PLANT SPACING ASPECTS OF ONION PRODUCTION

M. A. NICHOLS

Massey University, Palmerston North

Summary

Plant spacing involves a consideration of both plant population and plant arrangement. The importance of these factors in determining the yield of onions depends upon competition for soil moisture, soil nutrients, light, and carbon dioxide. Provided chemical methods of weed control prove to be efficient, there appear to be sound reasons for reducing the between-the-row spacings. Heavy yields of onions of the required size grade can then be obtained by adjusting the seeding rate (plant population) to the yield potential of the environment.

ONIONS are grown in New Zealand from seed which is sown, depending on the variety and district, from April until October, in rows 12 to 14 in. apart. The seeding rate is normally adjusted to produce 9 to 12 plants per foot run, and weed control is by a combination of mechanical cultivation, and the use of chemical weedkillers. The distance between the rows is governed by the absence of satisfactory chemical weedkillers, and the importance of mechanical cultivations to control weeds. Substantial improvements in both yield and uniformity are possible by altering the plant spacing (*e.g.*, by reducing the between-the-row spacing), but this is only feasible when a reliable method of chemical weed control becomes available. Cox (1968) has considered the relative efficiencies of the different chemical weedkillers available, and the purpose of this paper is to consider plant spacing aspects of onion production.

Plant spacing involves the consideration of two distinct factors:

- (1) Plant population—the number of plants per acre.
- (2) Plant arrangement—the relationship between the in-the-row and between-the-row spacings.

PLANT POPULATION

It can be shown that, as plants are spaced closer together, so the yield from each plant is reduced. However, because of the increased number of plants per acre, the yield per acre will usually be increased. This relationship has been demonstrated by Bleasdale (1966) for onions grown from seed, and for onions grown from sets by Nichols and Heydecker (1966) (Table 1). Close spacing reduces the yield per plant owing to increased competition for soil moisture, soil nutrients, light, and carbon dioxide.

PLANT ARRANGEMENT

Plant arrangement can be defined (for row crops) in terms of rectangularity, the ratio of the between-the-row, and in-the-row spacings.

TABLE 1: THE EFFECT OF PLANT SPACING ON THE YIELD PER BULB AND YIELD PER ACRE OF ONIONS GROWN FROM SETS

<i>Area per Plant (sq. in.)</i>	<i>Wt/Bulb (oz.)</i>	<i>Yield/acre (tons)</i>
9	2.2	42.5
16	3.3	37.0
25	4.5	31.5
36	5.5	26.5
49	6.4	22.5
64	7.1	19.0
81	7.6	16.0
100	8.0	14.0

TABLE 2: THE RELATIONSHIP BETWEEN RECTANGULARITY, AND THE IN-THE-ROW AND BETWEEN-THE-ROW SPACINGS

<i>Spacing between Rows</i>	<i>Spacing in Rows</i>	<i>Rectangularity</i>
16	1	16
8	2	4
4	4	1
2	2	1
1	16	16

This ratio is always made greater than 1.0, by taking the smallest number as the denominator (Table 2). Bleasdale (1964) compared the effect of two plant densities, and two between-the-row spacings on the yield and uniformity of onions, and found that, at a low plant density (2 plants/sq.ft), reducing the between-the-row spacing from 18 in. to 9 in. had little effect on yield or uniformity.

However, at a higher plant density (7 plants/sq.ft), reducing the between-the-row spacing from 18 in. to 9 in. not only increased the yield by about one fifth, but also reduced the proportion of none-ware onions. At the low plant density, reducing the between-the-row spacing had only a marginal effect on rectangularity, from 2.25 (18 in. rows) to 1.8 (9 in. rows), but at the higher plant density the rectangularity changed from 16 (18 in. rows) to 4 (9 in. rows).

The reason for the increased yield (and improved uniformity) with the smaller rectangularities is due to reduced competition. At any one plant density, the larger the rectangularity the sooner does competition commence, and the slower are the plants able to exploit fully the soil and air "space" available. With a large rectangularity, any small variation in seedling size, or any irregularity in spacing, leads to reduced uniformity, whereas with an all square spacing (a rectangularity of 1.0) the delay in competition ensures that the effect of variation in seedling size, and/or spacing, is minimized.

It is pertinent at this juncture to stress that experiments which examine yield/plant density effects by altering the plant population, but keeping the between-the-row spacing constant (*e.g.*, Webster, 1968), make it impossible to determine whether any yield change is due to changes in plant density, or to changes in rectangularity.

A knowledge of the effect of plant density and rectangularity on yield can enable the producer to space the onion plants in such a way as to produce the maximum crop of the preferred sized onion bulbs. However, competition for soil moisture, soil nutrients, and light can greatly influence the yield/density relationship.

COMPETITION FOR SOIL NUTRIENTS

Nichols (1967) has examined the effect of three levels of nitrogen, phosphate, and potash fertilizers on the yield/density relationship of onions using a systematic spacing design (Nelder, 1962), with a rectangularity of 1.0. The results from this experiment showed that there was a marked increase in the response to phosphate application with increased plant density (Table 3), which suggests that it may be more profitable to apply heavier fertilizer rates to high density plantings than to low density plantings. It appears probable that similar results could be expected for any soil nutrient in short supply.

TABLE 3: THE EFFECT OF PLANT SPACING AND COMPETITION FOR PHOSPHATE ON YIELD OF ONIONS

Area per Plant (sq. in.)	Yield (tons/acre)		Increase (tons/acre)
	No Phosphate	High Phosphate	
9	25.6	33.7	8.1
16	21.8	26.5	4.7
25	18.3	20.8	2.5

COMPETITION FOR WATER

No information is available on the competition for soil moisture at different plant populations. Strydom (1967) has shown that high soil moisture stress can cause a marked reduction in yield, and Winter (pers. comm.) has shown that late irrigation will prolong green foliage, but this may be at the expense of increased storage disorders. There does not appear to be any doubt that, if more than half the available water in the effective rooting depth of the soil is used, then irrigation is likely to be advantageous. The problem is when to cease irrigation in order to produce a good keeping onion. One approach may well be to irrigate late, and rely on artificial curing to reduce storage disorders.

COMPETITION FOR LIGHT (and CO₂)

Light, except at extremely low plant densities, is likely to be one of the major competition factors. It would not, however, be correct to state that the grower has no control over light. Within certain limits he can ensure that the optimum photosynthetic area is present in late December when the daily light integral is highest. Unfortunately, the developmental physiology of the onion may not permit a combination of a large leaf area and bulbing to occur in December because:

- (1) If sown too early in the autumn or winter, the young plants may go to seed in the spring.
- (2) If sown too late in the spring, bulbing may be delayed until January or February.

COMPETITION WITH WEEDS

Bleasdale (1959) has stressed the importance of weed control, particularly in the early stages. From experience at Massey University, and also at the University of Nottingham, it appears that at high plant densities (and low rectangularities), provided the crop is free from weeds at the commencement of bulbing, then the competition exerted by the growing bulbs for space, and by the roots and leaves for light, moisture, and nutrients virtually eliminates weed growth until the foliage dies down.

CONCLUSION

Onions, particularly in the early stages of growth, are very poor competitors with weeds. For this reason, although there are marked advantages in yield and uniformity, in reducing the between-the-row spacing, this advantage is likely to be purely theoretical unless a reliable chemical method of weed control is available.

REFERENCES

- Bleasdale, J. K. A., 1959: *J. Hort. Sci.*, 34: 7-13.
——— 1964: *Span*, 7: 33-6.
——— 1966: *J. Hort. Sci.*, 41: 145-53.
Cox, T. I., 1968: *Proc. 21st N.Z. Weed & Pest Control Conf.*: 17-23.
Nichols, M. A., 1967: *Hort. Res.*, 7: 144-7.
Nichols, M. A.; Heydecker, W., 1966: *Grower*, 65: 348-51.
Nelder, J. A. 1962: *Biometrics*, 18: 283-307.
Strydom, E., 1967: *S. Afr. J. Agric. Sci.*, 10: 767-80.
Webster, A. B. 1968: *N.Z. J. Agric. Res.*, in press.