Precision Planting of Lettuce[1]

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Abstract. Experiments were conducted to evaluate precision planting of single uncoated and spherically (clay) coated single seeds at 2 (uncoated only), 3, 4, 6, and 12 inches in the row. Three planters were used and compared to the conventional Planet Junior at accepted seeding rates. Sprinklers were compared with furrow irrigation. Seed emergence was superior with sprinkler irrigation. Coated seed and 6-inch spacing was not satisfactory with furrow irrigation, but was considered comparable to commercial stands with the sprinkler method (87.5% stand). In planting to a stand with a single seed every 12 inches (thus eliminating the thinning requirement), 84.4% of the desired stand was obtained with uncoated seed and sprinklers. Commercial stands most often range from 80 to 90% of the theoretical 12-inch spacing. Theoretical machine thinning of 3-inch plantings resulted in 8.6 single plants/10 ft of row indicating promise for this innovation.

Introduction

Mechanization of vegetable culture has undergone an increasing amount of study as a means of achieving efficiencies.

Nearly one-half (43% or 22.5 hr) of the labor used prior to harvesting lettuce may be for thinning (1, 3). Theoretically 24,890 single plants/acre 12 inches apart result from thinning 2-row beds on 42-inch centers (6). In practice stands are 10–20% lower due to effects of environment or losses in the hand thinning process. Twenty-four to 50 times the amount of seed needed is planted to insure a stand (5). This practice has remained unchanged for 40 years (5, 6, 10).

Experiments (8, 9) have shown that changing from furrow to sprinkler irrigation will remove surface salt, provide better soil-air conditions, and permit light seeding rates. This paper presents the results of 3 studies with 3 precision planters dropping single seeds at intervals of 2, 3, 4, 6, and 12 inches to determine the interval that would require removing the fewest excess plants and yet insure an economic stand. Synchronous mechanical thinning would require plants at least 2 inches apart (2). Planting to a stand (12 inches apart) eliminates the thinning requirement. Theoretical "synchronous" thinning was performed in one study.

Methods and Procedure

Experiments 1, 2, and 3 had split plot design, half of the plots receiving sprinkler irrigation and the other half furrow irrigation. Water was not a limiting factor as adequate amounts were applied. The initial irrigations were applied on October 29, 1964, October 21, 1965, and March 21, 1966.

Experiment 1. Precision planting was performed with a Clow Vac Jet (Clow Seed Company, Salinas, California) planter utilizing a continuous vacuum pump and small hollow tubes to pick up and drop seeds at 2-inch intervals, using uncoated seeds. Planet Junior planters were used for comparison at 0.7 and 3.0 lb./acre. Three replications were used for seeding in individual 3-bed plots 65 feet long. Data were obtained on loss of stand.

Experiment 2. Seed were dropped singly at 3-inch intervals on 2-bed plots having 2 seed rows per bed. Individual plots were 130 ft long. Planter No. 1 was a modified (University of California, Curley-Brooks) International Harvester 188, utilizing clay coated (Filcoat Process Full-Coat) seed. Planter No. 2 was the George Giannini-University of California precision vacuum needle planter for uncoated seed (4). Seed row covering of vermiculite (agricultural grade #3; 56 ft^3 per acre stabilized with 1:5 solution of polyvinyl acetate at 100 gal/A) was compared with soil. Eight replications were used for seeding treatments.

Sprinkler irrigation was effected with #14 rainbirds, 3/32-inch nozzles, 30 × 40 ft spacing, 40 psi.

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this leaf did not differ greatly from those of the first, third and fourth leaves as indicated by the regression analysis. Accordingly, the second leaf has been taken as the standard leaf for sampling. Detailed plottings of the results for the second leaf are presented for the petiole and blade tissues in Fig. 5 and 6. Fig. 5 shows the relationship between the fresh weight of tops to the percentages of K in the petiole tissues and Fig. 6 for the terminal blade tissues.

The critical K values for the various tissues are given in Table 5. The values are essentially consistent except for the immature tissues which are slightly higher. The critical K concentration can be set approximately at 2.3% for the petiole tissues and 1.1% for the blade tissues when determined at a 10% reduction of growth. These values give a good estimate of the K status of the potato plant relative to vegetative growth where stolons are removed. Additional experimentation is required to determine the effect of tuber development on the critical level (9).

Literature Cited

1. Dixon, W. J. 1967. "BMD Biomedical Computer Programs." University of California publications in Automatic Computation No. 2, Second Edition, University of Calif. Press, Berkeley and Los Angeles, California.
2. Fong, K. H. 1962. Potassium nutrition of White Rose potato in relation to growth and to potassium, calcium, magnesium and sodium in leaf and root tissues. M.S. thesis University of California, Berkeley, Calif.
3. Hoagland, D. R., and D. I. Arnon. 1950. The water-culture method for growing plants without soils. *Calif. Agr. Exp. Sta. Circ.* 347.
4. Jacobson, L. 1951. Maintenance of iron supply in nutrient solutions by a single addition of ferric potassium ethylenediamine tetraacetate. *Plant Physiol.* 26:411–413.
5. Johnson, C. M., and A. Ulrich. 1959. Analytical methods for use in plant analysis. *Calif. Agr. Exp. Sta. Bul.* 766.
6. Tyler, K. B., O. A. Lorenz, and F. S. Fullmer. 1961. Plant and soil analysis as guides in potato nutrition. *Calif. Agr. Exp. Sta. Bul.* 781.
7. Ulrich, A. 1943. Plant analysis as a diagnostic procedure. *Soil Sci.* 55:101–112.
8. Ulrich, A. 1952. Physiological basis for assessing the nutritional requirements of plants. *Ann. Rev. Plant. Physiol.* 3:207–288.
9. Ulrich, A., and K. H. Fong. 1969. Effect of potassium nutrition on growth and cation content of potato leaves and tuber relative to plant analysis. *J. Amer. Soc. Hort. Sci.* 94:356–359.

Emergence counts were made at 1 and 3 weeks. Data were obtained (at 2–3 true leaf stage, 19 days after first irrigation) on plant distribution by marking plant locations on adding machine tape. Each 10 ft sample tape was then theoretically synchronously machine thinned. This process made it possible to obtain data on the number of single plants that might have remained had the field actually been machine thinned.

Experiment 3. Using the same planters as in Experiment 2, coated and uncoated seed were dropped at 4, 6, and 12-inch spacings. The main plots again provided a sprinkler and furrow comparison. There were 10 replications of each seeding treatment. Individual plots were 100 ft long and 1 planted row. For conventional comparison 0.7 and 1.5 lb. seed/A were planted with the Planet Junior. Stand losses were determined.

Results and Discussion

Experiment 1. With the 2-inch single seed (Clow Vac Jet) treatment and sprinklers, 97.4% of a desired stand (one plant every 12 inches following thinning) resulted. Furrow irrigation resulted in 92.4% of a desired stand. Stand loss was less than 1% with 0.7 and 3.0 lb./A (Planet Junior) seeding treatments regardless of the irrigation method. Crop maturity was hastened and determinacy increased with the combination of sprinkler irrigation and 2-inch initial seed spacing (8, 12).

Experiment 2. In the analysis 4 of the 8 replications were discarded because of poor growth in the furrow plots. Table 1 presents the split plot analysis of seedling

Table 1. Effect of irrigation, row cover, and seed preparation on germination. Plants per 10 ft of row.

Irrigation	Seed cover	Seed	Number of plants	
			1 week	3 weeks
Sprinkler	Vermiculite	Uncoated	27.8	31.0
	Vermiculite	Coated	38.3	36.5
	Soil	Uncoated	29.0	35.8
	Soil	Coated	37.3	36.3
Furrow	Vermiculite	Uncoated	28.0	28.0
	Vermiculite	Coated	13.5	27.3
	Soil	Uncoated	27.3	25.3
	Soil	Coated	28.3	24.8
Analysis of Variance level of significance of difference:				
Replications			NS	10%
Irrigation			10%	1%
Vermiculite			NS	NS
Seed coated			NS	NS
Vermiculite × seed coated			NS	NS
Vermiculite × irrigation			NS	NS
Seed coated × irrigation			5%	NS

emergence at 1 and 3 weeks after the initial irrigation. Emergence was significantly greater under sprinklers in both periods. Coated seed emerged earlier under sprinklers. Coated seed under furrow irrigation with vermiculite covering exhibited a slower rate of emergence.

The number of single plant hills after theoretical synchronous thinning (12-inch) did not differ significantly due to any of the experimental treatments imposed and the grand average was 8.6 plants/10 ft of row. These very satisfactory results with a 3-inch seed spacing indicate machine thinning is feasible in lettuce culture with change to precision planting.

Experiment 3. The percentage of plants lost as compared to a desired stand of one plant every 12 inches is presented in Table 2, according to the method of Robinson and McCoy (8). These data were obtained from 40 ft of row in each of the 10 replicates of each treatment. It is of interest to note that as spacings between seed increased, the percentage of a desired stand decreased. In each case the sprinkler irrigation gave a better stand. The coated seed gave a poorer stand than the uncoated seed. This may have resulted in part from the surface placement of a significant portion of the coated seed.

Table 2. Effect of seeding equipment, spacing, seed preparation, and irrigation on per cent plants lost compared to a desired thinned stand of one plant every 12 inches.

Seeding equipment	Seed prep	Spacing inches	Amt seed lb/A	Irrigation	
				Furrow	Sprinkler
U.C. Mod I.H. 188	Coated	4		6.3	0.6
U.C. Mod. I.H. 188	Coated	6		22.5	12.5
U.C. Mod. I.H. 188	Coated	12		45.0	33.8
U.C. Gianinni Vacuum	Uncoated	4		5.0	1.9
U.C. Giannini Vacuum	Uncoated	6		8.1	2.5
U.C. Giannini	Uncoated	12		21.9	15.6
Planet Jr	Uncoated		0.7	0.0	0.0
Planet Jr	Uncoated		1.5	0.0	0.0

The results of *experiments 1, 2, and 3* with uncoated seed indicate that with the experimental conditions it would be possible to reduce seeding rate to the theoretical stand (1 seed every 12 inches) and expect acceptable results when compared to seeding 24 to 50 times (about 1½–3 lb., 400,000 seed/lb.) more seed, providing sprinklers are used to aid emergence. Likewise, 2-, 3-, 4-, and 6-inch planting intervals resulted in negligible theoretical stand loss. Significant effects of seed quality have been shown (7).

Post thinning coated seed stands under sprinklers were considered near perfect at 3- and 4-inch planter settings (11, 12).

According to our results, mechanical thinning of 3-inch interval field plantings is theoretically possible.

Literature Cited

1. Adams, R. L., and A. D. Reed. 1948. Farm management crop manual. *Univ. Calif. Syllabus Series No.* 306, pp. 129–130.
2. Garrett, R. E. 1966. Device designed for synchronous thinning of plants. *Agr. Eng.* 47(12): 652–653.
3. Gavett, Earl E. 1963. Truck crop production practices, Monterey County, California. *U. S. Econ. Res. Serv.* 129.
4. Giannini, G. R. W. J. Chancellor, and R. E. Garrett. 1967. Precision planter using vacuum for seed pickup. *Trans. Amer. Soc. Agr. Eng.* 10:607–610.
5. Knott, J. E. 1957. Handbook for vegetable growers. Wiley & Sons, p. 17.
6. McFarlane, N. L., R. S. Ayers, and G. L. Winright. 1957. California Desert Agriculture. *Calif. Agr. Exp. Sta. Circ.* 464.
7. Pauli, A. W., and B. L. Harriott. 1968. Lettuce seed selection for precision planting. *Agr. Eng.* 49(1):18–22.
8. Robinson, F. E., and O. D. McCoy. 1965. The effect of sprinkler irrigation with saline water and rates of seeding on germination and growth of lettuce. *Proc. Amer. Soc. Hort. Sci.* 87:318–323.
9. ———, and G. F. Worker, Jr. 1966. Factors affecting the emergence of sugar beets in an irrigated desert environment. *Agron. J.* 58:433–435.
10. Rogers, Stanley S. 1917. Lettuce growing in California. *Calif. Agr. Exp. Sta. Circ.* 160:1–3.
11. Zink, F. W. 1955. Studies with pelleted lettuce seed. *Proc. Amer. Soc. Hort. Sci.* 65:335–341.
12. ———. 1966. Effect of rate of seeding and date and method of thinning on growth and harvest density of head lettuce. *Proc. Amer. Soc. Hort. Sci.* 88:417–424.