Regression Techniques For Estimating Percent Crown Removed in Scalping Sugarbeet Roots

D. F. COLE AND G. J. SEILER

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Introduction

A portion of the crown of sugarbeet roots normally is scalped off during harvest to remove impurities which interfere with extraction of sucrose. Recent data indicate that the crown constitutes 15 to 25% of the total root (1,2,4,5). Cole and Seiler (1) indicated that sugarbeet growers removed 20% of the crown tissue during the scalping operation. Their estimate was made by manually harvesting scalped sugarbeet roots from 74 locations and comparing the remaining amount of crown material with the amount of crown material on sugarbeet roots that had not been scalped. A limited number of observations was made due to the labor and time requirement of this method (1). A reliable and rapid method for estimation of the amount of crown material removed by the scalping operation was needed. Our objective was to develop a regression model for estimation of the amounts removed by measurement of the diameters of the cut surfaces of sugarbeet crowns.

MATERIALS AND METHODS

Sugarbeet roots were obtained from three separate experiments in 1975 and 1976. Six commercial cultivars were grown at Fargo, North Dakota in 1975 in a dryland yield test. In 1976, five treatments of an irrigated

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The authors are Research Plant Physiologist and Adjunct Professor of Agronomy, and Research Technician.

long-term nitrogen experiment at Sidney, Montana were sampled (3). Also in 1976, roots from eight commercial cultivars were harvested from dryland demonstration strip-plots located in a commercial field near Kindred, North Dakota.

Leaves and petioles were removed from the roots by hand on the nitrogen experiment and with a commercial rotobeater on the cultivar plots. The roots were harvested manually, washed, and weighed. Three cuts through the crown were made so that the diameters of the cut surfaces were approximately equal to 25, 51, and 76 mm (1, 2, and 3 inches). A fourth cut was made at the lowest leaf scar to remove the remaining portion of the crown tissue. The diameter (nearest mm) of each cut surface was determined at a right angle to the longitudinal axis. The weight of each segment of the crown tissue and of the root was determined. A total of 894 roots and 3,576 observations was used in these tests.

Multiple regression analyses of measurements of the diameter, diameter^2, and the logarithm of the diameter of the cut surfaces were used to develop a predication equation to estimate the amount of crown material removed. The regression model was tested by determining the amount of material removed by a random cut in the crown areas of 100 roots selected at random and correlating the amounts with values predicated from the regression model.

RESULTS AND DICUSSION

The percent crown of total weight was converted to a logarithm for purposes of analysis. Analyses indicated that regression coefficients were affected by nitrogen level and cultivars in 1976. However, coefficients were unaffected by cultivars in 1975. Regression coefficients for diameter^2 were least affected by nitrogen level or cultivars. Coefficients for the logarithm of the diameter did not significantly improve the predictability of the equations for cultivars in 1975 or nitrogen levels

in 1976. Therefore, for the equation to be of practical value to a user unfamiliar with either the soil nitrogen level or cultivar, all experiments were combined into a single analysis.

Regression analysis indicated that the largest R^2 (Table 1) was obtained with a multiple regression model consisting of all three parameters: diameter, diameter^2 and the logarithm of the diameter. The three variables were entered into the regression model at the p = 0.01 level. The model to estimate percent crown is: log y = 0.0176 + 0.06527 (dia) -0.000268 (dia)^2 -0.932 (log dia).

Table 1. Estimate of R^2 and coefficient of variation for various regression models

REGRESSION MODEL	R^2	CV, %
Diameter	0.750	26.8
Diameter^2	0.606	33.5
Log diameter	0.818	22.8
Diameter, diameter^2	0.833	21.8
Diameter, log diameter	0.823	22.4
Diameter^2, log diameter	0.826	22.3
Diameter, diameter^2, log diameter	0.834	21.8

The amounts of crown removed by various diameter cuts estimated from the regression model are shown in Table 2. The data indicated that approximately 44% of the crown would be removed with a 76 mm cut. Cole and Seiler (1) indicated that growers were removing approximately 20% of the crown, which would indicate a diameter of 61 mm. To remove 50% of the crown, the diameter of the cut must be near 80 mm.

The correlation coefficient between predicated and actual amount of crown removed on a random sample of 100 sugarbeets (representing different cultivars) was r = 0.82. The actual amount of crown removed was 31.0% compared to the estimated amount of 32.0%. The data indicated that the regression model can be used to estimate the amount of crown material removed by growers during the scalping operation. A total of 400 roots is

Table 2. Estimates of the amount of crown removed by measurement of the cut surface of the crown at a right angle to the longitudinal root axis. Estimates were developed by regression analysis of data from three experiments over 2 years.

Diameter mm	Crown %	Diameter mm	Crown %	Diameter mm	Crown %
21	1.0	51*	10.6	81	54.1
22	1.1	52	11.3	82	56.2
23	1.2	53	12.1	83	58.4
24	1.3	54	12.9	84	60.5
25*	1.4	55	13.8	85	62.7
26	1.5	56	14.7	86	64.8
27	1.6	57	15.7	87	67.0
28	1.8	58	16.7	88	69.2
29	1.9	59	17.8	89	71.3
30	2.1	60	18.9	90	73.5
31	2.3	61	20.1	91	75.6
32	2.5	62	21.4	92	77.7
33	2.7	63	22.6	93	79.7
34	2.9	64	24.0	94	81.7
35	3.2	65	25.4	95	83.7
36	3.4	66	26.8	96	85.6
37	3.7	67	28.3	97	87.5
38	4.0	68	29.8	98	89.3
39	4.3	69	31.4	99	91.0
40	4.7	70	33.1	100	92.7
41	5.1	71	34.8	101	94.3
42	5.5	72	36.5	102*	95.8
43	5.9	73	38.3	103	97.2
44	6.4	74	40.2	104	98.6
45	6.9	75	42.1	105	99.8
46	7.4	76*	44.0	106	100.9
47	8.0	77	45.9	107	102.0
48	8.5	78	47.9	108	102.9
49	9.2	79	50.0	109	103.7
50	9.8	80	52.0	110	104.4

*25 ≅ 1 inch, 51 ≅ 2 inches, 76 ≅ 3 inches, 102 ≅ 4 inches.

needed to estimate the amount of crown removed by scalping at a P = 0.95 level within a confidence interval of 8 mm (Table 3).

SUMMARY

During harvest, sugarbeets are scalped to remove a portion of impurities that would otherwise enter a sugarbeet processing factory. A simple method for estimation of the amount of crown removed was not available. Our objectives was to develop a regression

Table 3. Number of roots needed for estimation of the amount of crown removed during scalping based on the diameter of the cut surface at various probability levels and confidence intervals.

Confidence interval mm	0.70	0.80	0.90	0.95	0.99
1	7,165	10,970	18,279	25,646	44,293
2	1,791	2,743	4,570	6,411	11,073
3	796	1,219	2,031	2,850	4,921
4	448	686	1,142	1,603	2,768
5	287	439	731	1,025	1,772
6	199	305	508	712	1,230
7	146	224	373	523	904
8	112	171	285	400	692
9	88	135	226	317	547
10	72	110	183	256	443

model, based upon the diameter of the cut surface of sugarbeet roots, to estimate the amount of crown removed by the scalping operation.

A multiple regression model, $\log y = 0.0176 + 0.06527 (x) - 0.000268(x)^2 - 0.932(\log x)$, where x equals the diameter of the cut surface at a right angle to the longitudinal root axis, was developed to estimate the amount of crown removed ($R^2 = .834$). A correlation coefficient of $r = 0.82$ was obtained between the actual and predicated amounts removed by two random cuts through crowns of 100 sugarbeet roots selected at random. The high correlation between actual and predicated crown removed demonstrates that a regression equation can be used to estimate the amount of crown removed by the grower during the scalping operation. The model coefficients may be different when sugarbeets are grown in different environments or when management practices are different from those of the north central growing area of the United States.

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