NEBRASKA POTATO EYES

Technical News Reports for the Nebraska Potato Industry

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Alexander D. Pavlista, Editor
Extension Potato Specialist

Editor's Note

Last December (1993) The Nebraska Potato Focus was held at Scottsbluff where over 90 people attended. The topics were weeds and herbicides and there was a special presentation on late blight by Dr. Gary Franc (Univ. of Wyoming). The reports will be mailed to all the attendees in July. The next conference is scheduled for December 8 and 9, 1994 and the main focus is IRRIGATION. Areas will be irrigation scheduling for potatoes, disease control, chemigation, ground water and equipment. Tentatively speakers will be from the Univ. Wisconsin, Colorado State Univ., Univ. Wyoming, Univ. Nebraska, and Lockwood Corp. A tour of Lockwood's irrigation pipe production is expected. More information is forthcoming.

In March, the High Plains Potato Late Blight Seminar was held at Scottsbluff. Over 70 people attended this one day intensive conference on late blight. Speakers were Duane Preston (N. Dakota St. Univ.), Gary Franc (Univ. Wyoming), Dave Hankey (grower in the Red River Valley) and Tom Harris (Ciba Co.). A panel discussion followed these presentations. Many have asked me for transcripts, tapes etc. The next issue of the Nebraska Potato Eyes is planned to be targeted at late blight and an edited, scaled-down version of the tape transcripts will be printed.

The 1993 potato chip sales show a 4% growth in dollars and a 1.9% growth in volume. Jack Nielsen is Nebraska's representative on the National Potato Board and will serve until 1995.

The EPA's "How to Comply" manual for Worker Protection Standards is available directly from ICCS Publication for $4.00.

The New England Journal of Medicine reported recently that consumption of cauliflower, potatoes, peppers, tomatoes, et al. Produce increased levels of nicotine in people. For example an 8 oz. ripe tomato from the garden will result in the ingestion of one mgm of nicotine, equivalent to the absorption of nicotine from sitting in a tobacco smoke-filled room for three hours. Question — In the second-hand smoke studies conducted by the government, were the people screened on their food consumption prior to sampling? (I heard that Russ Limbaugh had a ball with this one).

No Pesticide: A Boon?

Alex Pavlista
Extension Potato Specialist
University of Nebraska

A recent Farm Bureau study presented the effects of a 50% reduction and zero-use (elimination) on vegetable and fruit productivity in the USA. Potato production was studied in Idaho, Maine and North Dakota. According to this study, a 50% reduction in the use of pesticides on potatoes would result in a 27% loss in yield. The elimination of pesticides on potatoes in Maine would terminate production in that state. The drastic reduction or elimination of pesticide use would have the following consequences:

Yield Decreases	Quality Decreases
Cost Increases	Price Increases
Land Use Increases	Irrigation Increases
Smaller Farms Decline	Trade Imbalances Develop

TABLE. Percent changes in yield due to lower pesticide use.

Potato:	50% USE REDUCTION	ZERO-USE ELIMINATION
IDAHO	- 27% [loss]	- 57% [loss]
MAINE	- 70% [loss]	- 100% [wipe-out]
N.DAKOTA	- 35% [loss]	- 65% [loss]
Study Total*:	**- 37%**	**- 70%**

* apples (MI,WA); grapes (CA,NY); lettuce (CA); onions (CA,ID,TX); oranges (CA,FL); peaches (CA,GA); potatoes (ID,ME,ND); sweet corn (FL,WI), and tomatoes (CA,FL).

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CULTIVARS: SNOWDEN

Stanlet J. Peloquin and Christian Thill
Plant Breeders
University of Wisconsin, Madison, WI

Alexander D. Pavlista
Extension Potato Specialist
University of Nebraska, Scottsbluff, NE

The official release of SNOWDEN by the University of Wisconsin is still pending but, due to its rapid popularity, it will be described here. This cultivar is designated for the potato chip market. SNOWDEN (W 855) was selected in the late 1970s in Wisconsin from a cross between Wischip and B5141-6, and named in 1990. Selection and early testing was done by Dr. Stan Peloquin and Mr. Donald Kichefski at the UW-Lelah Starks Potato Breeding Farm, Rhinelander, WI. In 1993, 7,230 acres of certified seed were grown nationwide ranking eighth in acreage; a fourth (1730) of this acreage was in Nebraska, second to Wisconsin (Figure). It has been field tested for two years in the North Central Regional Trials, three years in the Snack Foods Assoc. Potato Chip Trials, seven years in the Wisconsin trials, two years in Michigan, and five years in Nebraska. In the North Central Trials, SNOWDEN was ranked 4th and 2nd best overall entry in 1988 and 1989, respectively. It is very much like Atlantic except that it chips out of 45F storage without reconditioning (Table 3).

Summary of Properties:
Purpose — Potato Chips
Maturity — medium-late, later than Atlantic
Emergence — emergence
Vine — erect, medium; closes rows later than Atlantic
Leaves — light green
Flowers — few per cluster, white with yellow anthers; tend to abort; male sterility common, fruit rarely develop
Eyes — medium, deeper at apical end; uniformly distributed
Tuber — white flesh; light tan skin, slightly netted; oval to round shape
Set — high; space further apart than Atlantic
Dormancy — medium
Yield — slightly less than Atlantic
Specific Gravity — same as Atlantic
Sugar — same as Atlantic; stores better; glucose = 0.1% and SR value = 0.4 to 0.75 (0.5 to 0.6 for Atlantic)
Chip Color — very light out of the field; can store to May at 45F and chip light without reconditioning; chips out of 45F like Atlantic out of 50F
Tuber discoloration - none
Bruising — not a problem
External Defects — none; smooth and uniform
Internal Defects — none
Disease — susceptible to early blight and common scab
Herbicide Sensitivity — metribuzin (preliminary data): less sensitive than most chipping cultivars such as Atlantic and Norchip
Fertilization — responds very well to higher levels of nitrogen
Irrigation — responds very well to added moisture

For all tables, numbers followed by the same upper-case and lower-case letters are not different at the 95 and 90% levels, respectively; if not followed by a letter than data are not significantly different at the 90% level.

Table 1. Performance of SNOWDEN in the North Central Region and Snack Foods Assoc. Trials.

Cultivar	US#1 Yield cwt/acre	Specific Gravity	Chip Color (1)
I. North Central Region Potato Trials (means of 2 years, 1988-89):			
SNOWDEN	259	1.080	54
Norchip	233	1.075	51
II. Snack Foods Assoc. Potato Chip Trials (means of 3 years, 1988-90):			
SNOWDEN	219b	1.085B	59
Atlantic	259a	1.090A	58
Norchip	210b	1.080C	58

(1) Agtron scale: excellent = >60, acceptable = 56 to 60, marginal = 50 to 55, and rejected = <50.

Table 2. Performance of SNOWDEN at the Hancock Research Station in Wisconsin, means of 7 trials in 7 years (1985-1991). [communicated by David Curwen]

Cultivar	US#1 Yield cwt/acre	Percent Solids	Chip Color (1)
SNOWDEN	589A	20.5A	3.4A
Atlantic	548B	20.2A	4.4B
Norchip	475C	18.6B	4.7A

(1) Scale is 1 (light) to 10 (dark); 4 is acceptable, chipped after 50 days storage at 50F.

Table 3. Performance of SNOWDEN at the Montcalm Research Farm in Michigan, means of 2 trials in 2 years (1988-89). [communicated by Richard Chase]

Cultivar	US#1 Yield cwt/acre	Specific Gravity	Chip Color (1) (out of field)
SNOWDEN	424	1.081	77
Atlantic	412	1.083	70
Norchip	324	1.074	65

	Chip Color (1) after 130 days storage at 50F	45F	45F plus 20 days reconditioning
SNOWDEN	64	61	66
Atlantic	67	48	60
Norchip	60	49	52

(1) Agtron scale: excellent = >60, acceptable = 56 to 60, marginal = 50 to 55, and rejected = <50.

The June 94 issue of the New York Times reported that a Dutch company is testing potato starch as a filler in breast implants.

Table 4. Performance of SNOWDEN in Nebraska, means of 11 trials over 5 years and 4 locations (1989-1993). [communicated by Alexander Pavlista]

Cultivar	US#1 Yield cwt/acre	Specific Gravity	Chip Color (1) P-C	50F	45F
SNOWDEN	313B	1.090A	64A	63	64a
Atlantic	376A	1.093A	61AB	62	59ab
Monona	312B	1.072C	57BC	62	57ab
Norchip	303B	1.082B	56C	60	53b

Note plant spacing was 9 to 10 inches.
(1) Agtron readings, refer to Table 3. P-C = after 3 weeks pre-conditioning, 50F = preconditioned and stored for 3 to 5 months at 50F, 45F = same as 50F but storage was at 45F. No reconditioning occurred. Data on P-C were means of eight trials over 3 years and 4 locations; Data on stored tubers (50F and 45F) were means of 4 trials over 2 years and 2 locations.

Table 5. Management profile, response to nitrogen and plant spacing, of SNOWDEN in Michigan Studies, 1989. (communicated by Richard Chase)

I. US#1 yield (cwt/acre) for combinations of nitrogen (lb/acre) and plant spacings (inches):

Nitrogen	9 in.	12 in.	15 in.
100 lb/ac	295E	323DE	343CD
150 lb/ac	360CD	388BC	425AB
200 lb/ac	425AB	428AB	445A

II. Effect of nitrogen rate, all spacings combined:

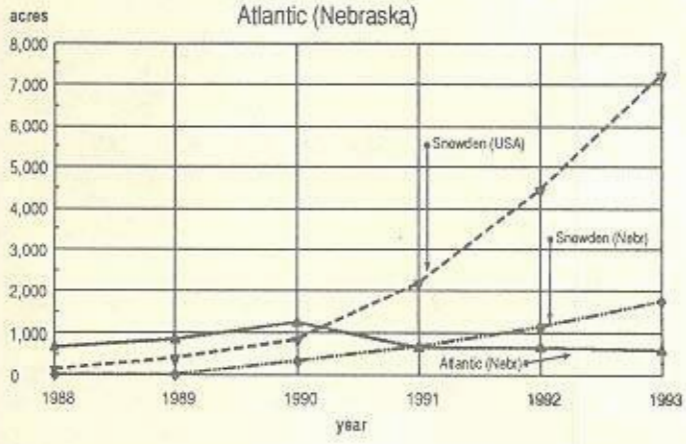
N rate (lb/acre)	US#1 Yield cwt/acre	Specific Gravity	Petiole Nitrogen (%)
100	320C	1.082B	2.0C
150	392B	1.085A	2.4B
200	432A	1.085A	3.4A

III. Effects of plant spacings, all nitrogen rates combined:

spacing (inch)	US#1 Yield cwt/acre	Specific Gravity	Petiole Nitrogen (%)
9	360B	1.084	2.6
12	379AB	1.085	2.5
15	406A	1.084	2.6

Certified seed acreage of

Snowden (USA and Nebraska)
Atlantic (Nebraska)



North Central Regional Potato Variety Trials

Gary A. Secor
Professor / Plant Pathologist
North Dakota State University, Fargo, ND

Alexander D. Pavlista
Assoc. Prof. / Extension Potato Specialist
University of Nebraska, Scottsbluff, NE

The 43nd year (1993) of the NCR Potato Variety Trial was conducted in 10 states and three provinces. Four of the 13 trial sites were lost due to the flooding, and one trial was lost due to frozen seed. Norqueen (ND671-4Russ) and AC Ptarmigon (F76080) are 1993-released cultivars which have been in these trials. Days from planting to harvest ranged from 96 in Iowa to 147 in Ohio and Wisconsin. In Nebraska planting was on 5/14 and harvest on 9/21/93 for 130 total days.

Environmental Conditions — Most trials were conducted on lighter sandy loam. Some trials were irrigated. In the northern states including Nebraska and the provinces, the weather was relatively cool and wet. Flooding was a problem in Indiana, Louisiana, South Dakota, and Manitoba. Late was observed in some areas.

Yields — Red Pontiac and ND 1871-3R had the highest yields. Other high yielding varieties were MN 15220 and Russet Burbank. The lowest yields were from W 84-75R. W 84-75R and Russet Burbank had the lowest percent US#1 and Norland had the lowest.

Maturity — Norland was the earliest maturing entry. Russet Burbank was the latest.

Total Dry Matter — ND 2471-8, ND 2417-6 and Norchip (all whites) had the highest percent dry matter (total solids), and Norland, Red Poniac and MN 15220 (reds and a purple) had the lowest.

Chip Color — ND 2471-8 and ND 2417-6 (all whites) appeared to be the best chippers.

Scab — Minnesota and Nebraska had the highest incidence of common scab. Scab was more prevalent in the white entries, Norchip and ND 2471-8, the red entries, Red Pontiac and W 1100R, and the russet entry, W 1099. The NCR Committee has decided to discontinue scab readings in the 1994 trial.

Grade Defects — Russet Burbank had the most tubers with off-shape and second growths, 22.1%; MN 15220 had the second highest at 10.8% of the tubers. Norchip and ND 2417-6 had the most sun-green tubers, 8.2 and 7.5%, respectively. The highest amount of hollow heart was observed in ND 2471-8 (9.3%), Russet Burbank (8.0%), and Red Pontiac (5.3%). Norchip and Red Pontiac had the most internal necrosis, 7.1 and 5.0%, respectively.

Overall Merit Ratings — The following table shows the cumulative ratings of the top entries and their previous merit ratings. Note, higher ratings indicate greater relative merit.

Table: Total Merit Ratings of Entries

Entry	Type	1991	1992	1993
W 1100R	red	—	10	21
ND 2417-8	white	—	—	17
ND 2471-6	white	—	—	17
ND 1871-3R	red	21	32	15*
MN 15111	white	—	—	14*
W 1099	russet	—	—	11*

* rated in Nebraska's trial; refer to NPE v5,i3 pp.7-8.

Table: Data averages of entries in the 1993 North Central Regional Potato Variety Trials

Entry	Total yield cwt/ac	US # 1 yield cwt/ac	Maturity	Total solids %	Merit points
red/purple:					
MN 15220 (p)	388	324	4.1	17.1	0
ND 1871-3R	393	332	3.7	17.7	15
W 1100R	375	306	2.9	17.9	21
W 84-75R	198	120	3.3	18.1	0
Norland	328	289	1.3	17.2	5
Red Pontiac	393	333	3.6	16.9	0
Russet:					
W 1099	321	279	3.1	18.3	11
R. Norkotah	318	261	2.3	18.8	4
R. Burbank	379	263	4.9	19.5	2
White:					
MN 13540	323	306	3.5	18.4	7
MN 15111	314	313	3.6	18.6	14
ND 2417-6	326	261	3.2	20.2	17
ND 2471-8	351	294	2.5	21.3	17
Norchip	340	282	2.5	20.2	2
Means:	339	283	3.2	18.6	--

*1= very early (Norland), 3 = medium (Red Pontiac), 5 = very late (Russet Burbank)

Potato Association America Meetings

Alexander D. Pavlista
Extension Potato Specialist
University of Nebraska, Scottsbluff, NE

The 77th annual meeting of the Potato Association of America was held at Madison, WI on August 8-12, 1993. The following are a few interesting tidbits that I came across.

The potato varieties Gemchip, Chipeta, Shepody, and Ranger Russet show resistance to early dying. There was no correlation between resistance or susceptibility to early dying, Verticillium wilt, and yield potential. The first selection criteria for early dying resistance should be yield production in infected fields. (D. Corsini)

In both field and greenhouse tests on Russet Burbank, *Verticillium tricorpus* reduced the incidence of Verticillium wilt and suppressed colonization of stems by *Verticillium dahliae*, the causal agent of Verticillium wilt. *V. tricorpus* is mildly pathogenic itself. It had no effect on total yield over a three-year period but did decrease yield of US #1 tubers by increasing the percent of malformed tubers. As a biocontrol agent, *Verticillium tricorpus* is not very exciting. (J. Davis)

Atlantic potatoes were grown in soils containing potassium (K) ranging from 90 lb/acre (low) to 300 lb/acre (moderate). The fields were split and additional K was added at the rate of 0, 120, and 240 lb/acre and studied over a three period. Yields increased in all three years. Even fields with a moderate amount of K showed a yield response to 120 lb K/acre. Plants grown on low K-containing soil without added K were stunted and blue-green in color with bronzed leaf margins. As yield increased about 15%, there was also a drop in specific gravity, about 0.005 for each 120 lb K/acre. This was a response to added K and not to soil K. Chip color improved slightly with added K. Leaf K levels at flowering changed with soil and added K. If leaf K levels were below 3.5% at flowering, yields were limited by the available K. If leaf K levels were greater than 3.5 to 4.0%, then specific gravity was reduced with no increase in yields. (G. Porter)

A large number of Russett Burbank lines were developed by being genetically transformed for enhanced starch synthesis. The lines were field tested in 1991 and 1992 using plantlets which gave broad yields. These showed higher dry matter content (solids, specific gravity) than the non-transformed controls. The range of increase in specific gravity was 0.005 to 0.010. Also observed were lower plant vigor and slight reduction in yield of quality tubers. The sort outs were primarily due to off-types. (M. Thornton)

From field trials on several varieties and clones, yield response to herbicide application was not consistent or correlated with foliar injury. There was greater yield decreases and lesser foliar injury from Prowl than from Sencor. (R. Thornton)

CIPC (chlorpropham) was applied at maximum labeled rate to Russet Burbank in storage. The potatoes were to be used for both processing and fresh market and residue of CIPC were measured in tubers stored under commercial conditions as well as at the storage research facility at Kimberly, ID. Some of the conclusions from this study are: 1. All residue levels were within the EPA-established tolerance range. 2. CIPC levels were higher at 40 than 45 F. 3. The level was higher at the bottom versus the top of the potato pile. 4. The level was higher further from the fan (injection point) than closer. (M. Lewis)

Atlantic potatoes were ventilated for 12 hours with air containing ethanol, held at 40 F for four weeks and then chipped. Chip color from ethanol exposed tubers was lighter than untreated tubers stored at 40 F and approaching the color of those held at 70 F for the same time period (4 wks). (M. Henninger)

Tour of Hancock Agricultural Research Station, University of Wisconsin.

In 1992, Wisconsin ranked highest in total acreage for processed vegetables in the USA. Potatoes account for about a third of the value of vegetable receipts. In 1992, over 25 million cwts were produced. In 1990, the per acre value of potatoes in WI was $1,935 compared to $1,374 for

pickles, $546 for snap beans, $386 for sweet corn, $260 for field corn, $230 for soybeans, and $74 for oats.

At the Hancock Ag. Res. Station, there are 412 acres dedicated to research on irrigated vegetables. It was established in 1916 with 95 acres in the Central Sands region of Wisconsin. About 3/4 of the potato crop in the state are produced in the Central Sands. Over 40 researchers are working on 120 projects at the Station in 1993. Potato research accounts for over 43 acres of the plot area.

Wisconsin's Potato Acreage, Yield and Production

Year	Acres Harvested (In thousands)	Yield/acre (In cwt)	Production, cwt (In millions)
1988	62.5	320	20.0
1989	68.0	340	23.1
1990	65.0	355	23.1
1991	66.5	350	23.3
1992	68.0	370	25.2

Potato Research Symposium

Alexander D. Pavlista
Extension Potato Specialist
University of Nebraska, Scottsbluff, NE

In April 1994, Zeneca Ag Products sponsored the second Potato Researcher's Symposium in San Francisco, California. It was well attended by researchers from across the USA and Canada, all of whom were invited. A proceedings of the meeting will be issued probably in the fall and will be available in the library here at the PREC.

State/Regional Reports

Colorado (R. Zink) — Potato acreage in 1993 increased to 73,000 and is expected to increase another 10% in 1994. The top variety is Centennial (38%) followed by Russet Norkotah (24%), Russet Nugget (12%), Sangre (8%), and Russet Burbank (3%). The use of sulfuric acid in vine desiccation is increasing; about a third of the acreage was treated. Vine desiccation with Diquat accounts for another third.

Idaho (P. Nolte/P. Patterson) — In 1993, Idaho had the third largest acreage in its history and, in 1994, is expected to have close to 400,000 acres in potatoes. Averaged over the past 10 years, there has been a 10% increase per year. Yield per acre has increased from 276 cwt/ac in 1983 to 313 in 1993, a 13% increase. The top variety is Russet Burbank; Shepody and Ranger Russet are increasing are stars of the future; Russet Norkotah has levelled in acreage. French fry processing accounts for 58% of the production; 26% for the fresh market, and 6% for seed.

Nebraska (A. Pavlista) — Potato acreage has expanded 70% since 1988, from under 10,000 to 17,000 anticipated in 1994 (Figure). Expansion in 1993 and 1994 is in both the fresh market and chipping potatoes. Atlantic remains the most popular chip variety but Snowden is gaining rapidly. Chipeta is also of interest. Russet Norkotah is replacing Norgold Russet and Ranger Russet is gaining popularity. Russet Burbank and Shepody are doing well in the Northcentral Nebraska.

Prairie Provinces (M. Pritchard) — Manitoba grows 50,000 acres of potatoes and is increasing; Alberta grows 30,000 acres which are mostly for seed shipped to Mexico; Saskatchewan grows 5,000 acres for fresh and seed markets.

Oregon (S. James) — Russet Burbank acreage is decreasing while Shepody, Russet Norkotah and Ranger Russet are increasing.

Ontario (S. Squire) — Potato acreage is about 35,000, of which seed accounts about 19,000 and chips about 14,000 acres. The main varieties are Superior, Shepody, Atlantic, and Frito-Lay numbers.

Red River Valley (D. Preston) — In 1927, Minnesota had the largest production of the nation with 400,000 acres; in 1993, it accounts 55,000 acres. In 1994, chip acreage was cut but replaced with an increase french fry acreage. Norchip acreage has dropped and Itasca is replacing Kennebec. The Red River Valley is increasing in irrigated acreage and Snowden is gaining in popularity. There is a need for a dry-land chipper and a long storing red variety.

Washington (G. Peltar) — In 1993, the state's record was passed with 150,000 acres and an average yield of 370 cwt/acre. There was an increase in leafroll virus and net necrosis, late blight, hollow heart and bruising. Russet Burbank still is the dominant variety with 69% of the acreage but has decreased since 1988 (79% of the acreage). Russet Norkotah, Ranger Russet and Shepody are increasing.

Symposia Notes

Physiological Seed Age (E. Plissey) — Apical sprouting with a strong apical dominance characterizes "young" seed; multiple sprouting indicates "middle-aged" seed; multiple hairy sprouts mean "old" seed, and the "little tuber syndrom" identifies "very old" seed. To determine the age of the seed, place seed tubers for one week at 50F and look for sprouting. Young seed can become old by 1. hot, dry weather, 2. stress, 3. high storage temperature, 4. de-sprouting, and 5. cutting. Develpmental differences between young and old seed exists (Table).

Table: Some characteristics of young versus old potato seed.

	Young Seed	Old Seed
Emergence	late	early
Stem Number	few	many
Tuber Initiation	late	early
Tuber Set	few	many
Tuber Size	large	small
Senescence	late	early

Large Seed Tubers (M. Thornton) — Advantages to large seed tubers are less cost, less likely from weak or stressed plants, lesslikely to be immature, and more seed treatment on pieces. Disadvantages are more blind pieces when cut, increased cut surface therefore more likely to decay, more likely to bruise, and more oversize pieces. There were no consistent differences in the performances, yield and specific gravity, between uncut, single-cut and double-cut seed pieces.

Seed Sanitation (P. Nolte) — Hyamine is being dropped from potato sanitation; "it's history." It currently has a Section 4 for label under the IR-4 Program. Precision Bin Disinfectant, a quartenary ammonium from Simplot, is legal only in Idaho. PQ 57, a copper quinolinate, is an

expensive wood perservative. Tclor is 10% sodium hypochlorite, bleach, with acetic acid; it's cheap but very hard to find. Not very good news here.

World Potato Production

Alexander D. Pavlista
Extension Potato Specialist
University of Nebraska, Scottsbluff, NE

The five major crops in the world in order are wheat, rice, corn, potatoes, soybeans. Although potatoes are still considered minor in the U.S.A. is major world-wide. With political changes in some important potato growing countries, protection of intellectual property, e.g. patents, may become a reality. With recognition of this legal protection, the agchemical industry could feel that the market for potato medicine will be sufficiently expanded to warrant work on potatoes as a major crop for research and development. The following table compares potato production is million cwts (hundred weights) for the 14 largest potato-producing countries in the five-year periods of 1982-86 and 1987-91. The six countries showing production gains are India, Turkey, China (People's Republic of China), the Netherlands, the United States of America and Canada; all the rest are losing production. The six countries with a 5% decrease or greater in production are Russia, Poland, Germany, France, Spain, and Czechoslovakia. Some interesting changes are projected from this comparison. 1. China will replace Poland as the second largest potato producing country. 2. India's production will be in the top five and be about the same as the U.S.A.; Germany (east and west combined) will drop to sixth. 3. Turkey will be in the top ten displacing Spain and catching up to France. 4. Canada will move into 13th position.

Table: World potato production and ranking of top countries.

Country by 87-91 Rank	Production Millions CWT 1987-91	Percent Change from 82-86	Projected Ranking * 1992-97
RUSSIA	1,492	(17)	1
POLAND	751	(5)	3
CHINA [PRC]	690	+18	2
USA	387	+ 7	4-5
GERMANY [E&W]	324	(18)	6
INDIA	315	+30	4-5
NETHERLANDS	153	+ 8	7
UK	146	(1)	8
FRANCE	140	(8)	9
SPAIN	115	(5)	11
TURKEY	95	+25	10
JAPAN	82	(1)	12
CZECHOSLOVAKIA	67	(14)	14
CANADA	63	+ 3	13
all others	1,113	+ 1	—
world	5,932	(3)	—

( ) decrease; + increase.
* based on the comparison of 1987-91 with 1982-86.

Ag Chemical Usage Survey

Alexander D. Pavlista
Extension Potato Specialist
University of Nebraska, Scottsbluff, NE

The information reported here is a compilation of 1,411 sample surveys conducted during the 1992 crop year. Fall season potato data were collected in eleven states — CO, ID, ME, MI, MN, ND, NY, OR, PA, WA, and WI. The US acreage included was 94% of the US fall potato acreage or a total of 1.07 million acres.

Nitrogen was applied to over 99 percent of the fall season potato acres in the 11 states surveyed. The amount of N applied ranged from a low of 90 lb/acre in North Dakota to a high of 308 lb/acre in Washington. Producers in the surveyed states averaged over two applications of nitrogen. Phosphate was as widely used. North Dakota and Minnesota applied the smallest amount per acre, 66 and 81 lb, respectively; Washington applied the most, 246 lb P/acre. The smallest number of applications was reported in New York, while the largest number of applications was reported in Oregon. Potash was applied to 88 percent of the acres in the 11 states surveyed. In Colorado, 79% of the acreage was treated with K and, in North Dakota, only 76 lb K/acre was applied, just under the 77 lb/acre applied in Colorado. Wisconsin applied the most potash at 301 lb/acre and is the only state to average more than two applications.

Herbicide use ranged from 42 percent of the acres treated in North Dakota to 99 percent of the acreage in Maine. Insecticide use was lowest in Colorado where 76 percent of the acreage was treated. Producers in all of the other states applied insecticides to 85 percent or more of the potato acreage. The number of treatments and application rates varied greatly between states. Acres treated with fungicides ranged from 39 percent in Idaho to 99 percent in Michigan. Information on 12 different herbicides, 28 insecticides, 15 fungicides, 4 desiccants, 2 soil fumigants, and 2 growth regulators was collected in the survey.

This survey is being updated in 1993. Potato growers in Nebraska were asked to participate and be included.

Table 1. Percent of acres treated with the ten most used pesticides by active ingredient, 1991 compared to 1990.

Active Ingred.	% Acres 1990	1991	1992	Product(s)	Type
metribuzin	62	60	66	Sencor/Lexone	herbicide
mancozeb	26	32	41	Several	fungicide
phorate	31	33	29	Thimet	insecticide
EPTC	29	30	26	Eptam	herbicide
diquat	23	26	26	Diquat	desiccant
chlorothalonil	23	16	26	Bravo	fungicide
methamidophor	20	23	23	Monitor	insecticide
esfenvalerate	20	29	21	Asana/Pydrin	insecticide
pendimethalin	13	17	17	Prowl	herbicide
carbofuran	14	13	17	Furadan	insecticide

Table 2. Fertilizer use in 1991, eleven states combined, total acreage is 1.13 million.

A.	% Acre applied	# of Application	Rate/applic #/acre	Rate/year #/acre
Nitrogen	99	2.2	92	200
Phosphorous	99	1.4	111	159
Potassium	88	1.3	109	147

B.	Herbicide	Insecticides	Fungicide	Other*
% acreage	81	90	72	43

*Other includes desiccants, fumigants and growth regulators.

Table 3. Vine desiccant use in 1991/1992, % acreage by state.

	Diquat	Paraquat	Dis-l-Cate	Sulfuric Acid
Colorado	52/29	0/0	0/0	29/27
Idaho	3/0	0/0	0/0	8/7
Maine	85/93	0/0	6/8	0/0
Michigan	47/53	0/0	0/0	0/0
Minnesota	32/43	0/0	0/0	13/0
New York	54/43	0/11	0/0	0/0
North Dakota	16/18	0/0	0/0	0/0
Oregon	17/10	0/0	0/0	0/0
Pennsylvania	40/70	0/0	0/0	0/0
Washington	27/15	0/6	0/0	0/0
Wisconsin	57/71	12/11	7/0	0/0

Table 4. Fumigant* and growth regulator** use in 1991/1992, % acreage by state.

	Vapam Busan etc	Telone II	Maleic Hydrazide
Colorado	0/0	0/0	0/0
Idaho	3/3	3/3	3/2
Maine	0/0	0/0	23/16
Michigan	0/0	0/0	0/0
Minnesota	0/0	0/0	0/0
New York	0/0	0/0	0/0
North Dakota	0/0	0/0	0/8
Oregon	18/16	20/20	8/8
Pennsylvania	0/0	0/0	0/14
Washington	35/40	18/33	23/29
Wisconsin	14/9	0/0	7/0

*Chloropicrin was used in 1992 in Washington on 12% of the acreage.
**Cytoknins were also used but there was too few reports to be included.

In the 1992 crop year, the survey also included a list of the ten most frequently reported target pests. Vine desiccation and growth regulation were considered as a target as well. The survey asked what chemical was used for a specific target. The following table lists those chemicals used for a particular target and the percentage of the target use for which the major chemicals are applied.

Table 5. Ten major target uses and the percent of that use for which the major chemicals are applied.

Target	Chemical and percent use
Beetles	Monitor—16%, Asana—9%, Imidan—9%, Thimet--6%
Col. Potato Beetles	Asana—14%, Thiodan—11%, Furadan—9%, Guthion—7%
Green Peach Aphid	Monitor—56%, Thiodan—7%, Thimet—6%, Ambush—5%, Diazinon—4%
Fungi	Bravo—15%, Ridomil—12%, Manzate—10%, Penncozeb—9%, Dithane—9%
Early Blight	Manex—15%, Penncozeb—13%, Bravo—8%, Ridomil MZ—6%
Late Blight	Ridomil MZ—15%, Dithane—19%, Manex—9%, Manzate—8%
Grasses & Weeds	Sencor—41%, Dual—16%, Eptam—11%, Prowl— 9%
Annual Grasses	Sencor—25%, Eptam—17%, Prowl—15%, Dual— 11%
Annual Broadleaves	Sencor—49%, Eptam—15%, Lexone—7%, Prowl— 6%
Vine Desiccants & Growth Regulants	Diquat—71%, Gramoxone—5% Sulfuric acid—5%, CIPC (Super Sprout Stop) — 8%, maleic hydrazide (Royal MN30) — 5%

Nebraska Potato Eyes Survey

Alexander D. Pavlista
Extension Potato Specialist
University of Nebraska, Scottsbluff, NE

In 1992, I conducted a survey principally of Nebraska and Wyoming potato people on the impact of this publication, "Nebraska Potato Eyes" (NPE). Of the 132 people contacted, 47 responded. All respondents felt the articles in NPE to be informative and 46 growers considered them practical (Table 1). Forty-two growers applied the information to their operations. Growers who indicated altering their operations due to NPE identified general operational areas that were altered. These were their perceived benefits. Eighty-three percent (35 growers) indicated that information on pest recognition and control had the most impact (Table 2). The major pest problems were diseases; common scab was mentioned specifically several times. Sixty-nine percent (29 growers) stated that they used the information on cultivars in their practices. Other listed areas were vine desiccation, fertilizer use, tuber handling, planting and harvesting operations, crop rotations, and irrigation scheduling. The growers were asked to grade the importance of different methods of technological transfer. The Nebraska Potato Eyes and the Nebraska Potato Focus were the most important sources of research information (Table 3). They were graded 4.3 and 3.9 on a 5-point scale, respectively. Personalized meetings were also important,

graded 3.2. Magazine articles were graded higher than university publications. Newspapers, television and radio were graded the lowest. Joe Guenthner reported on an extensive survey of Idaho growers in 1989 in which these growers considered contact directly with Extension Potato Specialists as one of the best guides for altering production practices. The mass media was considered one of the least reliable guides.

[Note: This was published as part of a larger article in the J. Nat. Res. Life Sci. Educ. 22:178-179. 1993 and was presented at the Potato Assoc. Amer. meeting in Madison, WI in August, 1993.]

Table 1. Responses of potato growers concerning Nebraska Potato Eyes.

Survey Item	Respondents answering 'yes' percent	number
Have you found the articles in general informative?	100%	47
Have you found the research related articles practical?	98%	46
Have you applied any of the information into your operation?	89%	42

Table 2. Topics listed as having an impact on grower's operation.

Topic	Respondents listing topic percent	number
Pest Recognition and Control	83%	35
Cultivar Releases and Trials	69%	29
Vine Desiccation	40%	17
Fertilization	36%	15
Tuber Management (seed & storage)	31%	13
Planting & Harvesting	14%	6
Crop Rotation	10%	4
Irrigation	10%	4

Table 3. Importance of specific technical-transfer methods used in Nebraska by potato growers.

Educational Method	Importance Grading*
'Nebraska Potato Eyes' (research reports)	4.3
'Nebraska Potato Focus' (annual meeting)	3.9
Personalized, One-on-one Meetings	3.6
Magazine Articles	3.0
'NebGuides' (short, 1-4 page, guides)	2.8
Field Tours	2.5
Extension and Research Circulars (booklets)	2.4
Audio/Video Cassettes (home study materials)	2.2
Newspaper Articles	1.9
Television/Radio	1.2

* 5 = Most Important Grading, 0 = Least Important Grading.

Folicote Use on Potatoes

Alexander D. Pavlista
Extension Potato Specialist
University of Nebraska, Scottsbluff, NE

Folicote is a hydrocarbon paraffin wax emulsion which forms a film coating on the leaf surface. It restricts water loss and lowers the daily water requirement of potatoes and several other crops. Protection against transplant shock in bell peppers, ozone injury in pinto beans and heat necrosis in Atlantic potatoes are other effects of Folicote. Yield increases especially under limited water availability were reported in sorghum, corn and the potato varieties Norgold Russet, Red LaSoda and Russet Burbank.

In reports on potatoes, Folicote was applied to run-off, above 100 gal/acre. Folicote treatments applied to sorghum and corn increase yields with 25 gal/acre. On sorghum, two drop nozzles were used. On corn, the amount of Folicote increasing yield was reduced by half when nozzles were situated to wet the underside of leaves compared to wetting the top only. The effect of Folicote persists for several weeks. Nonionic sticker/spreaders have been added to Folicote in all reported trials on potatoes.

In trials conducted in Western Nebraska from 1989 to 1992, Folicote was applied to Atlantic potatoes in July under semiarid conditions. Lower gallonages and drop nozzles to cover the underside of leaves were used. Corn oil concentrate was compared to X77, a nonionic sticker/spreader, as additives.

The yield of US #1 tubers was significantly increased 10 to 14% by Folicote at 4% (Table 1). Increases of 10 to 15% were primarily in the yield of tubers between 2 1/4 and 3 1/4 inches. Gallonages and additives were not significantly different. Note that, at 20 gal/acre, 6.7 lb Folicote is applied per acre and, at 40 gal/acre, double the amount is applied.

With respect to tuber defects, only hollow heart in tubers > 3 1/4 in was significantly reduced. Folicote at 4% applied at 40 gal/acre reduced the number of tubers with hollow heart in this size class by 30 and 50% depending on the additive; the lower concentration did not affect hollow heart. There was no effect on the degree of hollow heart. In 1989 and 1991, other tuber defects were too few for comparison. In 1990, tuber rots and vascular discoloration appeared in about 10% of tubers, and there was no effect by the treatments. Folicote also did not significantly affect specific gravity nor chip color one month after harvest.

In the Nebraska trials on Atlantic, Folicote was applied between bloom and five weeks before vine desiccation of Atlantic potatoes. In earlier reports, Folicote was applied between bloom to five weeks before desiccation on Norgold Russet, at bloom on Russet Burbank, and six weeks before harvest on Atlantic potatoes. The common factors are application of Folicote under reduced irrigation and/or at the onset of dry, hot weather, and the coating of leaf surfaces in the tuber bulking period.

Several Folicote concentrations have been tested at

different gallonages. Folicote at 4% gave the same effect on yield regardless of gallonage — 20, 40 and 80 gal/acre. The concentration of the wax emulsion seem to play a more important role than the amount sprayed per acre. Folicote at 4% was the most effective treatment at these lower than previously reported gallonages.

Application of 4% Folicote in 40 gal/acre represents an approximate cost to growers of $15/acre with about 10% gain in yield and less hollow heart in large tubers. Increased savings may occur in water usage by irrigation. However, it is important to consider wetting the undersurface of leaves with drop nozzles or high boom pressures, and using surfactants for good leaf coverage. Other wax emulsions have also been reported to reduce transpiration and increase yields of potatoes and the use of wax emulsions does not preclude using other methods of reducing transpiration in potatoes such as stomatal control agents.

Table 1. — Yields of potatoes variety Atlantic after treatment with 4% Folicote during hot, dry spells at tuber bulking, means of five trials over three years.

Gallonage (gal/acre)	Surfactant (0.5%)	Yield by tuber size, cwt/acre >1.88 in	2.25-3.25 in
Check	—	301	220
20	X77	331	243
20	COC	332	251
40	X77	333	244
40	COC	342	253
LSD	(0.05)	17	16

X77 = nonionic sticker/spreader, COC = corn oil concentrate

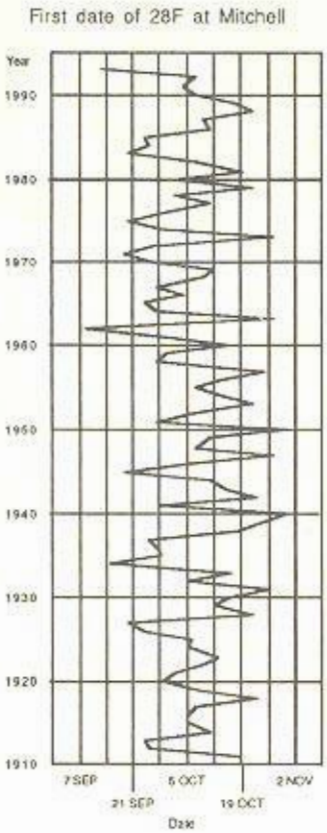
Fall Frost Predictability

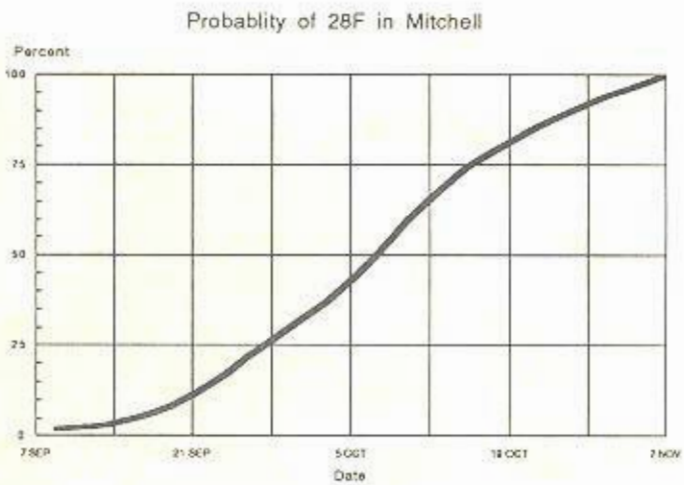
David Nuland and Alexander Pavlista
Extension Horticulturist and Potato Specialist
University of Nebraska, Scottsbluff, NE

Frosts that kill potato vines result from a number of different cold weather conditions. **Radiation** freeze happens during the night when heat is lost from the earth surface into the atmosphere. The last spring and first fall freezes are usually radiation freezes. **Advection** freeze happens when temperature drops below freezing from cold being transported into the area by brisk wind. Black frosts are the common aftermath. **Radiation-Advection** freeze results from cold air being transported into the area during daylight hours, followed by calm conditions favoring radiation freeze at night. This is the most damaging type of freeze. Current freeze classifications are:

Light freeze — 32 to 29° F
Moderate freeze — 28 to 25° F
Severe freeze — 24° F or lower

Once the minimum temperature drops to 28° F, regardless of the type of frost, the growing season for potato vines is terminated. The year to year variability for the first 28° F frost at the University of Nebraska Panhandle Research & Extension Center for the last 83 years is shown in Figure 1. The earliest 28° F frost occurred on 9 SEP 1962 and the latest on 1 NOV 1950, a range of 53 days. In 1993, it was on 13 SEP. A 28° F frost occurred prior to 21 SEP in eight years and six years after 26 OCT. In forty one of the 83 years this frost occurred on or before 6 OCT. From these data, it is virtually impossible to forecast the first 28° F freeze. But there are helpful clues. In Figure 2, the freeze event for each year is dropped to the bottom axis and the number of events for each weekly period tallied, converted to percent values (cumulated years over the 83-year period) each





of which are accumulated by week to form the freeze probability curve. This curve shows that, during the week of 5-12 OCT, there is a 50% probability the vines will freeze. More to the point, there is less than a 5% probability that vines will freeze by 14 SEP indicating the need to chemically and/or mechanically desiccate potatoes by 10 SEP in order to allow three weeks for tubers to mature and be harvested on 1 OCT.

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