POTATO

INCREASING POTATO YIELDS
THROUGH EFFICIENT IRRIGATION SOLUTIONS

HIGHER YIELDS. . . LOWER COSTS. . .
PRECISION APPLICATION

LINDSAY™

Why irrigate?

Getting the correct amount of water on your potato crop is essential for producing high yields. Zimmatic® irrigation systems bring a cost-effective solution, alleviating risk when the weather isn't cooperating. It also gives you more flexibility when it comes to planting, because your timeline is not as affected by nature.

Potatoes are shallow-rooted and more sensitive to soil moisture stress than crops with deeper roots. Moisture stress (depending on the crop growth stage) can reduce tuber yields, produce misshapen tubers, and negatively affect processing quality.

Above all, proper irrigation management helps optimize yields, size distribution and quality of both seed- and consumption-grade tubers.

RELATIVE POTATO YIELD FOR DIFFERING RELATIVE IRRIGATION AMOUNTS[1]

Total tuber yield as influenced by the difference between irrigation and evapotranspiration (ET) on 45 commercial potato fields in southeastern Idaho.

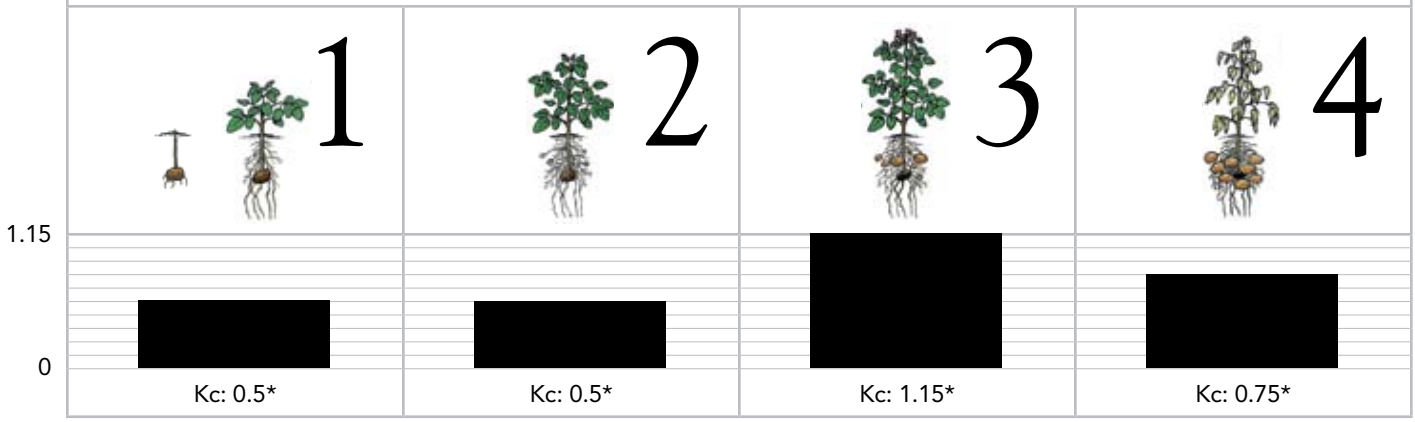
	Irrigation – ET		Total tuber yield	
	inches	centimeters	cwt per acre*	metric tons per hectare
Under	< -3	< -7.6	322	36.1
	-3 to -1.5	-7.6 to -3.8	358	40.1
	-1.5 to 0	-3.8 to 0	376	42.1
	0 to 1.5	0 to 3.8	398	44.6
Over	1.5 to 3	3.8 to 7.62	362	40.6
	>3	>7.62	360	40.4

Under-application Optimum Over-application *cwt = 100 pounds

IRRIGATION IMPACTS EVERY STAGE OF GROWTH

From establishment to harvest, effective water management is important at each stage of potato growth. At Lindsay, we take into account many factors when designing irrigation systems to meet your specific needs, such as local microclimate, soil type and elevation. Potatoes require a soil moisture content that must be maintained at a relatively high level. For best yields, a 120-150 day crop requires 20-27.5 inches (508-698.5 mm) of water. In general, deficits in the middle to late part of the growing period tend to reduce yield more than those in the early part.[1]

CROP COEFFICIENTS (Kc) USED FOR WATER MANAGEMENT[1]



Vegetative Growth: 15 to 30 Days. After planting, this stage of growth begins when the eyes break dormancy and produce sprouts.

Tuber initiation: 10 to 14 Days. Soil moisture levels should be watched closely because water stress during this period can reduce the number of tubers produced per plant.

Tuber Bulking: 60 to + 90 days. Tuber size and quality is closely related to moisture supply in this period. Total yield of potatoes is most sensitive to water stress during this period.

Tuber Maturation: Potato plants require less water for tuber bulking during this stage because of reduced transpiration from the dying leaves and lower tuber growth rates.

Note: A better Uniformity Coefficient alone does not ensure more tuber yield if the overall crop water requirement is not met and results in a water deficit.
*Stated Kc values are an average. Local Kc values will vary with local microclimate, terrain and potato variety.

Water Requirements

Moisture requirements for potatoes depend on several factors including: cultivar maturity characteristics, plant population, water-holding capacity of the soil, climate, and whether tubers are grown for seed or consumption markets.

Potatoes need a well-drained, well-aerated porous soil with a pH of 5 to 6. Fertilizer requirements are relatively high for an irrigated crop: 176 to 264 lbs/acre N (80 to 120 kg/ha), 110 lbs to 176 lbs/acre P (50 to 80 kg/ha) and 275 lbs to 352 lbs/acre K (125 to 160 kg/ha). The sowing depth is generally 1.9 to 3.9 inches (5 to 10 cm), and plant spacing is 2.4 x 0.98 ft. (0.75 x 0.3 m) under irrigation.[2]

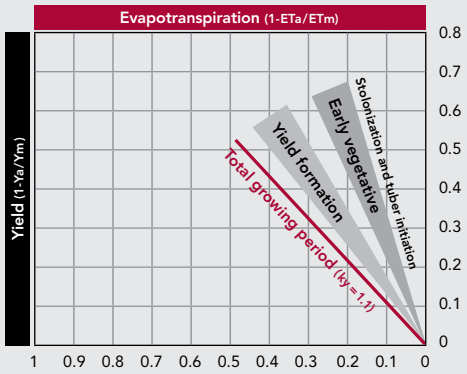
To effectively plan irrigation, growers need to account for evapotranspiration (ET). Evapotranspiration is the total water use of a crop, including evaporation from the soil and transpiration by the plant. Humidity, solar radiation, wind, as well as crop health and growth stage affect evapotranspiration.

Monitoring Evapotranspiration

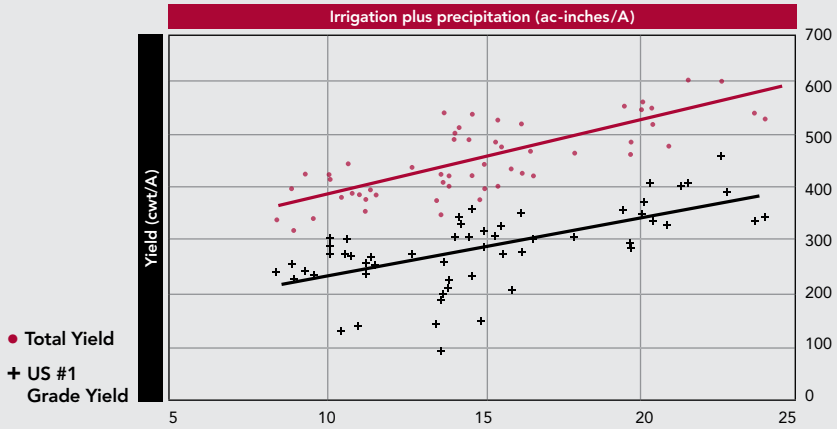
To measure and monitor crop evapotranspiration, access to the following information is needed:

1. A local weather station report that estimates potato crop ET.
2. A rain gauge placed in each field or group of adjacent fields.
3. A good estimate of the allowable water depletion for the soil (this can be calculated by extension agents and crop consultants).[3]

THE RELATIONSHIPS BETWEEN RELATIVE CROP YIELD DECREASE (1 – YA/YM) AND RELATIVE EVAPOTRANSPIRATION DEFICIT FOR THE TOTAL GROWING PERIOD[2]



EFFECT OF IRRIGATION PLUS RAINFALL ON POTATO YIELD AND GRADE WITHIN A THREE-YEAR PERIOD WITH MORE THAN FOUR VARIETIES IN ONTARIO, CANADA[3]



Irrigation Optimization

Potatoes are relatively sensitive to soil water deficits. To optimize yields, the total available soil water should not be depleted by more than 30 to 50%, and the soil should be maintained at a relatively high moisture content. Irrigation at 40% of field capacity (FC) is adequate for seed grade tubers, while "processing/table" crops benefit from irrigation at 65% FC.

Under conditions of limited water supply, irrigation should be directed toward maximizing yield per acre or hectare, rather than spreading the limited water over a larger area. Savings in water can be made primarily through improved timing and depth of irrigation application.

Very high yields can be achieved with irrigation systems where evapotranspiration losses are replenished each day or every two days.

References

[1] Reprinted with permission from Bradley A. King and Jeffrey C. Stark, Potato Irrigation Management, bulletin 789, University of Idaho Cooperative Extension System, Moscow, Idaho, 1997.
International Year of the Potato (IYP) Secretariat, Food and Agriculture Organization of the United Nations, http://www.potato2008.org
Thomas F. Scherer, Dave Franzen, James Lorenzen, Art Lamey, Dwight Aakre, Duane A. Preston, Growing Irrigated Potatoes AE-1040, North Dakota State University, (Revised) March 1999.

[2] Crop Water Management, AGLW Water Management Group http://www.fao.org/landandwater/aglw/cropwater/potato.stm

[3] Clinton C. Shock, Erik B.G. Feibert and Lamont D. Saunders, *Quality Potato Production Dependence on Irrigation Scheduling*, Malheur Experiment Station, Oregon State University, 1999.

CHEMIGATION/FERTIGATION

Nitrogen (N) is an essential nutrient that greatly contributes to the economic viability of irrigated potato production. The nitrate form of N can leach into groundwater if it's not managed properly.

Nitrogen management considerations for irrigated potatoes include:

- N rate
- Timing of N application
- Sources of N
- Use of diagnostic procedures to determine N needs during the growing season
- Effective water management
- Establishment of a cover crop after harvest

1. Effect of a controlled release N source on potato (Russet Burbank) yield.[1]

N rate[1]	N source			
	Urea	ESN[2]	Urea	ESN[2]
	Total yield		Marketable yield	
lb N/A (kg/ha)*	cwt/A (kg/ha)*			
80 (90)	643 (72.1)	679 (76.1)	499 (55.9)	526 (59.0)
160 (179)	698 (78.2)	695 (77.9)	579 (64.9)	582 (65.2)
240 (269)	676 (75.8)	677 (75.9)	583 (65.3)	560 (62.8)
320 (359)	660 (74.0)	625 (70.1)	576 (64.6)	519 (58.2)
240 (269) (ESN emergence)	-	737 (82.6)	-	631 (70.7)

[1]All treatments received 40lb N/A from diammonium phosphate at planting.
[2]ESN was applied at planting, except for the second 240lb N/A rate which was applied at emergence.

*Metric conversions are not representative of this study.

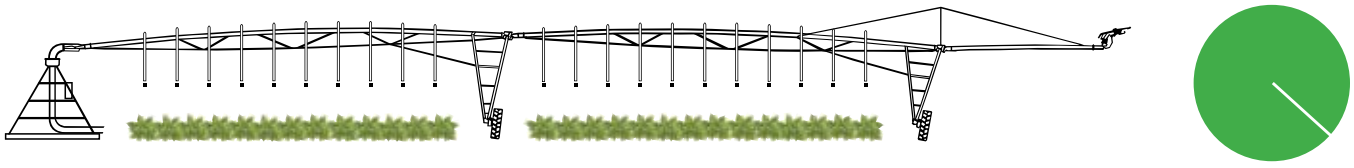
2. Potato yields affected by N management[2]

N	Treatment	Fresh Wt. 3+ oz. size	
		1991	1992
lbs/A (kg/ha)*		cwt/A (mg/ha)*	
0	0	282 (316)	240 (269)
120 (135)	40,40,40 (45,45,45)	403 (452)	427 (479)
160 (179)	80,80,0 (89.5,89.5,0)	381 (427)	455 (510)
240 (269)	0,120,120 (0,134.5,134.5)	411 (460)	538 (603)
240 (269)	40,100,100 (69,100,100)	421 (472)	505 (566)
240 (269)	80,80,80 (89.7,89.7,89.7)	411 (460)	516 (578)
240 (269)	120,60,60 (134.5,67.25,67.25)	401 (449)	481 (539)
200 (224)	40,40,40,40+40 (49,49,49+49)	435 (489)	455 (510)
Leaching	**+5" June (12.7cm)**	**4 rains**	**none**

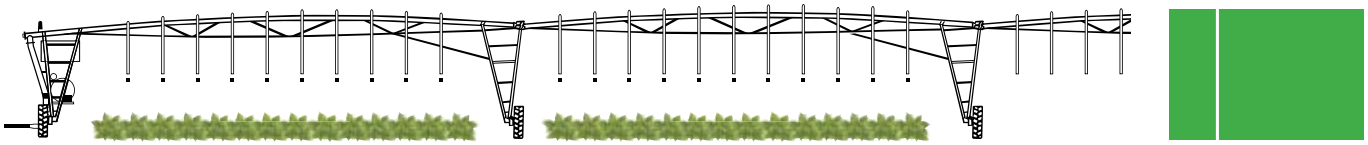
N splits – starter, emergence, hilling, post hilling, w/sap test
Source: Rosen, 1991 and 1992, University of Minnesota Soil Science Series

EFFICIENT APPLICATION FOR HIGHER TUBER YIELDS

Zimmatic Center Pivot Irrigation – Custom-fit your irrigation system to your fields for uniform application.



Zimmatic Lateral Irrigation – Irrigate 98% of square or rectangular fields, and tow your irrigation system between fields.



Why pivots/laterals?

Pivot/lateral irrigation systems – right amount, right time, right place

Applying the correct amount of water at the right time is crucial to getting a good yield, but it's also important to apply it uniformly. Surface irrigation systems fall short in this area, but pivot systems apply water evenly throughout the potato field.

References

[1] *Best Management Practices for Nitrogen Use: Irrigated Potatoes* – #08559, University of Minnesota Extension, 2008.

[2] Jerry Wright, Fred Bergsrud, George Rehm, Gary Malzer and Bruce Montgomery, *Nitrogen Application with Irrigation Water – Chemigation*, University of Minnesota Extension, 2002.

[3] Freddie Lamm, Daniel O'Brien, Danny Rodgers, Troy Dumler, *Sensitivity of Center Pivot Sprinkler and SDI Economic Comparisons* American Society of Agricultural Engineers (ASAE) Meeting Paper #MC02-201, 4/2002.

[4] *Economics of Irrigation Systems* – B-6113, Texas Cooperative Extension, Texas A&M University, 12/2001.

Pivots/laterals v. flood irrigation

Less waste

The most obvious benefit to irrigating with a pivot or lateral system is that it produces less waste. You get even, precise water application across the rows (Figure A), rather than having too much water at the upper end, and not enough water at the other end of the field (Figure B). You won't lose water to evaporation, and you can control the timing and amount of water that is applied. There's also less runoff, helping prevent contamination of the water table and nearby streams.

Figure A
Pivot/lateral irrigation

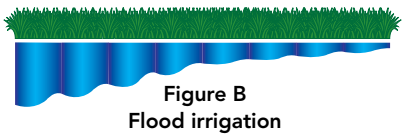


Figure B
Flood irrigation

Lower labor costs

The Zimmatic irrigation system by Lindsay is automated, so no one has to move pipes, or open and close floodgates. There are no ditches to maintain for pivots. One technician can operate as many as 25 pivots. Plus, remote control and monitoring options are available.

Higher return on investment

The long life of a pivot or lateral system will save you money year after year. You'll use less water, reducing your energy costs. A Zimmatic pivot or lateral system also applies chemicals and fertilizers evenly, accurately and inexpensively. All this adds up to consistently higher yields.

Pivots/laterals v. drip

Better return on investment

A pivot or lateral system costs less per acre (hectare) to install. For example, a Subsurface Drip Irrigation (SDI) system costs over 200% more than a pivot system to install on 125 acres (50 hectares).[3] On larger fields, the cost difference is even greater. The irrigation efficiency is similar with use of drops and LEPA nozzles (95% v. 97%).[4] And if you ever want to sell, there's a higher resale value on a pivot/lateral system, too.

Fewer maintenance hassles and labor costs

Compared to an SDI system, maintenance is extremely simple for pivot and lateral systems. There is no emitter clogging, and no filter maintenance – it requires only a screened intake. Rodents, roots and cultivation equipment won't damage your system. Even algae and chemicals aren't issues.

More benefits for you and your environment

You can monitor and control your pivot/lateral irrigation system remotely. You can quickly apply water after seeding and as often as needed after that. It's also easier on your field. When you want to remove your equipment, you won't have to remove and replace damaged or deteriorated SDI tape. Not to mention the fact that pivot systems are nearly 95% recyclable.

Why Lindsay?

Tough, dependable Lindsay irrigation systems have been the choice of the world's irrigators for more than 30 years. Lindsay irrigation systems pay for themselves many times over during their lifespan, and alleviate risk when weather conditions are not ideal for planting and growing conditions.

Yields: *maximized*

A Lindsay irrigation system can provide proper application to every part of a field throughout the growing season, even in those areas that are currently underutilized. Only Lindsay offers powerful, easy-to-use GrowSmart™ irrigation management products.

Time and labor: *saved*

When compared with other irrigation methods, a Lindsay system will help maximize the efficiency of both time and labor.

Flexible, intuitive GrowSmart irrigation control products make scheduling and operation simple.

Application: *precision*

GrowSmart's Hydra Inject chemical injection series offers effortless control and setup, pulse-free flow for precise adjustment of injection rates, and built-in safety features for reliable and accurate performance.

Downtime: *minimized*

Lindsay irrigation systems are designed and engineered for life on the farm. They're constructed using only the highest quality components for superior performance season after season.

Support: *certified*

Our network of certified dealers is trained to customize, install and service our entire range of irrigation systems.

Superior components built to last

Exclusive collector ring

Eliminates water flow restrictions, unlike internal design of other pivots.

Formed outlets

Ensures precisely matched threads for a watertight seal, unlike welded outlets that can leak on other pivot brands.

Uni-Knuckle span connector joint

Provides stress-free flexibility to handle uneven terrain and on slopes up to 30%.

Advanced drive line (center drive and PowerDrive gearbox)

Assures long life and durable operation in demanding potato applications, characterized by thick and damp foliage.

Poly-lined pipe

Heavy-duty High Density Polyethylene (H.D.P.E.) handles corrosive elements, saline and acidic water.

Horizontal pump station

Vertical pump station

Watertronics – Customized pump stations

Watertronics, a subsidiary of Lindsay, offers a complete, integrated pump station that helps you maintain consistent water delivery from river stations, irrigation reservoirs, canals and lagoons.

Factory tested, each pump station is engineered based on your needs and field conditions to ensure peak performance.

- All components are integrated and housed in one complete unit
- Precision energy efficiency Variable Frequency Drive provides immediate energy savings
- Simple monitoring and control
- Continuous surge-free pressure regulation for enhanced efficiencies

FieldBASIC

- Sets the standard for manual system control
- Easy-to-understand icons speed and simplify operation
- LEDs provide quick review of system status

FieldVISION

- Easiest to operate
- Unique graphic display provides quick visual status to enhance irrigation management
- Automated area plans save on water, energy and labor
- Accurately adjust water application depths by selecting from a customized list
- History log tracks water usage and pivot performance

FieldBOSS

- Most powerful, programmable and expandable
- Versatile operation in automated or manual mode
- Step-by-step planning options help you save water, labor and energy
- More memory than most other control panels

FieldNET™

Real-time, Web-based irrigation management

- Networks all of your pivots, no matter what brand – and gives you access and control from any computer or phone
- The user-friendly Web portal lets you configure irrigation requirements and make adjustments quickly and easily
- Precise application of water for maximum efficiency
- Text message alerts keep you updated on pivot status

Resource Management

- Soil moisture sensors optimize water, fertilizer and energy use
- Chemical injection systems improve application of fertilizers and chemicals

Offered by an international leader

Lindsay has a worldwide dealer network, factories in the United States, Brazil, France, and South Africa, and additional sales offices in Australia, China, Egypt, Guatemala and Mexico.

Lindsay has installed potato projects in Latin America, China, Europe, Africa, Australia and New Zealand. We can coordinate a variety of resources to implement turnkey irrigation systems wherever they're needed.

For more information, visit www.zimmatic.com or talk to your Lindsay dealer.

LINDSAY™

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