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Summary

Environmental conditions and management practices in many parts of the Pacific Northwest restrict the production of adequate perennial forages for year-round feeding of livestock. Annual forages may be able to offset the perennial forage deficit, but limited information exists regarding the production of annual forage crops that are adapted to this region. For this reason, production of spring-planted mixtures of pea and triticale were evaluated in northern Idaho.

The early- and intermediate-maturing pea varieties Columbia and Garfield, respectively, averaged 484 pounds per acre more dry matter across all harvest stages than the late-maturing Melrose variety. Mixtures containing 40 to 80 percent pea at seeding produced the highest dry matter yields and net profits when harvested at the boot or milk stage of triticale development and the lowest dry matter yields and net profits when harvested at the soft dough stage. Crude protein yield of mixtures was greatest at the boot and milk developmental stages (482 pounds per acre) while digestible dry matter yield reached a maximum at the milk developmental stage (3,962 pounds per acre). Crude protein and acid detergent fiber contents increased by 5.0 and 2.2 percentage units, respectively, as the amount of pea in the mixtures increased from 0 to 100 percent. When properly managed, spring planted pea/triticale mixtures can produce greater dry matter yields, quality and returns over costs than either species grown in monoculture and should be more adapted to ensiling than peas alone.

Introduction

Livestock producers in the Pacific Northwest often must prepare for winter by transporting their animals to lower elevations where adequate feed is available for overwintering. Yet use of relatively inexpensive silage storage structures could allow them to use high-yielding annual crops as winter feed and reduce the need for herd transportation.

Two annual crops with potential for use as silage are triticale and peas. Triticale, a cross between wheat and rye, is adapted for production in northern Idaho, and unlike other small grains such as wheat and barley, it has non-program status in federal food and grain programs. Peas are commonly grown in northern Idaho for seed production and have shown promise as silage (Murray et al. 1985). Mixtures of pea and triticale may provide a high-yielding, adequate-quality forage under northern Idaho conditions.

The forage production potential of triticale in the United States and in other countries has varied. In western Washington and southern Idaho, spring triticale that was harvested before heading produced dry matter yields and crude protein contents equal to those of other spring grains. When harvested after heading, however, triticale's crude protein content and digestibility were less than those of wheat or barley. In general, maximum forage yield and highest quality silage have been obtained when triticale was harvested slightly before heading.

Spring- and fall-planted peas also are potential forage crops in the Pacific Northwest. Winter pea offers a high-protein silage source for cattle production, but its high moisture content and low fermentable carbohydrate content at early stages of maturity reduce its ability to ferment and thus detract from its use as silage. Unfortunately, delaying harvest to reduce moisture content and increase yield causes large reductions in forage quality.

In northern Idaho, fall-planted winter pea harvested at early flowering has produced dry matter yields 0.5 tons per acre less than winter pea harvested with several immature pods and crude protein contents 5 percent greater. Mixtures of fall-planted winter pea and small grains have increased dry matter yield compared to either species grown alone and increased crude protein content compared to the small grains grown alone (Murray et al. 1985).

The production potential of spring-planted triticale and pea grown alone and in mixtures has not been adequately tested in northern Idaho. Producers who wished to grow mixtures of these crops lacked the necessary information to make management decisions that would maximize forage yield, forage quality and profit.

Experimental Procedure

Columbia and Garfield spring pea and Melrose Austrian winter pea, representing early-, intermediate- and late-maturing peas, respectively, were spring planted in pure stands or with 20, 40, 60, 80 or 100 percent of the pea seed replaced with an equal number of Whitman triticale seeds (Table 1). Generally, spring-planted Austrian winter pea flowers about 20 days later than early-maturing spring pea.

The research was done at Moscow during 1988 and 1989 and at Sandpoint during 1989. A single application of Imidan[1] insecticide was used at the Moscow location each year for control of the pea leaf weevil during crop establishment.

At Moscow, sodium acetate extractable phosphorus (P) and potassium (K) measured 14 and 108 ppm, respectively, nitrate-nitrogen (N) measured 6 ppm and soil pH was 6.8 to a depth of 12 inches. At Sandpoint, P, K and N measured 12, 90 and 4 ppm, respectively, and soil pH was 6.4 to a depth of 12 inches. Before seeding at Sandpoint, P and K were applied at 50 pounds per acre as triple superphosphate (0-44-0) and potassium chloride (0-0-60), respectively. Precipitation and air temperature were monitored throughout all studies (Table 2).

[1]This was an experimental use, and should not be taken as a recommendation.

Table 1. Seeding rates of three pea varieties and triticale.

	% Triticale/% pea[1]					
Variety	**100/0**	**80/20**	**60/40**	**40/60**	**20/80**	**0/100**
	(lb/acre)					
Garfield	83/0	65/75	50/150	33/225	17/300	0/375
Columbia	83/0	65/75	50/150	33/225	17/300	0/375
Melrose	83/0	65/45	50/90	33/135	17/180	0/225

[1]Percentage of pure live seeds.

Forage was harvested at the boot, kernel milk and kernel soft dough stages of triticale development. Pea maturity was determined at each harvest (Table 3). All results are reported on a 100 percent dry matter basis. To convert to the yield at 35 percent dry matter (the typical silage dry matter content), multiply presented yield values by 2.86.

An economic evaluation using cash production cost and return per acre was made for each treatment. Seed cost ranged from $11 per acre for the pure triticale treatments to $30 per acre for the pure Melrose treatment and $51 per acre for the pure Columbia and Garfield pea treatments. The estimated return from each treatment was based on the crude protein and energy contents of the harvested forage and was assumed to equal the cost of purchasing the same amounts of crude protein and energy as barley and cottonseed meal, respectively. Barley was valued at 6 cents per pound and cottonseed meal at 13 cents per pound based on 5-year average prices (1983-88).

Yield and Quality

Location

Forage nutrient contents were the same at both locations. However, yields at Sandpoint averaged 1.8 tons per acre less than at Moscow. This may have been caused by poor seedling establishment and growth

Table 2. Deviation from normal of monthly precipitation and mean daily temperature.

	Moscow			Sandpoint[1]	
	Normal	**1988**	**1989**	**Normal**	**1989**
Precipitation					
	(inches)				
April	1.78	+1.02	−0.75	—	—
May	1.86	+0.36	+0.98	2.30	+1.34
June	1.64	+0.32	−0.32	2.20	−0.70
July	0.66	+0.96	−0.46	1.01	−0.29
Temperature					
	(°F)				
April	46.0	+3.2	+3.8	—	—
May	53.2	+0.6	0.0	53.0	−1.4
June	59.5	−0.1	+1.2	59.6	+2.9
July	66.7	−2.6	−1.1	64.9	+0.9

[1]Sandpoint study was not initiated until May.

Table 3. Development of early-, intermediate- and late-maturing spring-planted peas at the boot, milk and soft dough stages of Whitman triticale development.

	Pea maturity group					
	Early		Intermediate		Late	
Triticale maturity at harvest[1]	**Total nodes[2]**	**Podded nodes[2]**	**Total nodes**	**Podded nodes**	**Total nodes**	**Podded nodes**
	(Number of nodes)					
Boot	16	6	17	2	18	0
Milk	16	6	18	4	23	3
Soft dough	16	6	18	5	25	5

[1]Boot, kernel milk and kernel soft dough stages of triticale development correspond to Zadok's scale 45, 74 and 85, respectively.
[2]Total node numbers begin with the first scale node above the cotyledons for all pea varieties. "Podded" refers to the number of nodes that have pods.

at the Sandpoint location due to relatively high precipitation and cool average daily temperatures during the month of establishment (Table 2). In addition, the soils at Sandpoint and throughout much of northern Idaho have a high volcanic ash content that makes P less available and generally limits forage production despite high P levels in the soil (Mahler and Menser 1986).

Pea Variety

The Columbia and Garfield varieties produced greater dry matter yields (2.3 and 2.4 tons per acre, respectively) than the Melrose variety (2.1 tons per acre). The relative yields of the pea varieties did not change with time of harvest or seeding mixture. Columbia and Garfield also produced greater crude protein and digestible dry matter (DDM) yields per acre at every seeding mixture and stage of harvest (DDM = 88.9 — ADF% × 0.779). The pea varieties had similar crude protein and acid detergent fiber contents at each harvest and seeding mixture.

Seeding Mixture and Stage of Harvest

When triticale was harvested at the boot stage, yield increased as the percentage of pea in the seeding mixture increased (Fig. 1). When harvest was at the soft dough stage, however, yield decreased as the pea percentage increased. Average yields of all mixtures within each harvest stage indicates that delaying harvest from the boot to the milk stage increased yield, but further delay decreased yield (Fig. 1).

The percentage of pea dry matter in the harvested forage decreased when harvest was delayed from the milk to the soft dough stage of triticale development (Fig. 2). This decrease can be attributed to senescence of pea leaves and pods at the later harvest. This response was similar for all pea varieties, suggesting that all varieties lost dry matter at similar rates regardless of their maturity class.

Increasing the pea percentage in the mixture from 0 to 100 percent raised the crude protein content to 11.8 percent from 6.8 percent and raised the acid detergent fiber content to 40.4 percent from 38.3 percent, averaged over all locations and years. Delaying harvest from the boot to soft dough stage decreased crude protein content to 7.8 percent from 12.9 percent and increased acid detergent fiber content to 40.6 percent from 35.9 percent.

Digestible dry matter yields paralleled dry matter yields due to the relatively small changes in percent acid detergent fiber among harvest stages and mixtures. Increasing the percentage of pea in the mixture increased the crude protein yield at the boot and milk stages of harvest but had limited effect at the later stage (Fig. 3). Maximum crude protein yields were obtained by

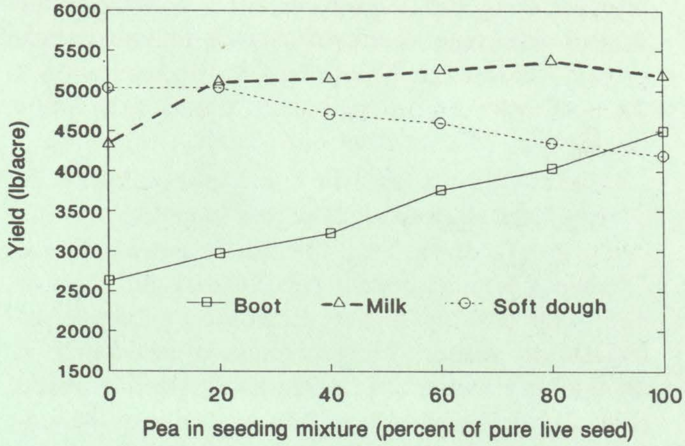

Fig. 1. Forage dry matter yield at the boot, milk and soft dough stages of triticale development as affected by pea/triticale seeding ratio. Yield is the average of three pea cultivars at Moscow and Sandpoint.

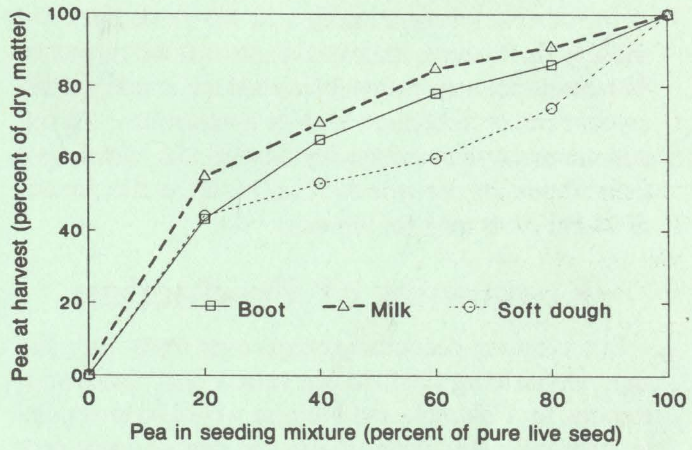

Fig. 2. Relative amount of pea in the harvested forage at the boot, milk and soft dough stages of triticale development as affected by pea/triticale seeding ratio. Values represent the average of three pea cultivars at Moscow and Sandpoint.

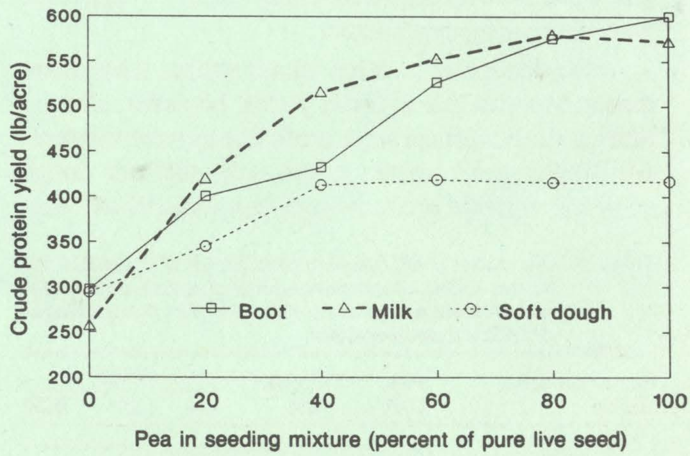

Fig. 3. Forage crude protein yield at the boot, milk and soft dough stages of triticale development as affected by pea/triticale seeding ratio. Yield is the average of three pea cultivars at Moscow and Sandpoint.

planting 80 to 100 percent pea and harvesting at the boot or milk stage. Averaged over all mixtures, crude protein yield was unchanged by delaying harvest from the boot to the milk stage but fell dramatically when harvest was delayed from milk to soft dough.

Delaying harvest from the boot to the milk stage of development allowed all observed parameters to accumulate (Table 4). Total dry matter accumulated at 79 pounds per acre per day ($\pm$22 pounds per acre per day) with pea dry matter accumulating faster than triticale dry matter. The percentage of pea forage in the total dry matter also increased during this period (Fig. 2). Delaying harvest from the milk to the soft dough stage reduced total dry matter by 36 pounds per acre per day ($\pm$29 pounds per acre per day), and only triticale accumulated dry matter.

Nitrogen Fertilizer

Although N fertilizer treatments were not considered in the current research, studies of fall-seeded pea and small grain mixtures indicate that on soils with less than 90 pounds per acre residual N, yield and crude protein content can be increased with N applications. To obtain optimum yield and quality on soils that contain less than 20 pounds per acre residual N, up to 100 pounds of N per acre may be required.

Economics of Production

In evaluating economic returns over costs, only the superior-yielding Garfield pea variety was considered. Returns for Columbia and Melrose would be lower due to their lower dry matter yields and similar crude protein and acid detergent fiber values. At Moscow during both years, harvesting mixtures of 40 to 80 percent pea at the milk stage of triticale resulted in the greatest returns over costs (Table 5). Returns over costs improved within the boot stage with increasing pea content while returns improved within the soft dough stage with decreasing pea content.

At the Sandpoint location all net returns were lower than at Moscow due to lower yields; however, all mixtures at the boot stage were profitable as were mixtures with lower pea contents at the milk and soft dough stages. Profitable production of pea and triticale mixtures without application of N fertilizer in the cooler environment and volcanic ash influenced soils of Sandpoint requires that mixtures be matched with an appropriate stage of harvest (Table 5) and that harvest not be delayed.

Table 4. Dry matter (DM), crude protein (CP) and digestible dry matter (DDM) accumulation rates of spring-planted pea and triticale at the boot, milk and soft dough stages of triticale development.

Accumulation period	Pea DM[1]	Triticale DM	Total DM	Total CP	Total DDM
	(lb/acre/day)				
Boot to milk	47	32	79	1	42
Milk to soft dough	−52	16	−36	−8	−25

[1]Average of early-, intermediate- and late-maturing pea cultivars.

Recommendations

Spring-seeded mixtures of pea and triticale produce more forage dry matter and contain higher percentages of crude protein than triticale grown in monoculture. However, spring seeding should not replace fall seeding in locations where seedlings can survive the winter because fall-seeded winter pea and small grain mixtures generally produce more silage than spring-seeded mixtures. Early- and intermediate-maturing pea varieties were superior to the late-maturing Austrian winter pea variety in all aspects of forage production.

To achieve greatest dry matter, crude protein and digestible dry matter yields per acre, harvest at the milk stage of triticale development. To achieve maximum quality (highest crude protein and lowest acid detergent fiber contents), harvest at the boot stage. When anticipating harvest at the boot or milk stage, include greater than 40 percent pea in the seeding mixture in order to produce the highest forage yield, quality and return over cost. However, when harvest is to occur after the milk stage of triticale development, include less than 60 percent pea in the seeding mixture.

Table 5. Return over cash cost for an early-maturing, spring-planted pea (Garfield) when harvested at the boot, kernel milk and kernel soft dough stages of triticale development as affected by pea/triticale seeding ratio.

Location year	Pea/triticale seeding ratio	Maturity at harvest: Boot	Milk	Soft dough	Mean
		($/acre)			
Moscow 1988					
	0/100	145	210	289	215
	20/80	184	261	258	234
	40/60	172	279	257	236
	60/40	253	302	184	246
	80/20	254	269	169	231
	100/0	242	230	143	205
	Mean	208	259	216	
Moscow 1989					
	0/100	36	145	173	118
	20/80	77	169	173	140
	40/60	79	177	75	110
	60/40	116	175	97	129
	80/20	130	216	86	144
	100/0	138	175	80	131
	Mean	96	176	114	
Sandpoint 1989					
	0/100	15	43	58	39
	20/80	41	26	30	32
	40/60	34	10	20	21
	60/40	57	6	9	24
	80/20	46	−20	3	10
	100/0	66	−16	−2	16
	Mean	43	8	20	

Additional information (e.g., on ensilability and fertility) is needed on production of spring-planted pea and triticale mixtures for forage in the Pacific Northwest. However, current research indicates that this mixture is profitable and will produce dry matter and nutrient yields equal to or greater than those of either species alone. Furthermore, growing the mixture does not alter the production base for producers involved in government food and grain programs.

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