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Stem Number, Tuber set & Size Distribution Relationships for Russet Norkotah selections (CO-3, CO-8) in the Columbia Basin

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Variation in average stem number per seedpiece from different seed lots affects tuber size distribution and crop value. The extent to which tuber size distribution changes with stems is cultivar-dependent and specific to a particular growing region. In response to requests from several growers and fresh packers, we conducted a series of studies to determine stem number, tuber set, and size distribution relationships for two CO Russet Norkotah selections. Knowledge of these relationships provides an opportunity to add value to these cultivars.

The practice of manipulating stem numbers through altering the physiological age of seed lots is not widespread and thus the stem-producing potential of a seed lot is usually unknown prior to planting. This lack of knowledge eliminates adjusting in-row spacing as a technique to fine-tune tuber set and size development in relation to predicted stem numbers. However, if stem number/size distribution relationships are known, stem counts just prior to row closure (~55-65 DAP) can inform subsequent in-season management decisions designed to modify a predicted size distribution, thus maximizing crop value in relation to market requirements for tuber size (e.g. adjusting vine kill dates, etc.).

When grown under the same levels of N nutrition, CO-3 and 8 greatly out yielded standard Norkotah (Table 1). However, the average tuber size of CO-3 was greater than 9 oz, reflecting a high proportion of oversize tubers (Fig. 1). This is at least partly due to the relatively low stem number and tuber set produced by CO-3 and its greater N use efficiency relative to the other selections. An important question is: **…to what extent will the substantial yield advantage inherent in CO-3 change along with tuber size distribution to affect crop value as stem numbers increase?**

Norkotah seed-tubers (standard, CO-3, CO-8) were stored at different temperatures for 200 days to produce a range of stem numbers for each cultivar. Seed was cut and planted (8 in deep, 10-in in-row spacing, 34 in between rows) in replicated plots at Othello and stem number, tuber set, and size distribution relationships were determined (121-day growing season; 3 cropping years). Tuber number per plant increased and average tuber size decreased with increasing stem numbers for CO-3, CO-8 (Figs. 2A, 3A) and standard Norkotah. These changes occurred with no change in marketable yields (Figs. 2B, 3B), reflecting substantial shifts in tuber size distributions with increasing stems (Figs 2C, 3C).

At low stem numbers (~2.0-2.5/hill), CO-3 produced a high percentage of oversize tubers relative to CORN 8 (Fig. 2C, Table 2; Fig. 3C, Table 3) and standard Norkotah (data not shown). **The percentage oversize of CORN 3 was reduced and economic return (fresh contract) maximized at 3.0 stems/hill (Table 2, Fig. 2D).** As stems increased, tuber size distributions shifted from 10.5 oz and greater to favor increased yields of tubers 8.5 oz and under (Fig. 2C, Table 2), and crop value (fresh pack) decreased accordingly (Fig. 2D). Crop values on a seed contract basis increased linearly with increasing stems, as smaller size tubers are favored for seed. *We estimate that seed should accumulate ~1000 degree-days (at 54-64^{o}F) from vine kill through wound-healing to produce 3.0 stems/hill in CORN 3. For WA-grown seed, ~240 degree-days normally accumulate during a 30-day maturation period between vine kill and harvest. The remaining degree days can be given during wound-healing.*

In contrast to CORN 3, CORN 8 and standard Norkotah (not shown) produced the most lucrative tuber size distributions at 2.4 (Fig. 3, Table 3) and 2.0 stems/hill, respectively. *Degree-day accumulation by these cultivars should thus be minimized from vine kill through storage to planting by limiting the maturation period under dead vines to 3 weeks and the curing period in storage to ~14 days at 54°F.* These results provide a basis for grouping compatible cultivars in seed storages, according to the degree-days needed to produce target stem numbers. **Implementing uniform handling and storage practices for seed will ultimately lead to more precise control and predictability of tuber size distributions.** The data presented herein can be used to estimate tuber set and size distributions from early season stem counts, allowing growers to make informed decisions about how best to manage a crop in-season to target a particular size distribution.

Table 1. Productivity of physiologically young seed of Norkotah selections at Othello, WA. Seed age was limited to about 200 to 250 degree-days (°C above 4°C) from vine kill through storage to planting. When grown under the same levels of N nutrition, CO-3 and 8 greatly out yielded standard Norkotah. However, the average tuber size of CO-3 was greater than 9 oz, indicating a high proportion of oversize tubers (see below). This was at least partly due to the relatively low stem number produced by the physiologically young seed of CO-3 and its greater N use efficiency relative to the other selections.

Stem Number, Tuber Set & Yield of Russet Norkotah Selections at Othello, WA
(3-yr avg, 2004-06, 121 DAP)

Yield Components	Norkotah Selection Std.	CO-3	CO-8
Stem No./plant	2.9	2.3**	2.7
Tubers/plant	8.9	7.7**	9.1
Tubers/stem	3.1	3.4**	3.4**
oz/tuber	5.8	9.4**	6.8**
	Tuber Yields (T/A)		
Total	29.5	40.8**	35.1**
Marketable	29.4	40.7**	35.0**
U.S.#1	24.8	38.9**	31.2**

*,** Selections were significantly different from standard Norkotah at P≤0.05 and 0.01, respectively

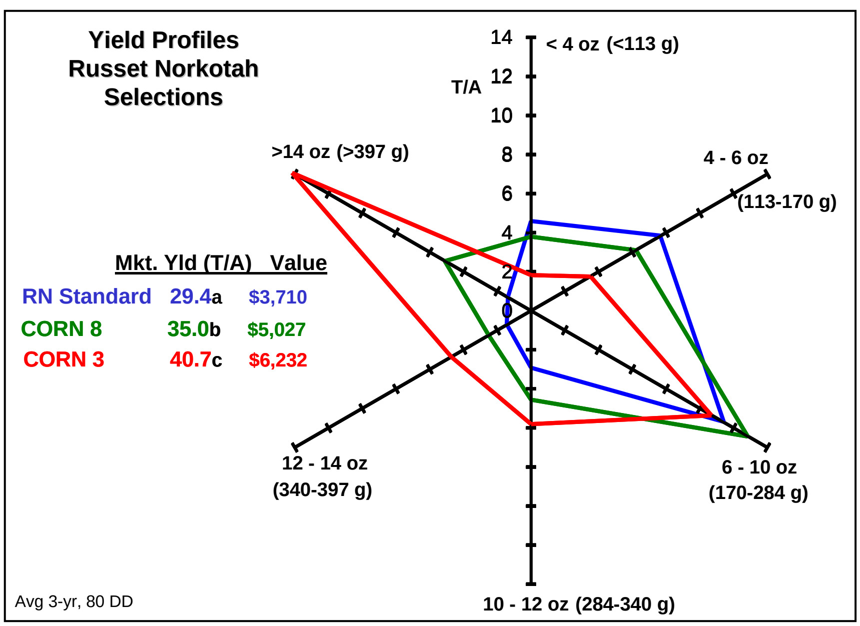

Fig. 1. Tuber size distributions produced by physiologically young seed of Russet Norkotah (standard), CORN 8 and CORN 3 at Othello, WA (3-year average). The axes of the polygonal plots range from 0 to 14 T/A for each of six tuber size classes. Note that CORN 3 produced 14 T/A of >14-oz tubers, characterizing its tendency to produce a high percentage of oversize tubers. The associated market yields (including <4 oz) and process value are indicated in the inset table (means with different letters, P<0.01). An important question is: can the size distribution of CORN 3 be shifted by increasing stem numbers without compromising yield? Figure 2 shows that this is possible.

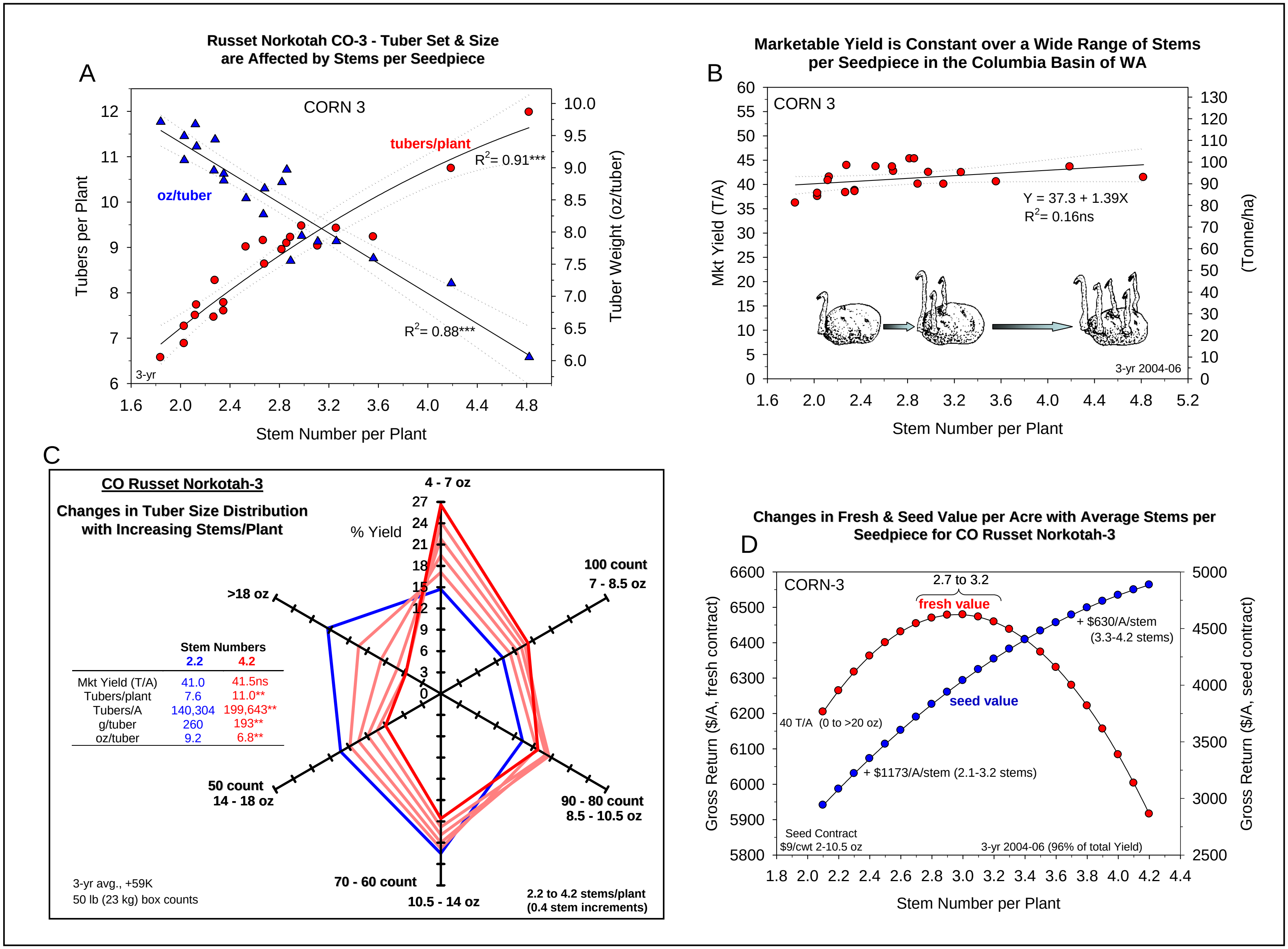

Fig. 2. Stem number, tuber set (A), marketable yield (B), tuber size distribution (C), and crop value (D) relationships for CO Russet Norkotah selection 3 in the Columbia Basin. Data are averaged over three growing seasons. The overlapping polygons (C) illustrate the progressive shift in tuber size distribution as stems increase in increments of 0.4 from 2.2 stems (blue polygon) to 5.2 stems (red polygon). See Table 2 for data on percentage size distribution.

Table 2. Predicted changes in tuber set and size distribution with increasing aboveground stems from **Russet Norkotah CO-3** seed-tubers planted in the Columbia Basin (regression models upon which these estimates are based were derived from 3 years of field data, 2004-2006).

Stems/Plant	Mkt. Yld (T/A)	Tuber Size Distribution (%Marketable Yield) CO-3							Tubers per plant	oz/tuber	Tubers/Acre (1000's)
		<4 oz	4-7 oz	7-8.5 oz	8.5-10.5 oz	10.5-14 oz	14-18 oz	>18 oz			
2.2	40	4.7	14.7	10.1	13.3	22.5	16.3	18.4	7.6	9.2	140.3
2.4	40	5.3	15.9	10.7	14.6	22.1	15.6	15.7	8.1	8.9	147.5
2.6	40	6.0	17.1	11.3	15.6	21.8	14.8	13.4	8.4	8.7	154.4
2.8	40	6.7	18.3	11.8	16.5	21.4	14.1	11.4	8.8	8.5	161.0
3.0	40	7.3	19.5	12.3	17.1	20.9	13.4	9.6	9.2	8.2	167.3
3.2	40	8.0	20.6	12.7	17.4	20.4	12.6	8.2	9.5	8.0	173.4
3.4	40	8.6	21.8	13.1	17.6	19.9	11.9	7.1	9.8	7.7	179.2
3.6	40	9.3	23.0	13.4	17.5	19.4	11.2	6.3	10.1	7.5	184.7
3.8	40	10.0	24.2	13.7	17.2	18.8	10.4	5.8	10.4	7.3	190.0
4.0	40	10.6	25.4	14.0	16.6	18.2	9.7	5.6	10.7	7.0	194.9
4.2	40	11.3	26.6	14.2	15.8	17.5	9.0	5.7	11.0	6.8	199.6
Trend[a]	-	LT	LT	QT	QT	QT	LT	QT	QT	LT	QT
Coeff of det (R^2)[b]	0.16 ns	0.98***	0.98***	0.98***	0.92***	0.94***	0.94***	0.96***	0.91***	0.88**	0.92***
Std. Error of Est.[c]	-	0.3	0.6	0.2	0.5	0.5	0.6	1.22	0.4	0.3	6.7

[a]LT, linear trend; QT, quadratic trend
[b]Values (x100) represent the percentage variation explained by the models.
,*Correlations were significant at the 0.01 and 0.001 levels, respectively.
[c]Standard errors of the estimates of percent yield, tuber set, tuber number, and tuber weight versus stem number per plant.

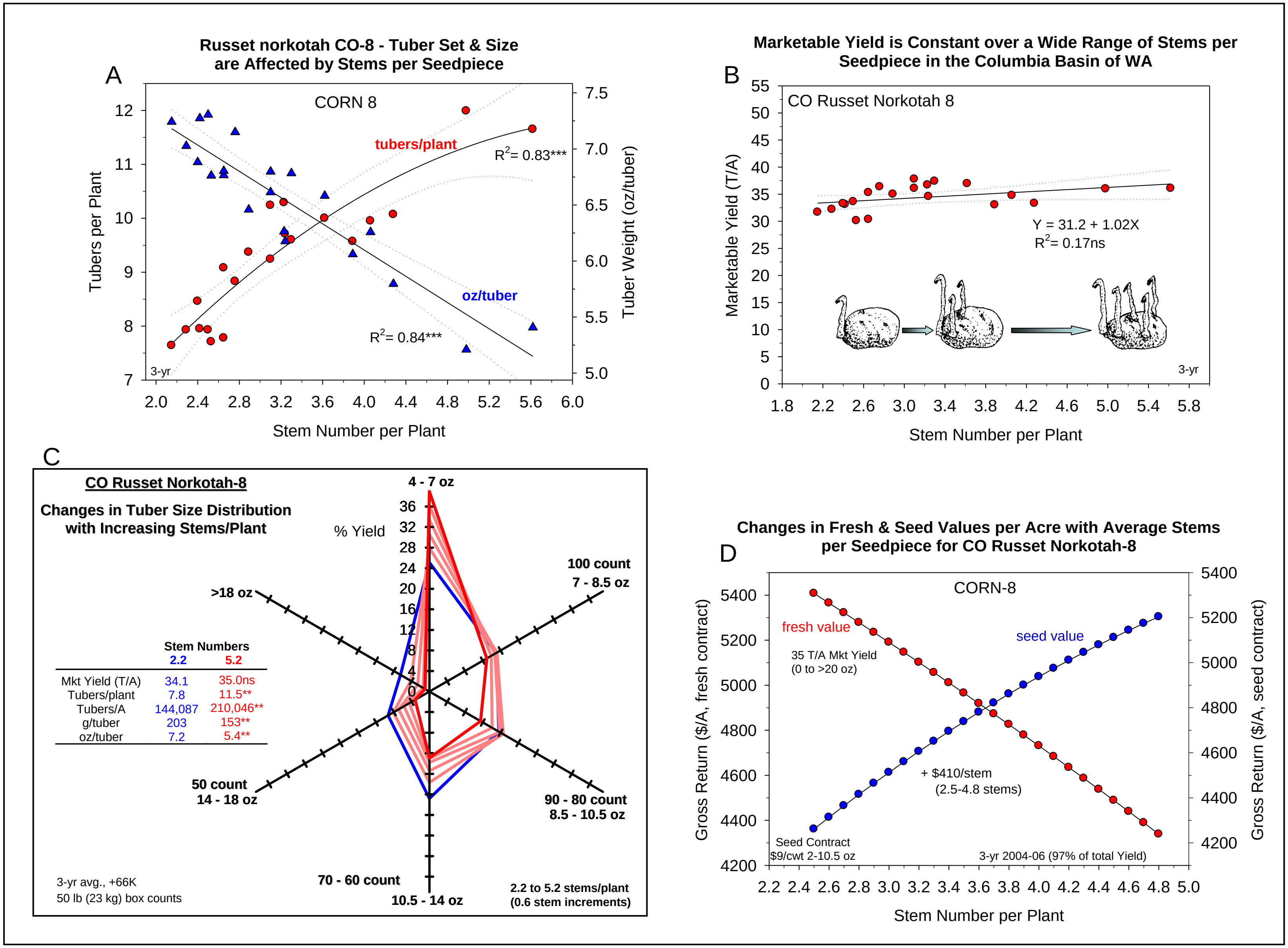

Fig. 3. Stem number, tuber set (A), marketable yield (B), tuber size distribution (C), and crop value (D) relationships for CO Russet Norkotah selection 8 in the Columbia Basin. Data are averaged over three growing seasons. The overlapping polygons (C) illustrate the progressive shift in tuber size distribution as stems increase in increments of 0.4 from 2.2 stems (blue polygon) to 5.2 stems (red polygon). See Table 3 for data on percentage size distribution.

Table 3. Predicted changes in tuber set and size distribution with increasing aboveground stems from **Russet Norkotah CO-8** seed-tubers planted in the Columbia Basin (regression models upon which these estimates are based were derived from 3 years of field data, 2004-2006).

Stems/Plant	Mkt. Yld (T/A)	Tuber Size Distribution (%Marketable Yield) CO-8							Tubers per plant	oz/tuber	Tubers/Acre (1000's)
		<4 oz	4-7 oz	7-8.5 oz	8.5-10.5 oz	10.5-14 oz	14-18 oz	>18 oz			
2.2	35	9.4	25.1	15.0	15.6	20.8	9.3	6.5	7.8	7.2	144.1
2.4	35	9.7	26.0	15.1	16.0	19.7	8.9	5.6	8.1	7.0	150.2
2.6	35	10.1	27.0	15.1	16.3	18.7	8.5	4.9	8.5	6.9	156.1
2.8	35	10.5	27.9	15.2	16.5	17.7	8.1	4.2	8.8	6.8	161.7
3.0	35	11.0	28.8	15.2	16.6	16.9	7.7	3.6	9.1	6.7	167.1
3.2	35	11.6	29.7	15.1	16.7	16.1	7.3	3.0	9.4	6.6	172.2
3.4	35	12.2	30.6	15.1	16.6	15.4	6.9	2.5	9.7	6.4	177.1
3.6	35	12.9	31.6	15.0	16.4	14.8	6.5	2.1	10.0	6.3	181.8
3.8	35	13.7	32.5	14.8	16.2	14.2	6.1	1.7	10.2	6.2	186.2
4.0	35	14.5	33.4	14.7	15.8	13.8	5.7	1.4	10.4	6.1	190.3
4.2	35	15.4	34.3	14.5	15.3	13.4	5.3	1.2	10.7	6.0	194.2
4.4	35	16.4	35.2	14.2	14.8	13.1	4.9	1.0	10.8	5.9	197.9
4.6	35	17.4	36.2	13.9	14.1	13.0	4.5	0.9	11.0	5.7	201.3
4.8	35	18.5	37.1	13.6	13.3	12.8	4.0	0.9	11.2	5.6	204.5
5.0	35	19.7	38.0	13.3	12.5	12.8	3.6	0.9	11.3	5.5	207.4
5.2	35	20.9	38.9	12.9	11.5	12.9	3.2	1.0	11.5	5.4	210.0
Trend[a]	-	QT	LT	QT	QT	QT	LT	QT	QT	LT	QT
Coeff of det (R^2)[b]	0.17 ns	0.97***	0.87**	0.56*	0.76*	0.69*	0.88**	0.75*	0.83**	0.84**	0.82*
Std. Error of Est.[c]	-	0.6	1.5	0.6	0.9	1.7	0.6	1.0	0.5	0.2	9.9

[a]LT, linear trend; QT, quadratic trend

[b]Values (x100) represent the percentage variation explained by the models.

*,**,***Correlations were significant at the 0.05, 0.01 and 0.001 levels, respectively.

[c]Standard errors of the estimates of percent yield, tuber set, tuber number, and tuber weight versus stem number per plant.