IRRIGATION AND N FERTILIZATION OF UMATILLA RUSSET

by
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Summary

Umatilla Russet was compared with Russet Burbank and Shepody for yield, grade, and processing quality response to four applied N rates under sprinkler irrigation in 1992, 1993, and 1994, and to four N rates under furrow irrigation in 1994, 1995, and 1996, and to four levels of sprinkler irrigation in 1992, 1993 and 1994. The varieties did not differ significantly in yield response to N rate, but specific gravity was reduced with increasing N rate. In the sprinkler irrigated N rate study, averaging over the three years at the optimum N rate each year, Umatilla Russet had the highest yield of US #1 tubers. Umatilla Russet and Russet Burbank had the highest total yield.

In the furrow irrigated N rate study Umatilla Russet had the highest yield of US #1 tubers and large #1 tubers. Shepody and Umatilla Russet had the lightest stem end fry color. In the non-stressed check treatments, averaged over three years, Umatilla Russet had the highest total yield, the highest yield of US #1 tubers, and yield of large US #1 tubers as high as Shepody. In these trials, with optimum to adverse irrigation and N levels, Umatilla Russet demonstrated good stability in tuber yield, grade, and processing quality compared to the other varieties. Deficit sprinkler irrigation decreased US #1 yield in all three varieties. Deficit irrigation did not significantly reduce total yield of Russet Burbank, and severe irrigation deficit increased yield of US #2 tubers in Russet Burbank. Specific gravity of Shepody was reduced by irrigation deficits, but remained stable in Russet Burbank and increased in Umatilla Russet.

Materials and Methods

Three potato varieties (Russet Burbank, Shepody, and Umatilla Russet) were compared for their response to deficit sprinkler irrigation, and to N rates under sprinkler and furrow irrigation in three separate trials. Each trial was repeated three years.

Experimental design for all studies: Randomized complete block design with N rates or deficit irrigation as main plots and varieties as split plots.

N rate study under sprinkler irrigation

N rates tested: 0, 120, 180, and 240 lb N/ac. Application mode: Urea was banded pre-emergence within one week after planting. Bands were on both sides of hill at seed piece depth and offset 9 inches from hill center.

Irrigation scheduling: Watermark soil moisture sensors (Model 200 SS, Irrometer Co. Riverside, CA) were placed at 8-in depth and offset 6 inches from the hill center. Watermarks were calibrated for the soils used in the trials (Shock et al., 1998). Irrigations were applied when mean water potential reached -60 kPa. Accumulated Et_c was applied at each irrigation. To avoid leaching, water applications at each irrigation did not exceed 1.2 ac-in/ac regardless of the accumulated Et_c. Irrigations started no sooner than 1 week before tuber set.

Year	Previous crop	Pre-plant soil NO_3-N + NH_4-N (lb/ac)	N mineralization (by anaerobic incubation) (lb/ac)
1992	alfalfa	115	241
1993	spring wheat	60	141
1994	spring wheat	68	141

N rate study under furrow irrigation

Application mode: Seventy percent of total urea was banded pre-emergence within one week after planting. Bands were on both sides of hill at seed piece depth and offset 9 inches from hill center. Thirty percent of total urea applied as water run urea in late June.

Year	N rate	Pre-plant soil NO_3-N + NH_4-N	Total N supply
	lb N/ac		
1994	0	60	60
Previous crop: soybeans	60	60	120
	120	60	180
	180	60	240
N mineralization*: 60 lb N/ac			
1995	0	36	36
Previous crop: wheat	84	36	120
	144	36	180
	204	36	240
N mineralization*: 50 lb N/ac			
1996	0	36	36
Previous crop: wheat	114	36	150
	174	36	210
	234	36	270
N mineralization*: 30 lb N/acre			

* from April 1 to July 31

Irrigation scheduling: Watermark sensors were placed at 8-in depth and offset 6 inches from the hill center. Irrigations were applied when mean water potential reached -50 kPa. Irrigations started no sooner than 1 week before tuber set.

Deficit irrigation study

N fertilizer at 20, 155, and 120 Lb N/ac was applied to all plots in 1992, 1993, and 1994, respectively. N fertilizer was applied as in the N rate study under sprinkler irrigation.

Irrigation scheduling: Watermark soil moisture sensors were placed at 8-in depth and offset 9 inches from the hill center as in the other trial. Irrigations were applied when mean water potential reached the treatment criterion. The accumulated Et_c (or percentage of) was applied at each irrigation. To avoid leaching, water applications at each irrigation did not exceed 1.2 ac-in/ac regardless of the accumulated Et_c. Irrigation treatments started no sooner than 1 week before tuber set.

Treatment	Irrigation criteria	Irrigation intensity
	(kPa)	(% of Et_c)
1	-60	100
2	-80	100
3	-80	70
4	-80	50,70,50[y]

[y]50% of accumulated Et_c replaced until tuber set, then 70% of Et_c replaced for six weeks, then 50% of Et_c replaced until last irrigation.

Results and Discussion

Variety response to deficit irrigation. Over three years, deficit irrigation reduced total tuber yield for Shepody, and Umatilla Russet, but not for Russet Burbank (Fig. 1). Deficit irrigation reduced US #1 yield for all varieties (Fig. 2). Deficit irrigation at the most severe level increased US #2 yield for Russet Burbank, but differences in the other varieties was not statistically significant. Averaged over three years and using the adequately irrigated check each year, the varieties had similar total yield and Umatilla Russet had the highest yield of US #1 tubers (Fig. 2). Shepody and Umatilla Russet had the highest yield of US #1 large tubers. Shepody had the highest stem-end fry color (lightest frying tubers) and Russet Burbank had the lowest stem-end fry color (Table 1). Effects on tuber specific gravity were inconsistent between varieties (Fig. 3).

Variety response to N rates under sprinkler irrigation. The varieties had similar responses to N rates. The total and US #1 yield were maximized for Umatilla Russet by N rates similar to the other two commercial varieties (Figures 4 & 5). Tuber specific gravity for all varieties was reduced by N fertilization (Fig. 6). Umatilla Russet and Russet Burbank had the highest total yield under sprinkler irrigation averaged over the three years and using the optimum N rate each year (Fig. 4). Umatilla Russet had the highest yield of US #1 tubers (Fig. 5) and Shepody and Umatilla Russet had the highest yield of US #1 large tubers. Russet Burbank had the lowest tuber specific gravity (Table 1 and Fig. 6). Umatilla Russet had relatively high tuber specific gravity. Shepody and Umatilla Russet had the lightest stem-end fry colors (Table 1).

Variety response to N rates under furrow irrigation. Tuber total yield and US #1 yield were highest with the unfertilized check in 1994. In 1995 total yield was maximized by 144 lb N/ac and US #1 yield was maximized by 114 lb N/ac and in 1996, both total and US #1 yield were highest with the highest N rate tested of 234 lb N/ac (Fig. 10). Each year the varieties had similar responses to N rates. Averaged over three years and using the optimum N rate each year, Umatilla Russet and Russet Burbank had the highest total yield while Shepody yielded less. Russet Burbank had the lowest US #1 yield. Shepody had the highest US #1 large tuber yield followed by Umatilla Russet. Umatilla Russet had the highest tuber specific gravity followed by Shepody (Table 1). Shepody and Umatilla Russet had the lightest stem-end fry colors (Table 1).

Russet Burbank yield shifted from US #1 tubers toward US #2 tubers when fertilized with more than 120 lb N/ac (Fig. 7). In contrast, tuber yield of Shepody and Umatilla Russet remained largely US #1 at N rates above 120 lb N/ac (Figures 8 & 9).

Conclusions

Deficit irrigation reduced US #1 yield for all varieties. Over three years, deficit irrigation reduced total tuber yield for Shepody, Ranger Russet, and Umatilla Russet, but not for Russet Burbank. Deficit irrigation at the most severe level increased US #2 yield for Russet Burbank, but not for the other varieties. Considering only the adequately irrigated check treatment, Umatilla Russet had the highest yield of US #1 tubers, and Umatilla Russet and Shepody had the higher yield of US #1 large tubers than Ranger Russet, which was followed by Russet Burbank.

In the N rate studies the varieties did not differ significantly in their responses to N rate. In the sprinkler irrigated N rate study, using the optimum N rate each year and averaging over the three years, Umatilla Russet and Russet Burbank had the highest total yield. Umatilla Russet and Shepody had the highest yield of US #1 tubers. In the furrow irrigated N rate trial Umatilla Russet had the highest yield of total US #1 tubers and US #1 large tubers. In both N rate trials Umatilla Russet and Shepody had the lightest stem-end fry colors.

Literature Cited

Shock, C. C., J. Barnum, and M. Seddigh. 1998. Calibration of Watermark soil moisture sensors for irrigation management. Irrigation Association. Proceedings of the International Irrigation Show. pp. 139-146. San Diego, CA.

Table 1. Tuber internal quality response to deficit sprinkler irrigation and to N rates under sprinkler and furrow irrigation by variety over three years. Only the optimum treatment in terms of tuber yield for each year in each trial was used for varietal comparison. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1992-1994.

Variety	Deficit irrigation trial		Sprinkler irrigated N rate trial		Furrow irrigated N rate trial	
	Fry color reflectance	Specific gravity	Fry color reflectance	Specific gravity	Fry color reflectance	Specific gravity
	%	g/cm^3	%	g/cm^3	%	g/cm^3
Russet Burbank	34.5	1.083	33.6	1.083	28.5	1.082
Shepody	47.1	1.087	45.4	1.085	42.7	1.086
Umatilla Russet	44.9	1.092	42.8	1.091	42.1	1.088

Figure 1. Tuber yield response of Russet Burbank, Shepody, and Umatilla Russet to deficit irrigation. Malheur Experiment Station, Oregon State University.

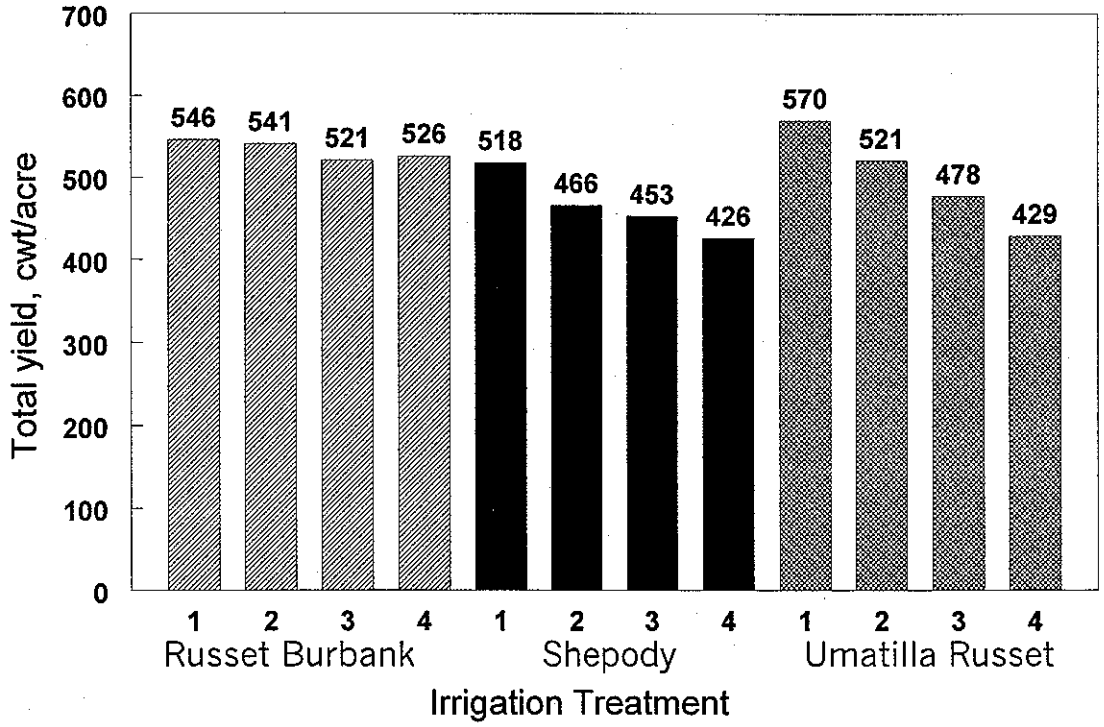


Figure 2. US No 1 yield response of Russet Burbank, Shepody, and Umatilla Russet to deficit irrigation. Malheur Experiment Station, Oregon State University.

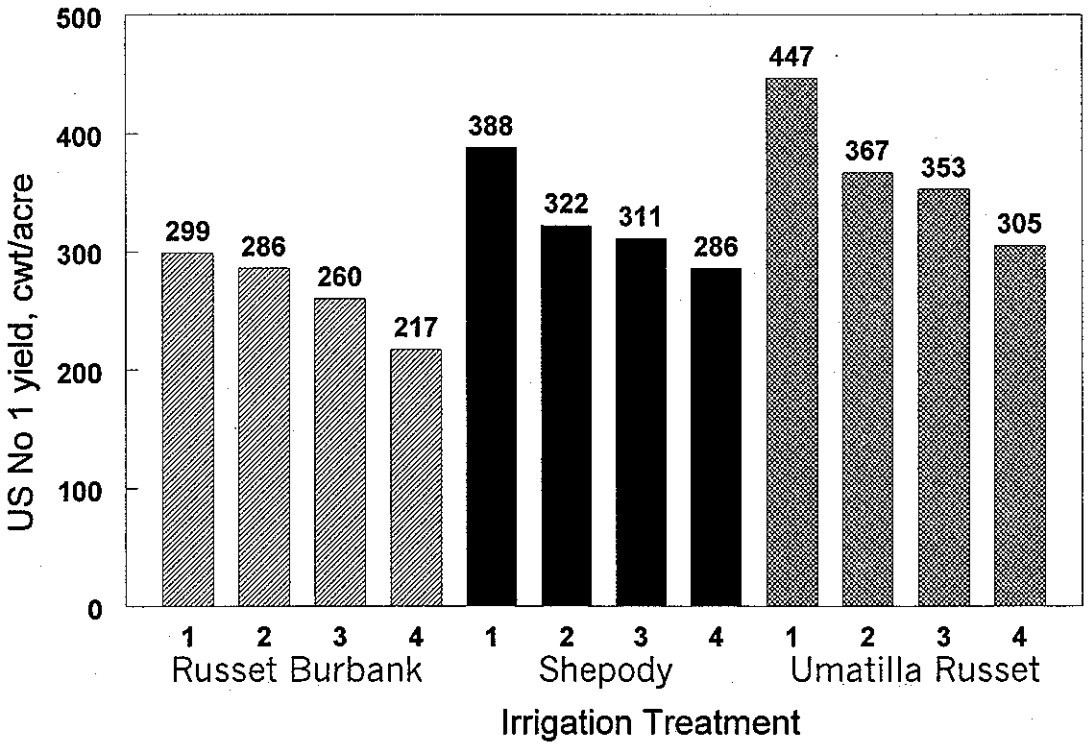


Figure 3. Specific gravity response of Russet Burbank, Shepody, and Umatilla Russet to deficit irrigation. Malheur Experiment Station, Oregon State University.

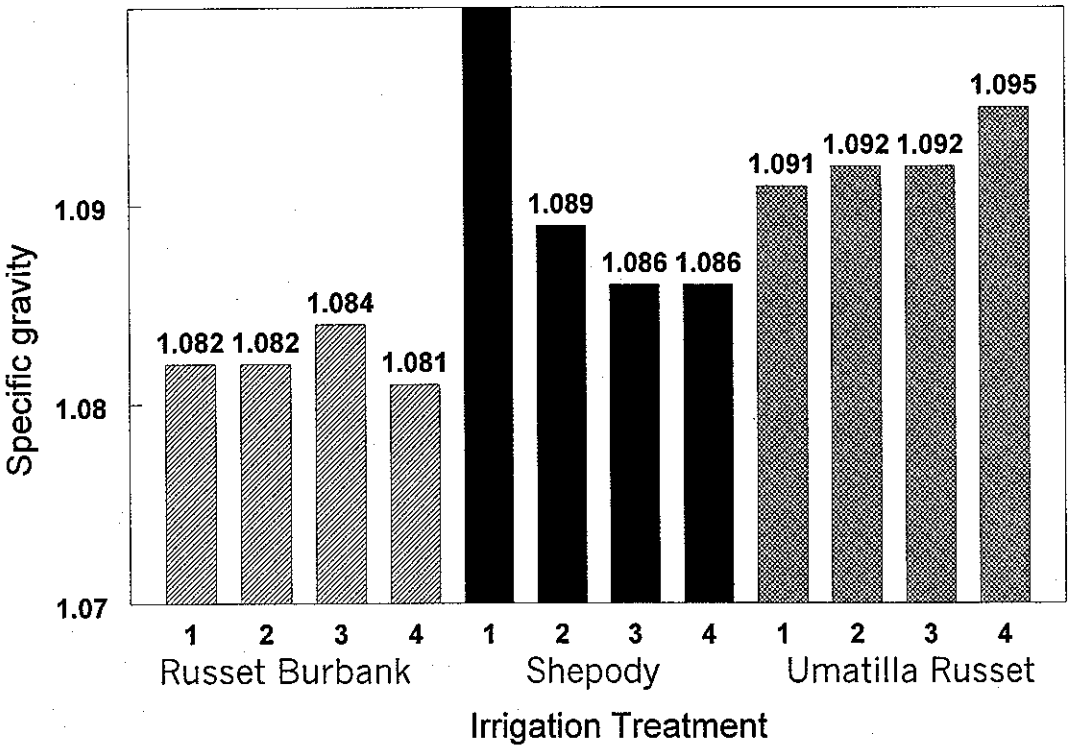


Figure 4. Total yield response of Russet Burbank, Shepody, and Umatilla Russet to N fertilization. Malheur Experiment Station, Oregon State University.

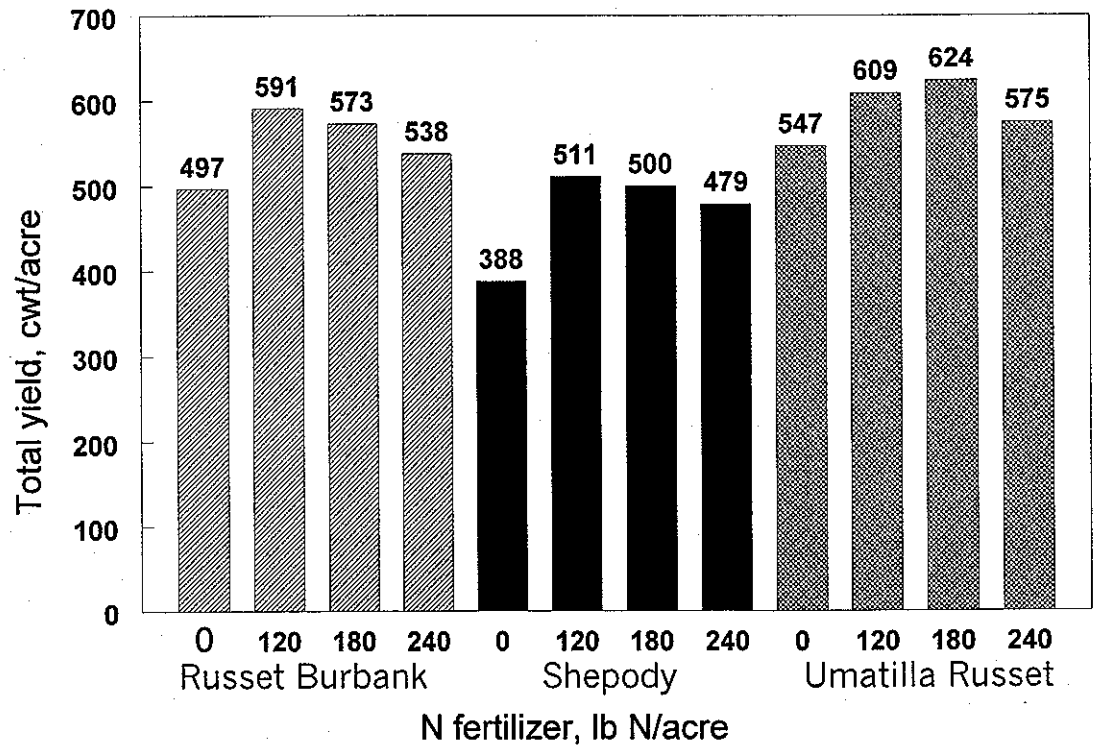


Figure 5. US No 1 yield response of Russet Burbank, Shepody, and Umatilla Russet to N fertilization. Malheur Experiment Station, Oregon State University.

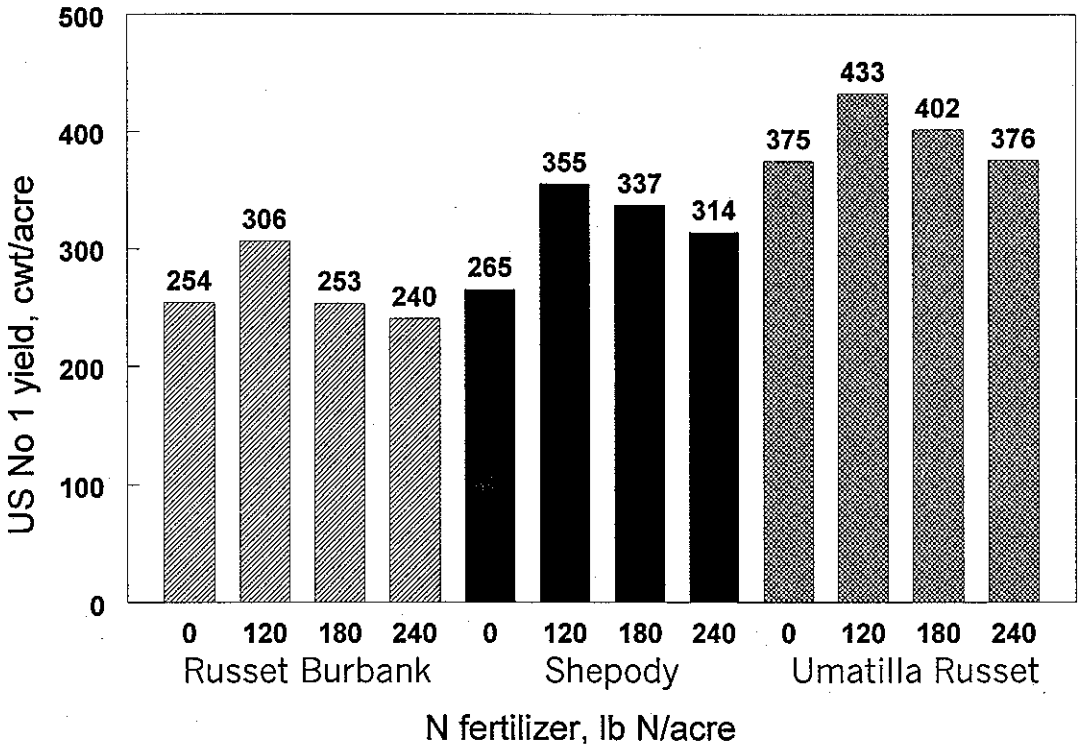


Figure 6. Specific gravity response of Russet Burbank, Shepody, and Umatilla Russet to N fertilization. Malheur Experiment Station, Oregon State University.

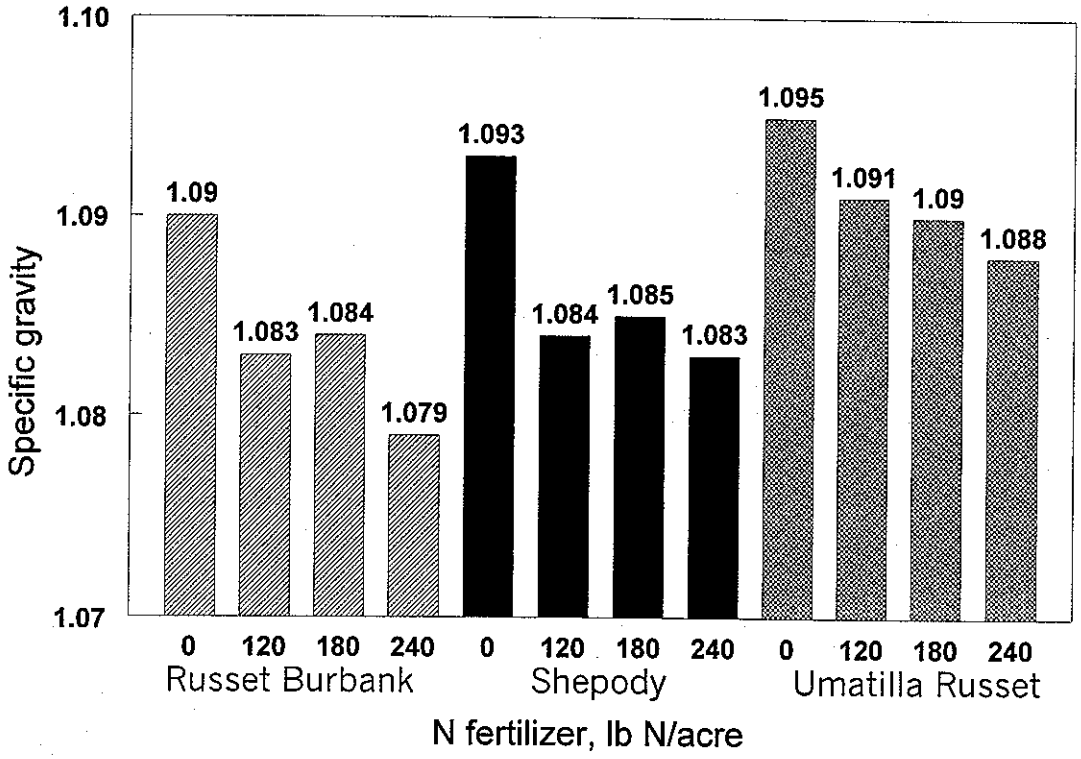


Figure 7. Russet Burbank tuber grade response to nitrogen fertilizer. Malheur Experiment Station, Oregon State University.

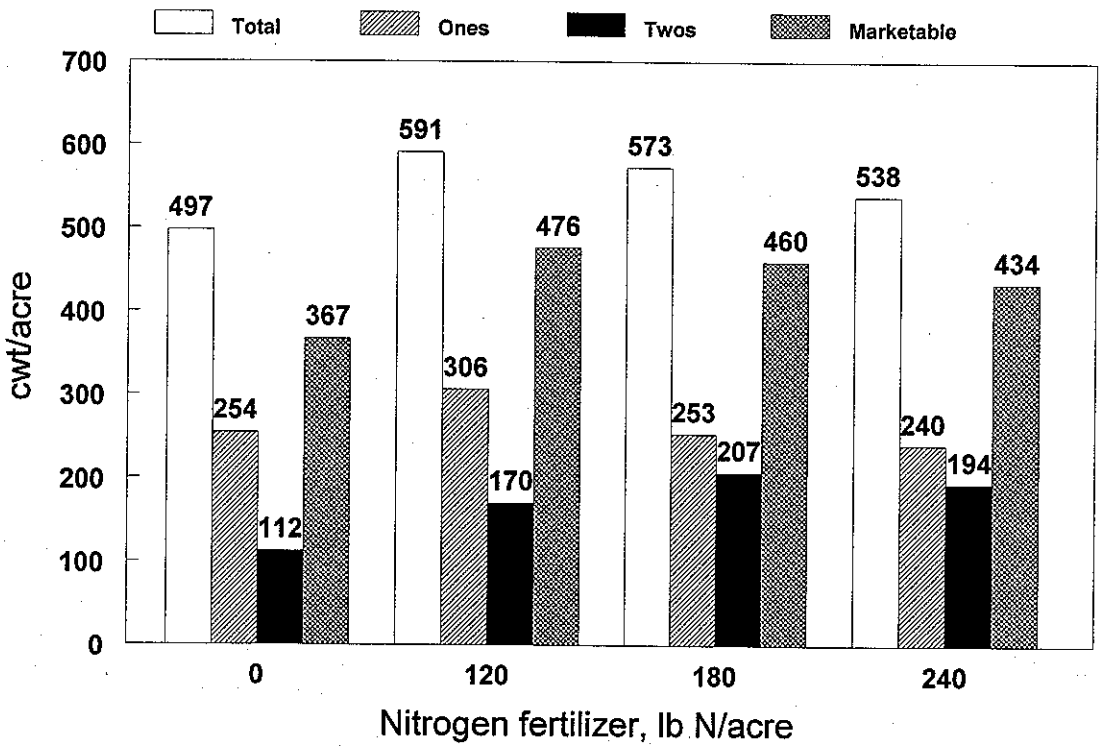


Figure 8. Shepody tuber grade response to nitrogen fertilizer. Malheur Experiment Station, Oregon State University.

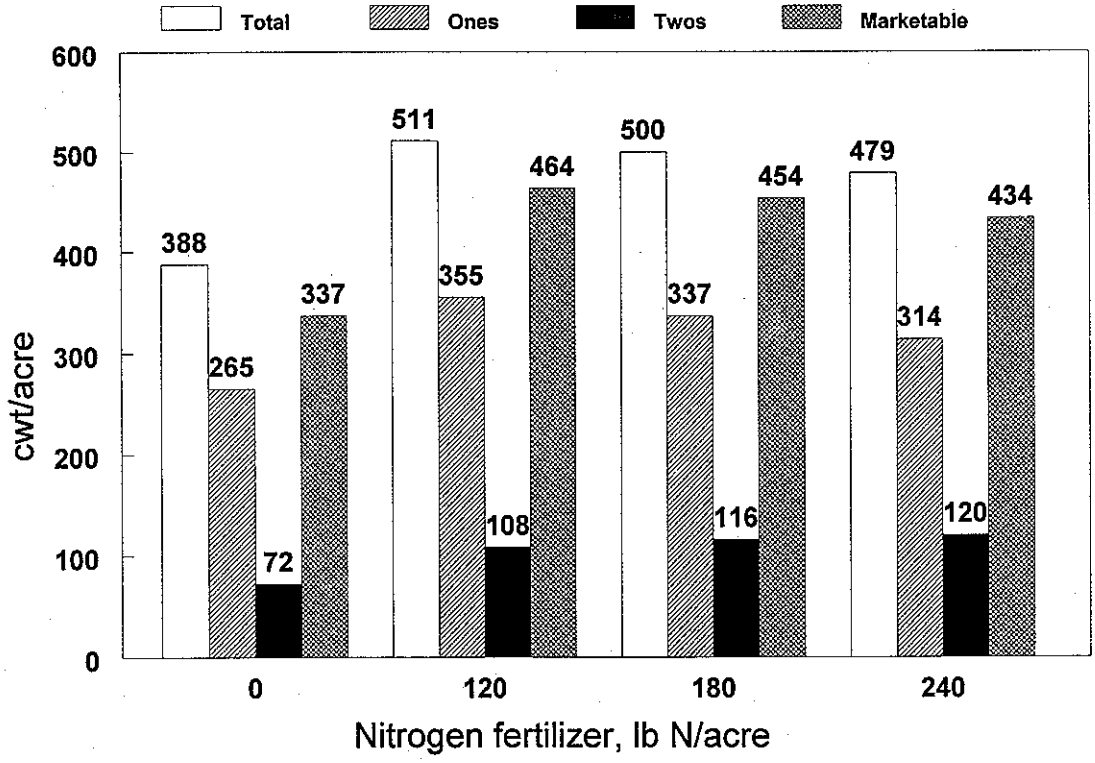


Figure 9. Umatilla Russet tuber grade response to nitrogen fertilizer. Malheur Experiment Station, Oregon State University.

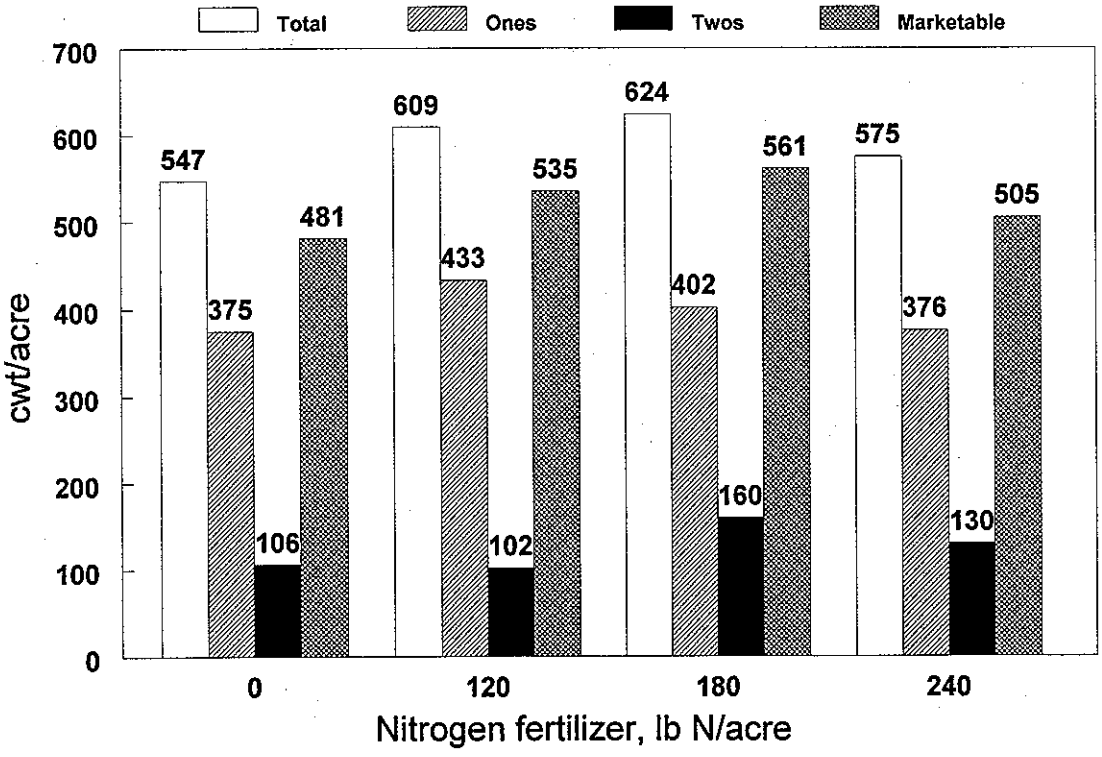
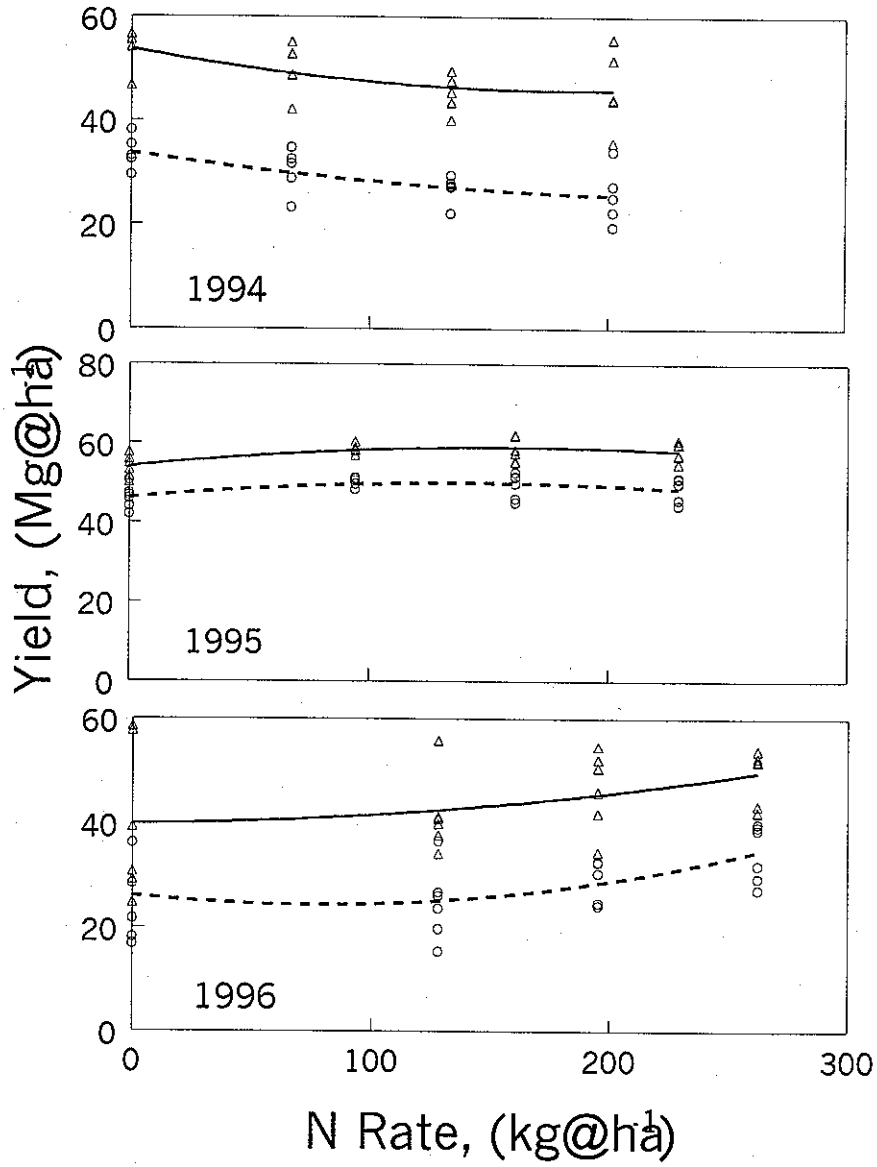


Figure 10. Total (-□-) and US #1 (-□-) yield response to N rate for furrow irrigated potatoes averaged over four varieties. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1994-1996.



20 Mg/ha of yield = 8.9 tons/acre, 100 kg/ha is about 89 lb/acre. Regression equations for total yield and US #1 yield, respectively are: for 1994, $Y = 53.8 - 0.0856 \cdot X + 0.000229 \cdot X^2$, ($R^2$ = 0.29, NS), and $Y = 33.8 - 0.0676 \cdot X + 0.000133 \cdot X^2$, ($R^2 = 0.42$, $P = 0.05$); for 1995, $Y = 54.1 + 0.0621 \cdot X - 0.000194 \cdot X^2$ ($R^2 = 0.42$, $P = 0.01$), and $Y = 46.3 + 0.0542 \cdot X - 0.000194 \cdot X^2$ (R^2 = 0.26, $P = 0.05$); for 1996, $Y = 39.9 + 0.00338 \cdot X + 0.000130 \cdot X^2$, ($R^2 = 0.15$, NS), and $Y = 26.2 - 0.047 \cdot X + 0.000304 \cdot X^2$ ($R^2 = 0.28$, $P = 0.05$) .