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Onion: effect of sowing date on maturity, yield, and quality of 'Pukekohe Longkeeper' and 'Early Longkeeper'

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Abstract Three field experiments, in successive seasons from 1981 to 1983, tested the effect of six sowing dates, at c. 3-week intervals from early May, on maturity, yield, and quality of the onion cultivars, *Allium cepa* L. 'Pukekohe Longkeeper' (PLK) and 'Early Longkeeper' (ELK). Sowing date had little effect on crop maturity date, which was about 22 days earlier for ELK than for PLK. Maximum total yield was recorded for the third sowing date for PLK (95 t/ha) and for the second sowing date for ELK (82 t/ha), and declined steadily with later sowing dates. The earlier sowing dates resulted in a high proportion of bulbs that bolted for both cultivars and severely reduced marketable yield. Reduction in total yield at the later sowing dates was caused by a reduction in average bulb size. The yield of marketable bulbs of > 57 mm diameter declined from 75 t/ha and 57 t/ha for PLK and ELK at the third and second sowing dates respectively, to 30 t/ha and 14 t/ha at the sixth sowing date. The effect of sowing date on the balance between quantity and quality of yield suggests that the optimum time to sow onions at Pukekohe is early June for ELK and late June for PLK.

Keywords onion; *Allium cepa* L.; cv. Pukekohe Longkeeper; cv. Early Longkeeper; sowing date; maturity; yield; quality

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INTRODUCTION

Onions (*Allium cepa* L.) are a major fresh vegetable export crop in New Zealand. Over 80% of the national production occurs in the Pukekohe district, and is based on cv. Pukekohe Longkeeper (PLK) and cv. Early Longkeeper (ELK).

Traditionally, onions have been sown during June and July. Over recent years, however, attempts to advance maturity and ensure onions are sown while weather conditions are suitable have led to earlier sowing dates. The effect of sowing date on the yield and quality of onions has not been well studied in New Zealand, so it was not clear whether the intended objectives of advanced sowing dates had been achieved. In this paper we report a series of field experiments carried out over three years at Pukekohe, New Zealand, examining maturity, yield, and quality of PLK and ELK onions sown from May to August.

METHODS

Site, design, and layout

All experiments were carried out at the Pukekohe Horticultural Research Station (latitude 37° 12′S), on a Patumahoe clay loam. The three experiments were on sites of similar base fertility and had similar designs.

In each season, six sowing dates were tested in factorial combination with the cultivars PLK and ELK. The sowing dates (Table 1) were c. 3 weeks apart in each season, but depended on weather and soil conditions appropriate for sowing. Each treatment was replicated four times in a randomised block design.

Plots measured 6.2 × 1.5 m, and comprised six rows. The datum area comprised the central 5 m of the central four rows (5.0 m^2).

Crop management

A base dressing of 250 kg P/ha (as 7% serpentine superphosphate) was incorporated at all sites before the first sowing date in each season. The crops were sown using a 'Stanhay' precision seeder, delivering 83 seeds/m^2. In 1983–84 only, the plants were

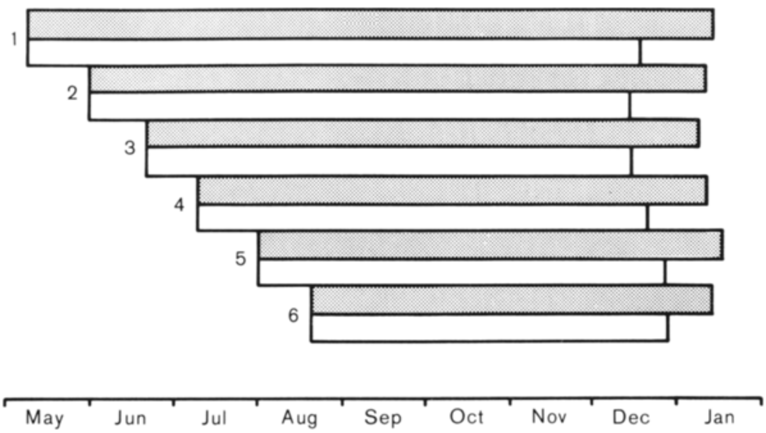

Fig. 1 Effects of sowing date and cultivar on days to crop maturity for 'Pukekohe Longkeeper' (■) and 'Early Longkeeper' (□). The mean sowing dates were: 1, 8 May; 2, 30 May; 3, 20 June; 4, 9 July; 5, 31 July; 6, 20 August.

Table 1 Sowing dates for onions sown in 1981–82, 1982–83, 1983–84, at Pukekohe.

	Sowing date					
Season	1	2	3	4	5	6
1981–82	7 May	28 May	16 June	7 July	27 July	19 August
1982–83	9 May	3 June	27 June	12 July	1 August	19 August
1983–84	7 May	29 May	18 June	9 July	3 August	21 August

thinned to c. 64/m² at the 2–3-leaf stage to ensure similar plant populations for all sowing dates.

Nitrogen was applied at 160 kg/ha (as urea), with half applied at emergence and the remainder at the 3-leaf stage of growth. Weeds were controlled with the herbicides chlorthal-dimethyl (8.0 kg/ha), propachlor (5.0 kg/ha), and ioxynil (0.3 litres/ha) as necessary. The fungicide maneb (1.2 kg/ha) was applied at 14-day intervals from early October until harvest for downy mildew (*Peronspora destructor*) control, and parathion-methyl (0.7 litres/ha) and maldison (3 kg/ha) applied for thrip control as required. The crops were irrigated as necessary.

Measurements

Emergence was assessed as the date when the first onion seedlings emerged. Maturity was assessed as the date when 50% of the foliage had fallen. Bulbs were lifted when > 98% of the foliage had fallen, and then field dried for c. 3 weeks before the tops were removed by hand clipping. Total yield of trimmed bulbs, number of bolters (bulbs from plants where a seed head had initiated), and yield of bulbs of > 57 mm diameter (the minimum size for premium grade bulbs) were then recorded. Seed stalks were trimmed from bolters and excluded from final yields.

Table 2 Effects of onion cultivar and sowing date on the total number of bulbs harvested (per m²).

	1981–82	1982–83	1983–84
Cultivar			
PLK	85	76	64
ELK	73	73	63
SEM	1.1	1.6	0.7
Sowing date			
1	71	59	62
2	80	69	63
3	80	78	63
4	80	70	62
5	79	92	63
6	84	79	67
SEM	1.9	2.8	1.2

SEM = standard error of the treatment means tabulated. PLK = 'Pukekohe Longkeeper'; ELK = 'Early Longkeeper'.

RESULTS

Crop maturity

Despite a spread in sowing dates within each season exceeding 100 days, the spread of dates for mean maturity for each cultivar was never more than 14

Table 3 Effects of onion cultivar and sowing date (first two only) on the percentage of all plants that initiated seed heads (bolters).

	1981–82	1982–83	1983–84
Cultivar			
PLK	46.8	31.3	24.6
ELK	27.3	21.6	24.9
SEM	3.6	5.6	1.5
Sowing date			
1	51.6	41.2	36.6
2	22.5	11.6	12.9
SEM	3.6	5.6	1.5

SEM = standard error of the treatment means tabulated. PLK = 'Pukekohe Longkeeper'; ELK = 'Early Longkeeper'.

Table 4 Effects of onion cultivar and sowing date on total yield (t/ha) of trimmed bulbs, excluding bolters.

	Sowing date					
	1	2	3	4	5	6
1981–82						
PLK	31.6	67.9	93.2	88.5	76.7	67.2
ELK	44.6	72.8	76.9	68.2	57.4	48.5
SEM (interaction)	3.4					
1982–83						
PLK	53.0	74.3	80.9	70.9	71.1	69.1
ELK	53.0	68.9	71.1	67.8	55.2	50.0
SEM (interaction)	3.7					
1983–84						
PLK	54.3	77.8	102.9	84.1	65.0	56.2
ELK	43.2	75.4	76.3	73.3	60.6	50.4
SEM (interaction)	3.5					

SEM = standard error of the treatment means tabulated. PLK = 'Pukekohe Longkeeper'; ELK = 'Early Longkeeper'.

days (Fig. 1). Hence, the time to maturity decreased as the sowing date was delayed. For PLK, the average time to maturity ranged from 251 to 146 days depending on sowing date, whereas that for ELK ranged from 225 to 130 days. Maturity occurred later in 1981–82 than in the other two seasons, on average by 13 days for PLK and 11 days for ELK. This difference may be related to the cooler than normal winter temperatures in 1981–82, which may also have resulted in the delayed crop emergence from the third sowing date in that season (29 days compared with 18 in the two later seasons). This suggests that winter temperatures as well as photoperiod affect the commencement of bulb formation and, hence, maturity time.

Plant densities

The mean plant densities at maturity were 79, 74, and 63 plants/m^2 for the 1981–82, 1982–83, and 1983–84 seasons respectively. There was no significant interaction between the effects of cultivar and sowing date on plant density. The plant densities were usually higher for PLK than for ELK, but this difference was significant in 1981–82 only (Table 2). There was a significant effect of sowing date on final plant density in all three seasons. The average density tended to be lowest for the early sown crops and highest for the late sown crops.

Bolters

Bolters were most prevalent from the first two sowing dates, with never more than 4% of plants affected for the third and subsequent sowing dates of both cultivars in any growing season. To estimate more reasonably the standard error, data from the first two sowing dates only have been statistically analysed (Table 3).

The incidence of bolters was affected significantly ($P < 0.001$) by cultivar in 1981–82, which was also the season in which highest numbers of bolters were recorded. Bolters were always most prevalent at the first sowing date, affecting, on average, 43% of all plants. Their incidence then declined very rapidly with subsequent sowing dates.

Total bulb yields (excluding bolters)

The mean total bulb yield was very similar for the three growing seasons, averaging 71 and 62 t/ha for PLK and ELK respectively. The effects of cultivar and sowing date on total bulb yield interacted in all three seasons (Table 4). Yield of PLK usually exceeded that for ELK, particularly for the later sowing dates. For PLK, yield increased from the first sowing date to the third sowing date, and then declined for later sowing dates. Yield for the sixth sowing date was, on average, 71% of that for the third sowing date. For ELK, yield also rose from the first to the third sowing date and then declined. Yield of the sixth sowing date was, on average, 66% of that for the third sowing date.

Graded yield

The effects of cultivar and sowing date on the yield of marketable bulbs of > 57 mm diameter interacted significantly ($P < 0.05$) in all three seasons

Table 5 Effects of onion cultivar and sowing date on yield (t/ha) of marketable bulbs of > 57 mm diameter.

	Sowing date					
	1	2	3	4	5	6
1981–82						
PLK	24.3	52.4	70.6	55.7	43.8	26.3
ELK	34.2	56.6	51.3	39.1	27.1	10.0
SEM (interaction)	3.5					
1982–83						
PLK	49.7	60.1	61.3	51.3	33.0	36.6
ELK	46.6	50.9	39.1	44.6	12.1	11.9
SEM (interaction)	4.1					
1983–84						
PLK	45.8	69.1	94.2	72.1	45.4	27.5
ELK	33.8	64.8	61.6	59.9	38.3	19.2
SEM (interaction)	4.0					

SEM = standard error of the treatment means tabulated. PLK = 'Pukekohe Longkeeper'; ELK = 'Early Longkeeper'.

(Table 5). For PLK, the average yields of marketable bulbs of > 57 mm diameter were less in 1981–82 than in the two later seasons. This was caused primarily by the increased incidence of bolters in the 1981–82 season. In all seasons, yields increased from the first sowing date (averaging 40 t/ha) to the third sowing date (averaging 75 t/ha), and then declined to the sixth sowing date (averaging 30 t/ha). For ELK, the yields in all seasons increased from the first sowing date (averaging 38 t/ha) to the second sowing date (averaging 57 t/ha), and then declined to the sixth sowing date (averaging 14 t/ha).

DISCUSSION

The experiments described here have shown how the balance between quantity and quality of yield is affected by sowing date, for the two major onion cultivars grown in New Zealand. The quantity of yield is determined primarily by the size of the plant when bulb formation commences (Brewster 1977) which, in turn, is controlled principally by day length (Magruder & Allard 1937). Accordingly, total yield should increase as the sowing date becomes earlier because the period of plant growth (and, hence, plant size) before the critical day length for bulb formation is increased.

There was a limit, however, to which total bulb yield recorded in this study could be increased by advancing the sowing date, because yields from the first and second sowing dates were less than that for the third sowing date, particularly for PLK. Sowing too early severely affected yield by increasing the incidence of bolting. This was more prevalent in 1981–82 than in later seasons, particularly for PLK, and coincided with lower than average temperatures in July and August of that season. Bolting may occur after the plant is exposed to low temperatures (Thompson & Smith 1938), although the critical temperature and the necessary duration of exposure have not been defined for PLK and ELK. Bolting was more prevalent in crops that emerged before (rather than during) the period of lowest temperatures in winter, and, hence, it appears that the plants needed to attain a critical size before they were receptive to the bolting stimulus (Voss 1979).

Crop maturity was little affected by sowing date. Earlier sown plants have more leaves and, hence, thicker necks (Hutton unpublished data) which may delay maturity. It is generally accepted, however, that the time from commencement of bulb formation to bulb maturity is related to environmental conditions during that period only, and little affected by previous growth or plant size (Voss 1979). Hence, attempts to advance crop maturity by advancing the sowing date have been essentially ineffective.

The yield decline with later sowing dates probably resulted primarily from a declining bulb size, because there was usually little variation in plant densities between the second and sixth sowing dates. In this way, sowing date affected the bulb quality as well as yield, because smaller bulbs have a lower market value per unit weight than larger bulbs. Accordingly, the effect of sowing date on yield of bulbs of > 57 mm was greater than the effect on total bulb yield.

The extent of the yield decline with delayed sowing dates was slightly greater for ELK than for PLK. Onion varieties are known to vary in their critical photoperiods for bulb formation (Abe et al. 1955), so this result probably reflects differing suitability of these cultivars for temperature and photoperiod conditions at the experimental site.

Maximising marketable yield therefore requires that sowing dates be advanced no further than the point at which bolter yield becomes significant. This date varied for the two cultivars tested here, being early June for ELK and late June for PLK. These dates approximated the second and third sowing dates respectively. The results presented in this paper agree broadly with those of Maeso (1980), Sinclair (1983), and Grauert (1985) for varieties grown in a wide range of latitudes. Our research has defined clearly the effects of sowing date on the balance between quantity and quality of yield of the cultivars PLK and ELK, and should clarify decisions for sowing times to maximise marketable yield of onions at Pukekohe.

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