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Yellowfeed Production in Saskatchewan

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Abstract

Yellowfeed is a harvesting method where an annual cereal crop grown for forage is sprayed with glyphosate at the milk-soft dough stage and allowed to stand until dry. Once dry the crop can be cut and then immediately baled. A study was conducted at 16 site by crop combination to monitor oat and barley forage yield and quality. After the application of glyphosate, dry matter yield was maximized at 20 days and protein concentration was minimized at 25 days. ADF, NDF, and TDN did not vary after glyphosate application. Yellowfeed is a viable alternative harvesting method when annual cereals are harvested for hay.

Introduction

Yellowfeed is a method of harvesting an annual cereal crop for hay where glyphosate is applied at the milk-soft dough stage and the crop is then allowed to stand until dry. Once dry, the crop can be cut and then immediately baled. The traditional method of harvesting annual cereals for hay or greenfeed is to cut and crimp the crop at the milk-soft dough stage, and allow the material to dry in the windrow before baling. However, there are number of disadvantages with the traditional method that yellowfeed harvesting potentially could solve.

Traditional harvesting of annual cereal forages has the following disadvantages. The mower-conditioners (cut/crimp) can result in leaf/stem losses of 1 to 5% of dry matter (Rotz 2001). Cells of cut forages remain alive until moisture content reaches about 48%, at which point they die. If drying conditions are poor, carbohydrates can be depleted and quality degraded from live plant cells (Mahanna 1994). Furthermore, heavy rains can dissolve its contents from dead cells and leach them from the hay and also compact the windrows. Raking, particularly when hay is dry (moisture content < 40%), can result in losses of 10 to 25% (Friesen 1980) and increase entanglement among the plants. Finally, traditional harvesting has significant labor/machinery costs because of the need for mower-conditioners and because windrows have to be turned after rains.

On the other hand, yellowfeed harvesting would provide greater ability to schedule harvesting because the dry down period rapid and more consistent; dry down time is a function of glyphosate effect rather than climatic conditions. More rapid and consistent dry down with yellowfeed harvesting would decrease the potential for weathering losses in the windrow during rainy conditions. The second advantage is that yellowfeed reduces labor/machinery costs because windrows do not have to been turned after rain, and only a swather vs. mower-conditioner is required to windrow the crop. Finally, preharvest glyphosate provide weed control, particularly for perennial species such as Canada thistle (Darwent et al. 1994), which can be a benefit for subsequent growing seasons.

Harvest management of annual cereal forage crops has not changed markedly over the past few decades. Preharvest management practices have the potential to maximize forage yields, but optimal harvest practices are essential to protect and obtain the potential economic gain from those yields (Schrickel et al. 1992). Therefore, our objective was to determine if yellowfeed, the use of glyphosate to facilitate dry down, can be use to maintain/improve the forage yield and quality of annual oat and barley.

Materials and Methods

In 2001, samples were collected from four producer oat fields at Balcarres, Carievale, Corning, and Francis, SK, and from one producer barley field at Wawota, SK. In 2002, samples were collected from two producer oat field at Corning and Fillmore, SK, and from one producer barley field at Wawota, SK. A five acre area of each oat or barley producer field in 2001 and 2002 was selected as the experimental area. Plots of oat and barley also were established at Redvers and Indian Head, SK, in 2002 and 2003, using a randomized complete block design with four replicates.

Glyphosate was applied on each experimental area or plot at the medium milk stage for oat, which is Zadoks stage 75, and at soft dough for barley, which is Zadoks stage 85. Applications were made at a rate of 890 g ai ha^{-1} using an isopropylamine formulation with application parameters suggested by the label recommendations for preharvest applications. The glyphosate was applied with a field-scale ground sprayer. Crops were generally dry enough to cut and bale 12 to 15 after glyphosate application, although in a couple of instances crops were still not dry enough for baling 38 days after glyphosate application. In 2002, there was an extended period of wet weather after the glyphosate was applied, thus lengthening the drying time.

Five zones were selected within each experimental area of each producer fields. Five 1-m^2 areas were identified in a transit at each sampling point for a total of 25 sampling points per producer field. One measurement was taken per plot at Redvers and Indian Head in 2002 and 2003. Each time the field was sampled the same pattern was followed with sample being taken near previous samples.

Samples were taken at each sampling point or in each plot approximately every 4 days following glyphosate application in 2001. Rainfall and delayed crop dry down made it difficult to adhere to the intended sampling interval. The actual calendar harvest dates, with the corresponding days after glyphosate application, are summarized in Table 1.

Table 1. Calendar Dates And (Days) Following Glyphosate Application When Annual Cereals Were Harvested For Each Location By Crop Combination In Southeastern SK During Three Years.

Year / Location	Crop	1[z]	2	3	4	5
2001						
Berry	oat	Aug 15 (0)	Aug 17 (2)	Aug 24 (9)	Aug 30 (15)	
Dorrance	oat	Aug 4 (0)	Aug 8 (4)	Aug 11 (7)	Aug 15 (11)	Aug 18 (14)
Klein	oat	Aug 18 (0)	Aug 22 (4)	Aug 27 (9)	Aug 30 (12)	Sept 5 (18)
Pattison	barley	Aug 9 (0)	Aug 13 (4)	Aug 18 (9)	Aug 22 (13)	Aug 27 (18)
Wood	oat	Aug 10 (0)	Aug 15 (5)	Aug 18 (8)	Aug 22 (12)	Aug 27 (17)
2002						
Dorrance	barley	Aug 6 (0)	Aug 19 (13)	Aug 29 (23)	Sep 14 (39)	
Johnston	oat	Sept 4 (0)	Sept 14 (10)	Sept 30 (26)		
Wood	oat	Aug 29 (0)	Sept 14 (16)	Sept 22 (24)	Sep 30 (32)	
Indian Head	barley	July 29 (0)	Aug 14 (16)	Aug 20 (22)	Sept 5 (38)	
Indian Head	oat	July 29 (0)	Aug 14 (16)	Aug 20 (22)	Sept 5 (38)	
Redvers	barley	Aug 21 (0)	Sept 23 (33)			
Redvers	oat	Aug 21 (0)	Sept 23 (33)			
2003						
Indian Head	barley	Jul 24 (0)	Aug 8 (15)	Aug 19 (26)		
Indian Head	oat	Jul 24 (0)	Aug 8 (15)	Aug 19 (26)		
Redvers	barley	Jul 29 (0)	Aug 8 (10)	Aug 18 (20)	Aug 29 (31)	
Redvers	oat	Jul 29 (0)	Aug 8 (10)	Aug 18 (20)	Aug 29 (31)	

[z] Quality parameters were assessed at all dates in 2001 and 2003. Quality parameters were not assessed at Dorrance - Aug 19 (13), Wood - Sept 14 (16), Indian Head (barley and oats) – Aug 14 (16).

Biomass yield samples were taken from a 1 m^2 area by hand clipping just above the soil surface. Samples were dried and then weighed to determine dry matter yield. Forage quality assessments were made from composite samples. Samples taken from five areas within each of the five zones of the experimental areas in each producer fields were combined, thus providing five forage quality samples per sampling date per producer field. At Redvers and Indian Head in 2002 and 2003 samples collected in the first two replicates and last two replicates were combined for each crop material. Therefore, four forage quality samples per sampling date per study site were collected producer field at Redvers and Indian Head. Nitrogen concentrations of biomass samples were determined using Kjeldahl (block) digestion. Crude protein was then calculated from N concentration. Neutral detergent fiber (NDF), acid detergent fiber (ADF) and total digestible nutrients (TDN) concentrations were determined using an ANKOM 200 Fiber Analyzer (ANKOM Technology, Macedon, NY).

Annual cereal responses were regressed against days to harvest following glyphosate application (DAA). The regression was conducted as a multilevel random-coefficient model using the PROC MIXED procedure available from SAS (SAS Institute Inc. 1999). The DAA and corresponding intercept were modeled as both fixed and random effects. The estimation of the random effect of intercept and DAA were made across location by year by crop combinations using the ‘subject’ option in the ‘random’ statement. An ‘unstructured’ covariance structure in the random statement allowed the estimation of three variance components, one for the intercepts, slopes, and covariance between them. Output from the analysis included fixed effect estimates for the intercept and DAA (slope), variance estimates for regression coefficients and the covariance between them, and estimated deviation (empirical best linear unbiased predictions) from the mean intercept and slope for each location by year by crop combination. Regression coefficients and corresponding variance estimates were declared significant at $P <$ 0.05.

Results

Dry matter yield and crude protein responded in a curvilinear manner to days after glyphosate application, when responses were summarized across all sites (Fig. 1; Table 2). Dry matter yield was maximized when annual cereal was harvested 20 days after glyphosate application; harvesting prior to after this time results in lesser yields. Crude protein was minimized when harvesting occurred 25 days after glyphosate application; harvesting prior to after this time results in greater protein levels. ADF/NDF, TDN, and relative feed value were not affected by the days after glyphosate application when annual cereals were harvested (Table 2).

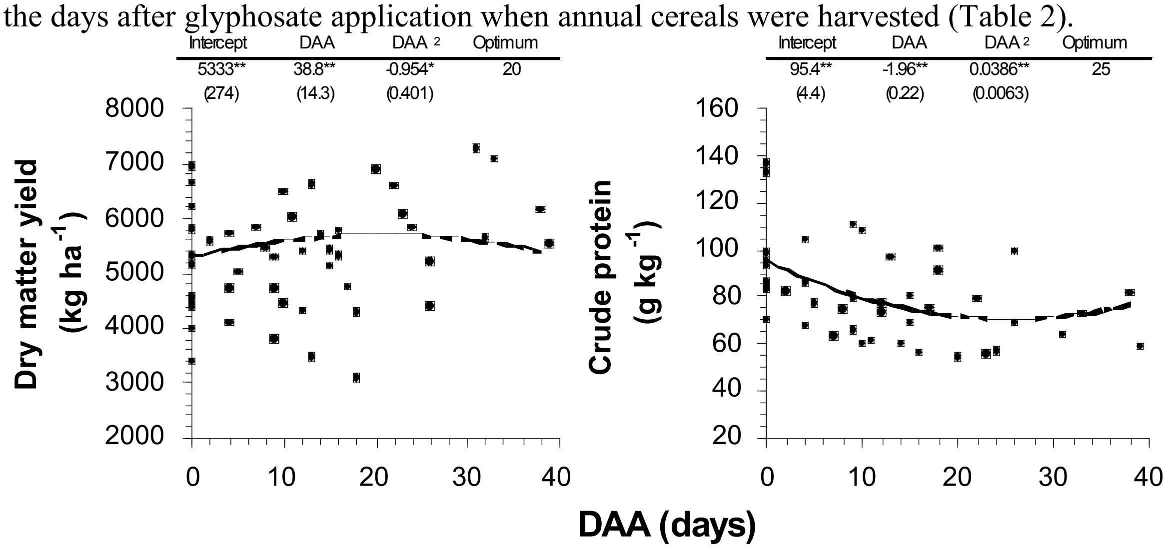

Fig. 1. Regression parameter estimates for annual cereal responses vs. days to harvest after glyphosate application across location by crop combinations in southeastern SK from 2001 to 2003. The statistical significance of regression parameters are indicated as follows: ‘*’ = 0.05 ≥ P value ≥ 0.01; and ‘**’ = P value < 0.01. Trends are included for those regressions where at least one of the slope coefficients was statistically significant.

Table 2. Slope Coefficients (SE In Brackets Immediately Below) For The Regression Of Annual Cereal Responses To Days To Harvest After Glyphosate Application In Southeastern SK During Three Years.

Variable	Intercept ($g\ kg^{-1}$)	DAA ($g\ kg^{-1}$) day^{-1}	DAA^2 [z]
ADF	344**[y]	-0.479	0.0327
	(12)	(0.839)	(0.0254)
NDF	585**	0.378	0.0101
	(16)	(1.158)	(0.0343)
TDN	631**	0.718	-0.0489
	(18)	(1.253)	(0.038)

DAA units squared.
[y] The statistical significance of the regression coefficients are indicated as follows: '*' = 0.05 ≥ *P* value ≥ 0.01; and '**' = *P* value < 0.01.

Apparently, it takes about 20 days for glyphosate to completely shut down dry matter accumulation of oat and barley. It is thought protein synthesis has ceased long before this time, thus the reason for the dilution effect on protein concentration(decrease with time) following glyphosate application, however, there is a decrease in the total mass of protein per hectare, indicating that dilution alone will not account for the change in protein and the decrease must be due to biochemical processes occurring in the plant during later stages of maturity. Decrease in yield following the optimum could be due to some leaf loss following the extended dry down period after glyphosate application.

Analysis showed that the intercept varied among sites by crop combinations, but not slopes (Table 3). The deviations for the site by crop combination intercepts from overall intercept ranged considerably: 1) dry matter yield -1604–1791; 2) crude protein = -23–35; 3) ADF = -59–76; 4) NDF = -76–82; 5) TDN = -114–88. The statistical variation for the intercept would be expected because of variable environmental conditions at different sites and the corresponding differential responses of oat and barley to these variable conditions. The statistically similar slopes among sites indicates that choosing to harvest annual cereal forages 20–25 days after glyphosate application will consistently result in optimal yield and minimum crude protein.

Table 3. Variance Estimates For Regression Parameters Of Annual Cereal Responses To Days To Harvest After Glyphosate Application Across Location By Crop Combinations In Southeastern SK From 2001 To 2003.

Parameter	Dry matter yield	Crude protein	TDN	ADF	NDF
			(Variance estimate)[z]		
Intercept	1031273**	288**	4018**	1804**	3021**
Slope	276	0.071	0.49	0.218	0

[z] The statistical significance of variance component are indicated as follows: '*' = 0.05 ≥ *P* value ≥ 0.01; and '**' = *P* value < 0.01.

There are a number of other questions that have arisen and observations that have been made regarding yellowfeed harvesting. Producers have reported that the palatability of yellowfeed is equal to or greater than greenfeed. The economics of yellowfeed could be studied further, and future studies should consider: 1) expected changes in forage yield and quality from spraying to harvest; 2) cost of herbicide and application; 3) diminished the potential for regrowth and fall grazing; 4) cost of swathing compared to crimping; and 5) potential benefit of perennial weed control. Barley stands well after spraying, but the heads tend to curl over close to the soil surface when the crop is left standing after it has dried. Oats tends to lay over horizontally at about a 12–18 inch height. This does not interfere with cutting because the cutter bar can be set below this height. Barley dries about 4–7 days sooner than oats after glyphosate applications, although leaves and kernels have been observed to remain attached, even when left standing 7–10 days after reaching a moisture content that would be considered dry.

Yellowfeed appears to be a viable method for drying annual cereals prior to baling, and the application of glyphosate does not cause a significant negative effect on forage yield and most quality parameters. The flexibility associated with application timing of glyphosate and control of dry-down time help avoid reduced yield and quality of annual cereal forages during harvest. Results from this study show that yellowfeed is a viable alternative for the harvest management of annual cereal forages in Saskatchewan.

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