	4.8	+1.7	77.5	+75.5
February	4.4	+2.4	66.6	+67.3
March	7.7	+1.2	88.1	−23.7
April	12.9	+1.6	42.9	−5.9
May	17.1	+0.1	77.8	+16.8
June	20.9	−0.5	200.9	−16.4
		Seogwi		
October	18.5	+0.5	67.3	−58.9
November	13.3	−0.7	85.7	−75.9
December	8.3	+0.5	47.3	−20.2
January	6.0	+0.6	62.3	+75.4
February	6.5	+2.1	78.4	+53.9
March	9.5	+1.0	97.5	−20.0
April	13.9	+2.0	193.0	−55.5
May	17.7	+0.4	218.6	−18.2
June	20.6	−0.1	262.7	+9.9

a) Normal mean air temperature and precipitation at Cheju, Aeweol and Seogwi were 5-year (1984-1988), 4-year (1986-1989) and 30-year (1951-1980) means, respectively.

7, 19 and 12, respectively, and managed for high grain yield. Barley for the forage utilization system at Cheju, Aeweol and Seogwi was seeded on October 13, 11 and 10, respectively, and managed, as a dual purpose crop, to provide clipping during vegetative growth and grain production after forage utilization. The seeding rate was 14kg/10a, regardless of production system. Fertilizer was applied at a rate of 4-9-6kg/10a (N-P_2O_5-K_2O) for the grain-only system and 6-9-6kg/10a for the forage utilization system, prior to planting and 4kg/10a of nitrogen was topdressed in mid-February and mid-March, irrespective of production system. Two or three days after planting, all plots were irrigated once to promote emergence, because soil was too dry for seeds to germinate. Weeds were controlled by preemergence application of butachlor at 180g/10a and by handweeding as necessary.

Each experimetal plot consisted of 5 rows, 3.6m long, with 40cm between rows. Plots were arranged in a randomized complete block design, with four replications for each cultivar.

To simulate grazing, the plots for the forage utilization system were clipped three times (late December, early February and mid-March) for naked barley and two times (late December and early February) for maliting barley, to a height of about 5cm. Malting barley was not cut in mid-March because some growing points were removed by a second clipping.

It was warmer during the growing season of 1988 to 1989 than normal, regardless of location (Table 2). It rained much less in October and November of 1988 than normal, irrespective of location, resulting in unfavorable conditions for early growth.

Forage, gain and straw yields were measured by harvesting 2.5m length of three interior rows. Dry forage yield was determined drying samples for at least two days at 80℃. At maturity, 0.2㎡ samples were taken from each plot to determine the number of spikes per ㎡ and kernels per spike. Grain yield and 1000-kernel weight were adjusted to 14% moisture content.

Variables were analyzed with randomized complete block analysis of variance techiques on each location's data seperately and then merged together in a combined analysis, across location for each cultivar.

Results and Discussion

Forage yields of two cultivars in the forage utilization system for three locations are given in Table 3. Total fresh forage yields of naked barley, harvested three times at Cheju, Aeweol and Seogwi, were 1247, 820 and 1327 kgk/10a, respectively, and dry forage yields were 173, 142, 222kg/10a, respectively. Malting barley harvested two times yielded 1189, 515 and 930kg/10a of fresh forage at Cheju, Aeweol and Seogwi, respectively, and 92 to 81kg/10a of dry forage. The forage yields in this experiment were comparable to those of wheat grown in Texas, for dual production of forage and grain (Dunphy et al., 1982).

Delaying termination of clipping retards heading of winter cereals (Cutler et al., 1949; Dunphy et al., 1982; Kang et al., 1986; Kang, 1989) In this trial, the clipped naked barley headed two days earlier than the unclipped control, averaging three locations (table 5) since the forage utilization system

Table 3. Forage yield of two barley types in the forage utilization system at the three locations

Location	Fresh forage yield (kg/10a)				Dry forage yield (kg/10a)			
	1st*	2nd	3rd	Total	1st	2nd	3rd	Total
				Naked barley				
Cheju	436	296	517	1247	58	39	76	173
Aeweol	216	148	456	820	37	27	78	142
Seogwi	359	363	605	1327	66	66	91	223
				Malting barley				
Cheju	586	603	-	1189	84	71	-	155
Aeweol	383	132	-	515	67	25	-	92
Seogwi	502	428	-	930	96	85	-	181

* 1st, 2nd, 3rd indicates clippng times in late December, early February and mid-March, repectively.

was seeded 23 to 31 days earlier than the control. In malting barley, the clipped plants grown at Cheju and Seogwi headed 1 and 12 days later, respectively, than the unclipped control plants and at Aeweol headed 8 days earlier. Compared with the grain-only system, delayed heading of malting barley (spring barley) by forag utilization at Seogwi probably resulted from removing some growing points since air temperature at Seogwi was warmer than at the other locations after planting.

Mean squares from the analysis of variance for agronomic characteristics of each cultivar, as affected by the production system and location, are presented in Table 4. Grain yield, yield components and the other agronomic characteristics are shown in Table 5. Forage utilization reduced culm length of naked barley regardless of location and significantly shortened that of maliting barley, except at Seogwi, where that of malting barley in the grain-only system was shorter than the other locations. These results are generally consistent with the previous reports (Morris and Gardner, 1958; Pumphrey, 1970; Winter and Thompson, 1987; 1990; Winter et al., 1990)

Forage utilization slightly increased spike length of naked barley irrespective of location but did not significantly affect the three location average spike length of malting barley. The number of spikes per ㎡ was not

Table 4. Mean squares from analysis of variance for some agronomic characteristics of two barley types as affected by production system and location

Source	df	Culm length (㎝)	Spike length (㎝)	No. of spikes per ㎡	No. of kernels per spike	1000-kernel wt. (g)	Test weight (g/ℓ)	Grain yield (㎏/10a)	Straw yield (㎏/10a)
					Naked barley				
Location (L)	2	573.2*	2.895**	57982	779.8**	22.36	18008**	19464	11358
Reps/location	9	53.3	0.371	16792	75.0	5.44	673	12297	13542
Production system (PS)	1	486.0**	0.317**	1232	6.0	82.14**	3853**	10086	41673*
L X PS	2	32.0	0.051	22314	139.5	1.86	1090*	1928	4605
Error	9	35.1	0.038	10418	77.0	4.32	201	4404	6445
					Malting barley				
Location (L)	2	302.0	0.740	32039	171.5**	33.74*	4093	32112	8626
Reps/location	9	91.8	0.237	33916	4.4	6.60	338	19994	18557
Production system (PS)	1	726.0**	0.022	150	15.4	3.56	178	6319	42665*
L X PS	2	158.0**	0.049	66786	28.5*	18.89	1292	17743*	13545
Error	9	19.1	0.194	20295	5.1	4.68	427	2315	5307

*, ** Significant at 0.05 and 0.01 probability levels, respectively.

Table 5. Effects of production system on gain yield. yield components and the other agronomic characteristics of two barley trpes at the three locations in Cheju province

Location	Production system a)	Heading date	Culm length (cm)	Spike length (cm)	No. of spikes per m²	No. of kernels per spike	1000-kernel wt. (g)	Test weight (g/ℓ)	Grain yield (kg/10a)	Straw yield (kg/10a)
						Naked barley				
Cheju	Grain	Apr. 23	79	4.4*	428	45.2	30.9**	825	387	328
	Forage	Apr. 21	74	4.5	421	50.2	26.5	825	378	293
Aeweol	Grain	Apr. 21	75*	5.4*	525	34.8	27.5	767*	493	442*
	Forage	Apr. 16	62	5.6	654	26.2	24.9	739	422	311
Seogwi	Grain	Apr. 11	64*	4.2*	510	27.4	27.8*	759*	386*	354*
	Forage	Apr. 11	55	4.6	431	34.0	23.7	713	343	270
Average	Grain	Apr. 18	73**	4.7*	488	35.8	28.7*	784*	422	375*
	Forage	Apr. 16	64	4.9	502	36.8	25.0	758	381	291
						Malling barley				
Cheju	Grain	Apr. 6	83**	6.0*	709	24.5*	38.6	677	349*	369
	Forage	Apr. 7	69	6.2	493	23.4	39.9	668	275	265
Aeweol	Grain	Apr. 7	83*	6.6	584	22.0*	39.2	638*	477**	423
	Forage	Mar. 30	65	6.7	686	16.4	34.9	608	378	268
Seogwi	Grage	Mar. 10	65	6.2	463	13.7	40.9	636	287	277
	Forage	Mar. 22	64	6.1	562	15.6	41.6	656	362	283
Average	Grage	Mar. 28	77**	6.3	585	20.1	39.6	650	371	356*
	Forage	Apr. 1	66	6.3	580	18.5	38.8	644	338	272

a) Grain=grown for grain only : Forage=clipped two (Doosan 22) or three (Saessalbori) times. then grown for grain.

*, ** Grain and forage utilization systems differ at 0.05 and 0.01 probability levels, respectively.

significantly influenced by the production system regardless of location. Forage utilization did not have an impact on the number of kernels per spike of naked barley, but significantly reduced that of malting barley at Cheju and Aeweol. Forage utilization reduced 1000-kernel weight of naked barley but did not greatly affect that of malting barley. Test weight of naked barley was significantly reduced by forage utilization at Aeweol and Seogwi, but was not at Cheju, resulting in a significant location x production system interaction. However, test weight of malting barley was not influenced by forage utilization. except at Aeweol where clipping reduced test weight.

In naked barley, the three-location average grain yields of two production systems did not significantly differ at 0.05 probability level, but grain yield at Aeweol was reduced by forage utilization, resulted from reduced 1000-kernel weight in the forage utilization system. In malting barley, forage utilization significantly decreased grain yield at Cheju and Aeweol, but not at Seogwi, resulting in a significant location x production system interaction. Yield reduction of the forage utilization system at Cheju and Aeweol resulted from the rduced number of kernels per spike. ·The three-location average straw yields of two cultivars were significantly reduced by forage utilization. The data indicate that use of naked baley for dual production of grain and forage would be profitable in Cheju province. However, forage utilization of malting barley would be disadvantageous, since forage havesting of currently recommending malting barley cultivars significantly reduced grain yield.

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摘 要

濟州地方에 있어서 種實用보다 早播한 쌀보리와 麥酒보리의 生育初期 青草利用이 生育 및 收量에 미치는 影響을 구명하고자 濟州, 涯月, 西歸에서 새쌀보리와 斗山 22號(麥酒보리)를 공시하여 시험한 결과를 要約하면 다음과 같다.

1. 3回 刈取한 쌀보리의 青草收量은 濟州, 涯月, 西歸에서 각각 1247, 820, 1327kg/10a였고 2回 刈取한 麥酒보리의 青草收量은 각각 1189, 515, 930 kg/10a였다.

2. 쌀보리의 3 地域 平均 出穗期는 種實單用區에서 보다 青草利用區에서 2日 빨랐으나 맥주보리에서는 青草利用에 따른 出穗期는 지역에 따라 차이가 있었다.

3. 稈長은 西歸의 麥酒보리를 제외하고는 青草利用에 의하여 減少되었다.

4. ㎡당 穗數는 品種과 地域에 관계없이 種實單用과 青草利用區間 차이가 없었다. 穗當粒數 ,1000粒重, L重은 品種과 地域에 따라 青草利用에 따른 일정한 경향이 없었다.

5. 3 地域 平均 쌀보리의 種實收量은 種實單用과 青草利用區間 차이가 없었으나 麥酒보리의 種實收量은 濟州 및 涯月의 경우 青草利用에 의하여 減少되었다. 10a當 藁重은 品種에 관계없이 青草利用에 의하여 減少되었다.