Yield of Fall-planted Spinach Surviving Low Temperatures[1]

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Abstract. **Fall-planted spinach (*Spinacia oleracea* L., cv. Bloomsdale Long Standing), field grown 2 successive years in Plant Hardiness Zone (PHZ) 5 at Manhattan, Kansas, under 13 soil fertility treatments, withstood as low as -21°C and yielded satisfactorily a month earlier than when spring planted. There were no significant differences in yield due to soil fertility treatments.**

Spring grown spinach is common throughout the United States but a 2nd crop in the fall often is reduced by high temp early in the growth cycle followed by rapidly decreasing temp and photoperiod.

In PHZ 5, (1), spring-grown spinach is generally planted March 15 to April 15 (2). An April 1-15 planting generally will reach marketable size about June 1 after approx 6-8 weeks, with most growth the last 3-4 weeks (9). This growth pattern is attributed to relatively low temp and short photoperiod which inhibits development of roots and leaf area in early spring. Optimal germination temp is 20°C (4, 5) but weekly mean temp in March and early April in PHZ 5 rarely reach 20°C and generally tend to be much less (Fig. 1).

If one could begin a spinach crop with an already-formed root system and considerable photosynthetic area, a marketable crop much earlier could be expected. That would necessitate fall planting, overwintering, and earlier harvesting. Little work has been reported on survival of spinach in relation to winter field temp. Some workers report that spinach will withstand low temp but not how low (5, 9). The problem in PHZ 5 and similar areas is whether fall planted spinach can be expected to successfully survive severe winters and produce economic yields the next spring. Another problem is whether soil fertility treatments can be used to enhance cold resistance as has been reported with certain organic fertilizers (10). Reported here are yields and survival of field grown spinach and how fertility treatments affected survival.

Fall-planted 'Bloomsdale Long Standing' spinach was grown 2 years on a Hayne very fine sandy loam using a RCB design with plots 6 m square and 4 replications. Seed was drilled in rows 45.7 cm apart using a Planet Jr. model 300A planter. The 1st and 2nd-year crops were planted Sept. 25 and Sept. 1, respectively. Feedlot manure at rates up to 89.6 MT/ha with equivalent mineral fertilizer was applied (7).[3] Weeding was done mechanically. Rainfall was

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[3]Analyses done by the Soil Testing Laboratory, Kansas Agricultural Experiment Station.

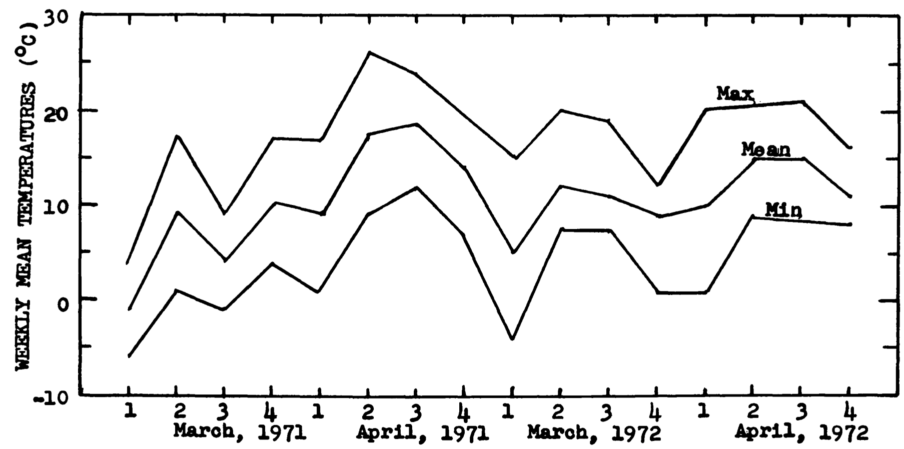

Fig. 1. Weekly mean temp during the latter part of the growth cycle of the 1st and 2nd crops of spinach (U. S. Dept. Commerce Climatological Data, Kansas, 1971 and 1972).

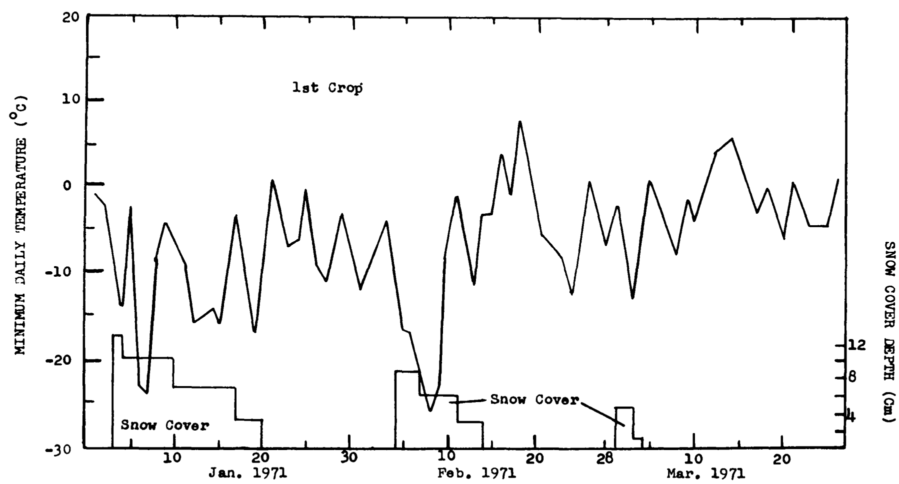

Fig. 2. Winter temp and snow cover during early spring, 1971. Minimum daily temp for periods later than shown >– 12°C (U.S. Dept. of Commerce, Climatological Data, Kansas, 1971).

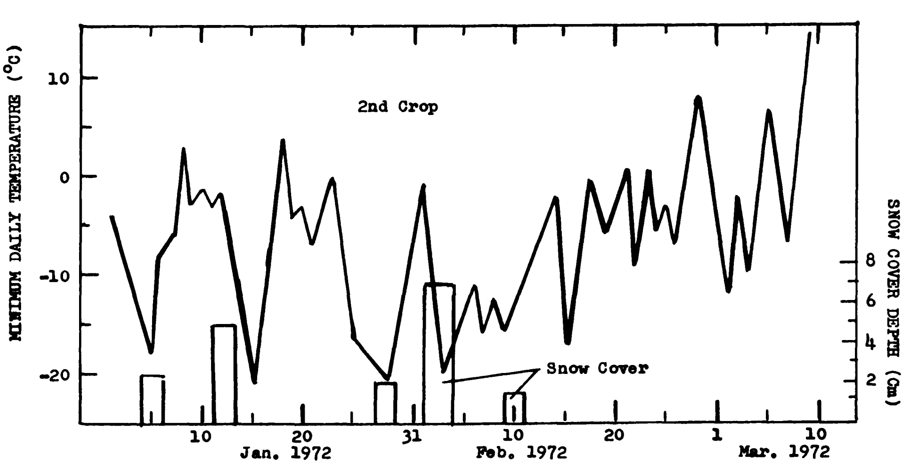

Fig. 3. Winter temp and snow cover during early spring, 1971. Minimum daily temp for periods later than shown >–6°C (U.S. Dept. Commerce Climatological Data, Kansas, 1972).

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supplemented by sprinkler irrigation when necessary.

The crops were harvested the first week of May both years, by severing plants at the soil surface. Just before harvest, plants of the 2nd crop damaged by winter cold were counted. Half the area of each plot and all the area in each plot was harvested the 1st and 2nd crops, respectively.

The 1st crop experienced severe cold to -26°C, but always with snow cover when below -16° (Fig. 2). Other short periods of fairly low temp occurred without snow cover but daily minimum temp (DMT) was -12°C or higher. No winter damage was observed in any plot the next spring. Total yields ranged from 6.3 to 9.6 MT/ha with no significant difference among fertilizer treatments (Table 1).

The 2nd-year crop experienced 5 brief periods of severe cold, 2 with no snow cover and with DMT as low as -22°C (Fig. 3), including DMT of -11° or less for 8 consecutive days in early Feb. Total yields of spinach ranged from 8.8 to 11.3 MT/ha (Table 1) again with no significant differences among soil fertility treatments. All plots contained some dead, chlorotic, or dwarfed plants but differences in the no. of cold-damaged plants were not significant.

Plants of both crops appeared visually to have resumed normal growth approx March 7 (Fig. 2, 3) when DMT were at or above -8°C. Temperature curves for both years were similar for early March (Fig. 2, 3), so the compensation point in spinach may be at a DMT of approx -8°. Harvest was the first week in May, approx 3 weeks earlier than that of spring-planted crops in the same area (4, 8).

Table 1. Total yield of fall-planted compared to spring-planted spinach.

Fertilizer treatment	Rate (MT/ha)	Yield (MT/ha) Fall crop 1970[z]	Fall crop 1971[y]	Spring crop 1970[x]	Spring crop 1971[w]
Control	–	7.67	8.80	6.24	7.45
Organic					
(Feedlot manure)	22.4	6.77	9.50	7.53	8.74
	44.8	7.18	9.29	8.77	8.85
	67.2	6.27	9.16	9.19	6.51
	89.6	7.64	9.13	8.99	8.67
Mineral					
(Nutrient equivalent	22.4	7.17	9.79	9.96	10.17
to manure)	44.8	9.41	11.34	9.40	13.51
	67.2	9.23	9.92	7.95	13.42
	89.6	8.17	10.34	5.77	11.74
(Split N:	22.4	9.58	10.56	10.40	12.78
nutrient equivalent	44.8	9.27	7.98	8.63	12.58
to manure)	67.2	9.01	10.04	7.35	12.92
	89.6	9.36	11.24	7.83	15.50
LSD 5%		NS	NS	.31	.53
Seasonal mean		8.21	9.78	8.31	10.99

[z]Planted Sept. 25, 1970; harvested May 3, 1971.
[y]Planted Sept. 1, 1971; harvested May 5, 1972.
[x]Planted April 7, 1970; harvested May 16, 1970.
[w]Planted April 21, 1971; harvested June 8, 1971.

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Rapid Vegetative Propagation of Asparagus through Lateral Bud Culture[1]

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Abstract. **A modified procedure was developed for vegetatively increasing normal diploid *Asparagus officinalis* L. This is accomplished by culturing stock plants from unrooted lateral buds from spears, and by rooting buds from basal portions of shoots of stock plants. Murashige and Skoog's inorganic medium with added growth substances was used.**

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Many workers have searched for a practical technique for vegetative mass production of asparagus from somatic cells and organ cultures (1, 2, 6, 7, 8, 9). Complete plants have been obtained by cell and callus culture, but most were tetraploid and involved aneuploid cells (4, 8). Recently, Murashige, et al. (6) and Hasegawa, et al. (3) reported that normal plants could be obtained by shoot apex culture. We also describe a procedure that avoids callus formation 1) in establishing aseptic stock plants from lateral buds of asparagus spears, 2) in producing rooted plantlets from the buds of stem segments of the stock plants.

The nutrient media which we used contained: inorganic salts according to Murashige and Skoog (5), 3% sugar, 0.7% agar, 2 ppm glycine, 100 ppm myo-inositol, 0.5 ppm nicotinic acid, 0.5 ppm pyridoxine•HCl, and 0.1 ppm thiamine•HCl. NAA (α-naphthalene acetic acid) and kinetin were added separately and in various combinations in the following concentrations: NAA-0.0, 0.01, 0.05, 0.1, 0.2, 0.3, 0.4, 0.5, and kinetin-0.0, 0.01, 0.05, 0.1, 0.2, 0.3 ppm.

The media were adjusted to pH 5.7 with either 1N NaOH or 1N HCl. The media were autoclaved at 6.8 Kg for 15 min at 121°C. The cultures were maintained at 27 ± 1°C under 16 hr of 100 ft-c of light daily from 20-W Gro-Lux fluorescent lamps.

Production of stock plants. Selected male plants of the *Asparagus officinalis* L. 'University of California 500W' selection were taken from field plantings. Spears 15 to 20 cm long were obtained from the selected plants. The apical 2 cm of each spear was removed.

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