CANTERBURY CHAMBER OF COMMERCE
AGRICULTURAL BULLETIN
No. 464 8/1968

EXTENSIVE VEGETABLE PRODUCTION

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INTRODUCTION

It is now possible to grow vegetables free of weeds. This long standing aim has become a reality in the last ten years. The technique is one of the greatest advances to be made in vegetable growing, yet this knowledge has not been exploited in New Zealand, probably due to lack of demonstration and extension.

Traditional methods of growing have relied on interrow cultivation to control weeds. For this reason vegetables are grown in rows considerable distances apart to make way for cultivation equipment but this also gives weeds a chance to grow without competition.

Depreciated prices for traditional farm products has led mixed cropping farmers and horticulturists to look for more rewarding alternatives. Vegetable growing by traditional methods has high labour costs and is not a very attractive proposition but with new methods it opens up profitable possibilities.

If New Zealand is to expand its exports of fresh and processed vegetables a low cost quality product will be needed to break into world markets. To do this growers must develop and exploit new techniques in order to reduce costs of production and increase yields per acre. In my opinion we have the soils and the climate but we must use the optimum methods available and develop better methods still.

ADVANCES IN VEGETABLE PRODUCTION

A. Plant Density

Bleasdale[1] at the National Vegetable Research Institute in England and other workers, notably those in the United States, have done extensive work on the optimum plant densities of the principal vegetable crops. This density probably lies somewhere between 4-12 inches on a square or triangular planting pattern. Thus, traditional wide-row planting does not make efficient use of available land. However, a drastic rearrangement of plants has implications throughout the husbandry of the crop-fertilizers, weed control, water availability and irrigation, machinery, planting and harvesting, pest and disease control and crop breeding.

B. Precision Sowing

As early as 1949, the National Institute of Agricultural Engineering[2] in the United Kingdom developed a way of placing single seeds accurately into the soil to obtain optimal yields. Because specific herbicides were unavailable at the time, it was not possible to use the seeder to put in the crop at the optimum density and hence yields remained unchanged. However, the seeder eliminated singling and between 1953 and 1961 United Kingdom growers bought 25,000[3] seeders.

C. Seed Size

Following work in Britain and America, Theile[4] has shown that seed size can influence uniformity of plant performance in New Zealand vegetable crops. Although the importance of seed size on plant vigour and final yield may not be important in precision drilling where each plant has optimal space for development, variation in seed size is a limitation to accuracy in that it can interfere with the seed selection ability of the machine, especially when seeds are small and irregular in shape.

D. Pelleted Seed

Pelleted seed is not an innovation. It was commercially available in the United States as early as 1948. However, germination problems in pellets were widespread and the high cost precluded their use for commercial development. However, with precision drilling and the possibility of obtaining optimum plant densities, pelleting has become important because it reduces variability of size within and between seed lines. Also the manufacturers can incorporate pesticides and fertilizers within the pellet. As a result, research work aimed at improving germination has been stepped up.

E. Herbicides

The development of effective herbicides will have a profound effect upon the vegetable growing industry in New Zealand since it eliminates inter-row cultivation and makes it possible to have optimum plant densities.

In essence optimum plant density requires each of these advances—precision drilling for accurate seed placement, seed grading for uniformity in seed size, pelleting for precision drilling of irregular seeds, together with pesticide and fertilizer incorporation.

It was with this background in mind that the Horticulture Department at Lincoln College embarked upon preliminary research into the application of these techniques to large scale vegetable production in New Zealand.

PRELIMINARY INVESTIGATIONS INTO PRECISION DIRECT SEEDING OF VEGETABLES

Cabbages

The traditional method of growing cabbages has been to sow the seed in seedbeds and then to lift the plants and transplant into the field. Such a method involves considerable labour as well as causing a check to growth of the cabbage.

Direct sowing of cabbage removes both the labour and check to growth with consequent reduction in time to produce a cabbage. In addition, spacing and associated size of cabbage is controlled.

Work carried out with spring cabbage (Flower of Spring) showed clearly the advantages obtained with precision direct sown cabbage. The establishment of seedlings before onset of frosts and poor weather in winter is very important for production of a worthwhile crop. Direct sown cabbages came to maturity six weeks earlier than transplants and produced by far the best quality heads.

In summer varieties such as Golden Acre the same advantage was found. Plants transplanted out in the summer months even with applied irrigation took four weeks longer to reach maturity.

In order to obtain satisfactory emergence and quality of cabbages it is important that seed should be of high germination capacity. Flower of Spring seed was graded to between .0787"-.0625" which allowed satisfactory seeding with 67% emergence of sown seeds. If this grading is not done then the accuracy of planting will decrease. It was found that pelleting of seeds was not necessary for accuracy of sowing with the varieties of cabbage used. There is no reason why cauliflower, broccoli, brussel sprouts and any other leafy vegetables should not also show marked advantages of precision direct sowing.

However, it is the study of hybrid varieties that should provide greatest advances. Hybrid cabbage with its very great uniformity lends itself to mechanization and bulk harvesting. Unfortunately, hybrid seed is irregular in shape and size and therefore probably not suitable for precision sowing as bare seed. It is almost certain that direct sowing of pelleted seed would provide a saving of 75% on this expensive seed compared to traditional growing.

Lettuce

At present most lettuce is direct sown and then thinned out by hand, a time-consuming and therefore very expensive operation. The advantages of precision drilling are therefore very obvious. However, the irregular flattened nature of the seed prevents the precision planter from selecting individual seeds and the only method possible with unpelleted seeds is trickle sowing. Although this did help in minimising thinning of the crop, it did not give the advantage that precision drilling gave with cabbage.

Pelleted lettuce seed failed to germinate in the field on two occasions despite very different prevailing weather but new pellets under development show considerable promise for the next season.

Celery

The size of celery seed makes it very difficult to precision drill except by means of pelleted seed. The amount pelleting material has been shown in America to be very critical for germination and this was borne out at Lincoln when direct sown pellets gave inconsistent results. Plates 7 and 8 showed that precision direct sowing of pelleted celery seed will be a possibility after more work.

Onion

During the 1967-68 season the effectiveness of onion pellets and herbicides was assessed at Lincoln.

The herbicide treatments used were:

1. **Pre-emergence** C.I.P.C.— 2lb a.i. per acre. Paraquat—½lb a.i. per acre
   followed by
   Post-emergence Linuron—½lb a.i. per acre

2. **Pre-emergence** BiPc/PCA—1.8lb a.i. per acre
   followed by
   Post-emergence Alicep—1.8lb a.i. per acre

3. **Pre-emergence** Propachlor — 4lb a.i. per acre
   followed by
   Post-emergence Propachlor—4lb a.i. per acre
   Cypromid—0.5lb a.i. per acre

4. **Hand Weed Control.**

Pre-emergence herbicides did not affect the initial emergence of onion plants whatver the depth of sowing.

Increasing the depth of sowing of pellets from ½ inch to 1 inch, decreased germination of pellets by 50% compared to bare seed. Similarly extremes of weather or soil conditions can reduce germination.

Post-emergence applications of herbicides did appear to influence numbers especially in treatment 3. Despite this apparent effect, treatment 3 gave the most efficient and reliable weed control for the growing techniques envisaged.

Other significant effects observed were the earlier maturity of onions sown at ½ inch depth. It was considered that herbicide treatment 3 may also have induced earlier maturity.

The result of this early maturity was to allow greater exposure to pathogens with consequent greater numbers of diseased onions in the samples concerned. This points out the importance of uniformity in ripening of onions if minimal disease incidence is to be obtained.

The effect of precision drilling on yield and the composition of yield is seen by reference to Plates 1 and 2. Trickle sowing gives no control of seed placement and gives inconsistent plant spacings along a row (Plate 1). It should be noted that the technique of trickle sowing by a precision drill is probably more precise than sowing by Planet Junior although no way of determining this was tried. Precision sowing using pellets gives much greater uniformity (Plate 2).

Although none of the treatments influenced total yields to a great extent the composition of the yield was markedly changed. Precision sowing led to greater uniformity of the crop and it is envisaged that the size of onions obtained can be manipulated by development of this technique.

Tomatoes

Traditionally tomatoes both for fresh market and processing have been obtained from transplanted crops. Success with other vegetable crops from direct seeding led to preliminary investigations into the growing of tomato crops direct sown.

Plantings were carried out in five foot beds using the following treatments:

1. 1 row of pelleted seed spaced 1 inch apart.
2. 2 rows of pelleted seed spaced 2 inches apart.
3. 3 rows of pelleted seed spaced 4 inches apart.
4. 4 rows of pelleted seed spaced 6 inches apart.
5. Pellets sown in drills to side of bed and transplanted to give one row with plants spaced at 12 inches in the row.

Resulting Plant Densities—Based on 5 foot beds on 15 January, 1968

	Seeds/ ft.	Actual Plants/ ft.	Plants/ sq. ft.
T.R. 1	12	4.3	0.86
2	6	2.7	1.08
3	3	1.8	1.08
4	2	0.4	0.32
5		1.0	0.20

Although density of plants was similar in treatments 1-3 the actual spatial arrangement of the plants was very different.

This resulted in different morphology of the plants in the different treatments and consequent different yield characteristics. The overall yield of ripe fruit, however, was not very different in any of the treatments 1-4 but whereas the yield in treatment 1 represented over 60% of the potential total (green and red fruits) that of treament 4 was only 44% of the total. The check to transplanted tomatoes was such that yield up to the same time was only 16% of the total. Quality of fruit was effected only slightly by increased plant densities and was not a critical factor.

Disease which is often a problem when densities are increased was apparent in these trials.

Diseased and Reject Fruit—lbs

	Total	Total % Yield	
TR. 1	4.82	6.4	
2	13.62	12.2	High Density
3	12.80	14.0	
4	4.82	5.4	
5	2.87	18.6	Low Density

The low frequency in treatments 1 and 4 was highly significant but in no treatment was the problem very great considering no fungicide sprays were applied in what was a wet humid season.

PLATE 1

Onions by a Stanhay precision drill using bare seed trickle technique showing irregular spacing and size.

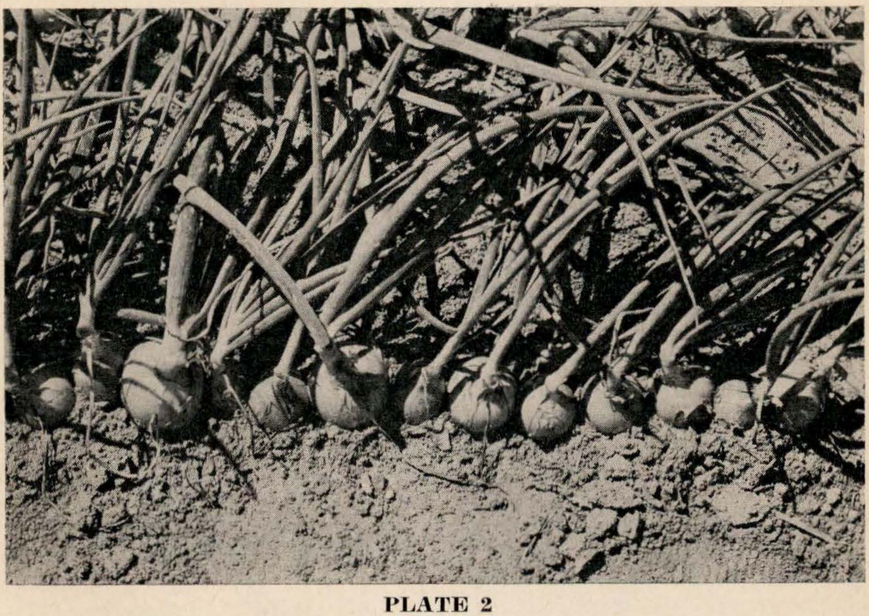

PLATE 2

Precision sown pelleted onions showing regular spacing and size.

The overall picture given by these preliminary trials into tomato growing is one of optimism. It appears that these new techniques of growing could give yields of tomatoes in excess of 20 tons in Canterbury even with existing varieties and in a manner suitable for mechanical harvesting.

It is apparent that expensive transplating techniques $45-50[5] per acre could be replaced by less costly direct sowing techniques with very little difficulty. Such a move would result in higher yields which would raise the profitability of this crop. In some areas[5] growers actually make losses.

In Canterbury the use of transplants even for an early crop could be uneconomic. This conclusion is arrived at after a study of meteorological data for the area. This shows that in the last 20 years tomatoes above the soil surface by mid-November stand to be lost by a late November frost one year in twenty and perhaps as frequently as one year in seven. It follows that the growing season for transplants commences in mid-November in Canterbury while drilling of direct sown tomatoes could take place several weeks earlier than this. If the transplanting check to tomatoes is similar to the 4-6 weeks of other transplanted crops, as would appear probable, then the transplant loses nearly all its initial advantage over a direct sown crop.

The reliability of Canterbury for tomato growing has been assessed by means of Growing Degree Days. This assumes a base temperature above 50 degrees F. for tomatoes[6]. All mean temperatures above 50 degrees F. are thus credited to growth of the tomato crop. e.g. If the maximum temperature for a day is 60 degrees F. and the minimum 50 degrees F. the mean for the day will be 55 degrees F. giving a 5 growing degree day or 5 heat units. This method has been used in the following table:—

Heat Unit Days — Tomatoes — Base 50°F.

Lincoln College

	Mid. Oct.	Nov.	Dec.	Jan.	Feb.	March	Total
1965-66	57.8	177.0	361.9	369.9	369.9	411.5	1670.3
1966-67	65.2	163.8	280.7	280.7	363.0	348.9	1587.8
1967-68	69.3	147.6	302.2	302.2	343.7	360.2	1611.5

The variety of tomato—Amateur—used in these trials yielded a best yield of 21 tons of ripe fruit using 1604.3 heat units. Other varieties more suitable for the work developed by H. Giesen of Crop Research, D.S.I.R., Lincoln, appears to require only 1586 heat units for full maturity. It would appear that over the last three years which have brought both the best and worst types of summers, profitable crops of tomatoes in excess of 20 tons per acre could have been obtained using these new techniques.

From the work carried out on various vegetable crops during the 1967-68 season it is apparent that precision direct sowing together with effective herbicide application can revolutionise the economics of vegetable production. Before this can occur there must be considerable fundamental research to place these developments on a sound footing.

If vegetable production for the fresh or process market is to develop then a great deal more fundamental research is essential. It is futile to base economic production studies on technique already obsolete by world standards if we hope to capture these markets. Only by leading the world in production techniques can we hope to break in on this competitive market.

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