Achievement of maximum seed yield in coriander (*Coriandrum sativum* L.)

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Abstract

Coriander seed production was investigated in 1994/95 at Lincoln (43° S) to determine the optimum time of harvest for maximum viable seed yield. Seed yield, thousand seed weight (TSW), seed moisture content and germination were recorded at 2 day intervals from 21 days after peak flowering (DAF) to 58 DAF. Maximum yield and quality of coriander seed was reached at 37 DAF and maintained for 10 days before yields declined. At this time seed germination was 66-72%, TSW 10.1-10.8 g, seed moisture content 25-45% and viable seed yield was 680-813 kg/ha. The number of days from sowing to harvest and from peak flowering to optimum harvest time varied considerably between years; most of the variation was explainable by the degree days required for development. A seed moisture content of between 40 and 45% is likely to be the best guide for timing the harvest.

Additional key words: *Coriander,* Coriandrum sativum, *germination, moisture, seed yield, thousand seed weight, time of harvest*

Introduction

Coriander (*Coriandrum sativum* L.) is an annual herb belonging to the family Umbelliferae and is a native of the Mediterranean region. It is one of the earliest spices used by mankind and is cultivated extensively for seed and as a herbal crop in India. It is also found widely in the countries of the former USSR, central Europe and Asia.

The young plants are used in chutney, sauces, curries and soup. The dried fruits are an important ingredient of curry powder, pickling spices, sausages, seasonings, confectionery, pastries, buns, and cakes, and are also used in flavouring gin and other spirits (Ridley, 1912). Coriander is used medicinally for a number of purposes, particularly as a carminative. The fruits and the oil are used as a flavouring agent to cover the taste or correct the nauseating or griping qualities of other medicine.

Coriander is a slender, erect plant which grows to a height of 20-90 cm. Flowers are small, pink or white borne in compound umbels about 4 cm across. The umbels have no definite pattern of emergence on the plant, and an umbel may give rise to a shoot which develops into another umbel. Flowers at the outside of the umbellet bear 3-4 large petals in each flower. Flowers in an umbellet commence blooming at the periphery. The average number of flowers per umbellet is four and there are about five umbellets per umbel, hence producing about 20 flowers per umbel. Hermaphrodite and staminate flowers may occur in each umbel, but there is much cross-pollination, mainly by bees. The fruits are nearly globular, 3-4 mm in diameter and consist of two halves known as a schizocarp (2 mericarps).

The only previously published New Zealand work on coriander seed production (Wati, 1981) was undertaken in the North Island. This project was undertaken to evaluate seed production and seed development of coriander in Canterbury, the research supporting trials on the potential of coriander seed and foliage as possible finishing feeds for livestock to impart desirable flavours to meat (W. Rumball, pers. comm., AgResearch).

Materials and Method

The experiment was conducted on a Templeton silt loam at Lincoln (43°S) in 1994/95. Coriander was sown at 20 kg/ha in 50 cm wide rows on 12 October, 1994. The treatments were arranged. in five randomised complete blocks, with time of harvest being the main treatment. Superphosphate (0-9-0-11) at 100 kg/ha was applied before sowing and nitrogen was applied as urea at 96 kg N/ha in a split application in early and late spring. The crop was sprayed with linuron at 500 g ai/ha on 14 November, 1994 for the control of annual broadleaf weeds and grasses.

Peak flowering was determined by visual scoring. Plots were harvested starting early February at 2 day intervals commencing 21 days after peak flowering (DAF) using a sample size of 0.5 m x 0.5 m. Harvesting started at 10 am and comprised cutting the stems at ground level and storing the cut material in hessian bags to prevent seed loss.

The seed moisture content at each harvest was measured from fresh seeds from plants selected at random, using an infra-red heat lamp for 20 minutes. Seed samples were ambient air dried for 21 days and then hand threshed and cleaned using different size sieves. The dried seed was weighed to determine yield and the thousand seed weight (TSW) determined using 100 seeds from the dried sample from each harvest. Seed germination was determined using air dried seeds by placing the seeds on moist germination papers under continuous light at 20°C and counting germinated seeds at 7 and 21 days (ISTA,1993).

A seed multiplication trial with coriander was carried out at the same site in 1995 and near by on a heavier soil (Wakanui silt loam) in 1996. Data on number of days to flower and to harvest and the degree days (0°C base temperature) during the crop period were used to compared with those from this trial. Irrigation was used in all three sites.

Results and Discussion

Days to flowering and harvest

Peak flowering in coriander occurred at 95 DAS in 1994/95 and 104 DAS in 1996/97 (Table 1). This compares with 82 days reported for the North Island (Wati, 1981) and between 93-108 days for seven genotypes evaluated in India (Jindla *et al.*, 1985). From sowing to harvest required from 132 to 168 days (Table 1), and this compares with 110 days for the North Island (Wati 1981), and from 111 days (day/night temperature 24/12°C; 16 hours daylength) to 193 days (at 18/12°C with 10 hours daylength)as reported by Putievsky (1983).

Table 1. The effects of temperature (Degree days; Base 0°C) on coriander seed production

	Sowing dates		
	12 Oct '94	26 Oct '95	16 Oct '96
Sowing to peak flowering			
Degree days	1340	ND	1442
Number of days	95	ND	104
Peak flowering to harvest			
Degree days	635	ND	972
Number of days	37	ND	64
Sowing to harvest			
Degree days	1958	2411	2399
Number of days	132	158	168
Seed yield (kg/ha)	1168	1110	2860

ND = Not determined

Degree days

The coriander seed crop required 1390 degree days from sowing to peak flowering, and 804 degree days from peak flowering to harvest (Table 1). From sowing to harvest over 3 years an average of 2256 degree days was required. This compares with calculations we made from the data of Wati {1981) of 1160, 464 and 1624 degree days from sowing to flowering, flowering to harvest and sowing to harvest, respectively. From sowing to peak flowering, both in our trials and in that of Wati (1981), required an average temperature of 13.9 to 14.1°C (degree days/number of days). In controlled temperature studies Putievsky (1983) reported that coriander growing at either 10 or 16 hours daylength, required 20 to 30 more days to reach harvest at 18°C than at 24°C.

Thousand seed weight

Physiological maturity can be defined as the point when seed reaches maximum dry weight (Harrington, 1972). The thousand seed weight at 21 DAF was 7.3 g. There was a rapid increase in seed weight of 0.23 g/day until 35 DAF, when the maximum of 10.3 g was reached. After this time the weight of seeds remained constant (Fig. 1).

Seed moisture

The seed moisture content (SMC) at 21 DAF was 69% with a large proportion (about 90%) of seeds being green and immature. Seed moisture content (SMC) decreased at around 1.5% per day from 21 DAF to 58 DAF by which time it was 12% (Fig. 1).

Germination

Germination (the proportion of normal seedlings) was just over 10% from seed at 25 DAF and increased at 4% per day reaching a maximum of 72% at 39 DAF. The remaining 28% of seeds did not germinate. There was no change in germination of seeds after 39 DAF (Fig. 1). The germinations reported here were considerably higher than those reported by Wati (1981) who used only 14 days (compared to 21 days in this study). The ISTA rules (1993) for coriander germination are 21 days.

Dry matter

In the 1994/95 season the crop dry matter reached 2000 kg/ha by 21 DAF and remained relatively constant until 58 DAF. Dry matter accumulation from sowing to 21 DAF was 15 kg/ha/day. In comparison the dry matter production in 1996/97 on a Wakanui silt loam soil was 9130 kg/ha, a production rate of 54 kg/ha/day. The 1996/97 crop not only produced more than four times the bulk, but had double the seed yield compared to the crop sown in 1994 (Table 1). This result suggests that seed yields are determined by rate of dry matter accumulation (which may be influenced by nutrients or water availability). This hypothesis needs to be tested.

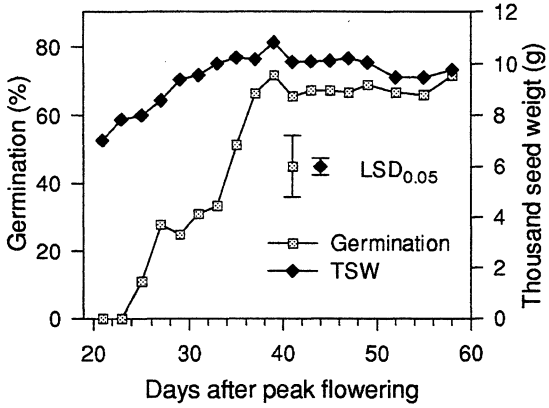

Figure 1. Changes in germination and thousand seed weight during seed development in coriander.

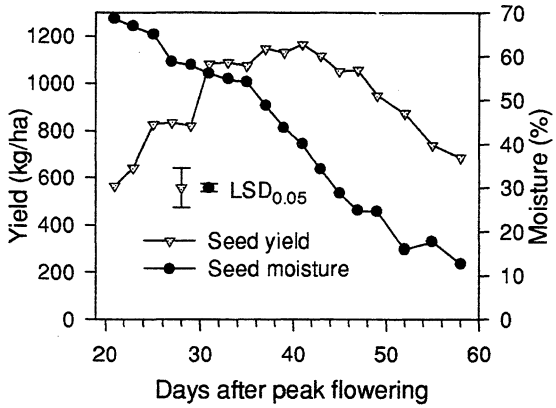

Figure 2. Changes in seed yield and seed moisture during seed development in coriander.

Seed yield

The seed yields in these trials ranged from 1110 to 2860 kg/ha (Table 1). These yields compare with those obtained by Wati (1981) of 800 kg viable seed/ha and (Rao *et al.*, 1983) of 750 to 880 kg viable seed/ha. In the seed development trial, seed yield at 21 DAF was low because a large amount of the seed was immature. Seed yield at 21 DAF was contributed largely by the primary umbels which represented only a small percent of the total. From 21 DAF seed yield increased rapidly (40 kg/ha/day) and reached 1063 kg/ha by 33 DAF (Fig. 2). At this stage, seed had a moisture content of 55%, germination of 33% and TSW of 10.1 g.

Harvesting at 37-47 DAF when seed moisture was 25-45%, germination was 66-72% and TSW was 10.1-10.8 g produced 1015-1168 kg seed/ha. However, the seed yield from the 1996/97 crop on a Wakanui silt loam soil produced 2860 kg/ha. This crop had more bulk (9130 kg DM/ha) and had developed under cooler conditions. This raises the question as to whether achieving more bulk, slowly, results in more umbels being produced. Soil type was probably also important as the Wakanui soil would have a greater moisture holding capacity and was probably more fertile. The importance of bulk and its effect on seed yield needs to be examined in a future trial.

Seed Shattering

Seed yields started declining after 47 DAF mainly due to seed shattering. Significant shattering losses occurred when SMC had reached 25%, a result similar to that of Wati (1981) who reported that shattering increased rapidly when seed moisture had reached about 27%.

General Discussion

Harvesting coriander before physiological maturity resulted in lighter seed, reduced viability and low seed yield. Delaying harvest until seed moisture reached 20% resulted in extensive seed loss through seed shattering. The optimum time to harvest must be determined by balancing changes in thousand seed weight, germination, seed yield and seed shattering. The highest seed yield occurred 37 DAF and was maintained for another 10 days until 47 DAF when seed germination was 66-72%.

Days from sowing, and days after peak flowering are not considered reliable indicators of time to harvest, as considerable year to year variation occurs. Degree days will give a better prediction, but seed moisture content of

40 and 45% for windrowing is likely to be the best guide for timing the harvest. Delaying the harvest had no detrimental effect on seed weight and germination but a reduction in seed yield is likely to occur, mainly due to the tendency of the seeds to detach from the plant when the seed moisture falls below 45%.

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