Effects of sowing time on pyrethrins yield of pyrethrum (*Tanacetum cinerariifolium)* in Tasmania

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ABSTRACT

The effect of sowing time on pyrethrum yield has not been reported in pyrethrum agronomy literature. A field trial was conducted on Tasmania's north coast to investigate the effect of September, October, November, and December sowings. Results from the harvest some 14 to 17 months later identified that while high yields were generated from October and November, poor yields were obtained in the September and December sowings. Low yield from the September sowing was attributed to low plant populations, while low yield in December was a result of low plant dry weight and fewer flowering tillers. Dry weight per flower (capitulum) increased with lateness of sowing. "In field time" had no influence on pyrethrins assay, number of flowers per tiller, or flower maturity.

KEYWORDS

Pyrethrum, pyrethrins, sowing time, yield, Tasmania, *Tanacetum cinerariifolium.*

INTRODUCTION

Regardless of whether a plant is an annual, biennial, or a perennial, certain environmental and endogenous requisites have to be satisfied before reproductive yield is achieved. In pyrethrum, vernalisation, photoperiod and juvenility have been investigated and found to potentially have an impact on the of pyrethrum plants flowering behaviour.

Working in a highland tropical region, Glover (5) identified that intensity of flowering was directly related to number of hours at or below 16?C in the previous three months. To initiate flowering, temperatures must fall below 16?C for six weeks. During this time, if the plant was exposed to temperatures above 24?C for a week, bud initiation was inhibited (5). Where plants were cultivated in lowland tropical environments, they were often found to remain vegetative or 'blind' as they failed to receive the cool period essential for flower initiation. Vernalisation is therefore an essential requirement for flower initiation in pyrethrum. In Tasmania's cool temperate climate, summer maximum temperatures average 18-20?C and winter maximum temperatures average 10-12?C. As such, the vernalisation required for flower initiation is satisfied (7). Temperatures required for vernalisation (3) indicate that in Tasmania vernalisation requirements are met in every month of the year.

The influence of photoperiod on flowering in pyrethrum has also been investigated (3). Light tunnel experiments demonstrated that increasing photoperiod had a quantitative positive effect on both initiation and subsequent flower development. Increased flowering was considered to be a result of the higher daily light integral rather than due to any photoperiodic effect.

A juvenile phase period in which both seedlings and splits are not able to respond to flowering-inductive conditions has been described (3). Brown (3) observed that attainment of meristem competence to flower was linked to the release of lateral buds from apical dominance. Concurrent to this, older axillary meristems (further away from the meristem) lose their competence. Light tunnel studies (3), which compared competence to flower of splits and seedlings, revealed that seedlings were very slow to respond to inductive conditions, taking some 190 days longer to initiate flowers than did the splits.

Bhat (2) investigated the effect of planting date of splits on flower yield and reported that yield declined significantly with later sowings. Conversely, pyrethrins concentrations varied little between treatments, a finding which was in agreement with earlier investigations (8).

Since pyrethrum crops are now established from seed in Tasmania, the impact of sowing time on yield needed investigation. A Tasmanian autumn trial (4), with monthly sowings from January to April identified that the percentages of the plants that flower by February in the year following sowing decreased with lateness of sowing. The mean number of flowering tillers on the flowering plants was also found to decline with lateness of sowing. Limited growth and delayed plant development contributed to low yield in the January sowing and later sowings. Yields generated in the following February after autumn sowings were considered too low to be commercially viable. The current work reports on a trial conducted in the spring of 1996 that investigated the influence of spring sowing times on pyrethrins yield and yield components.

MATERIALS AND METHODS

The trial was established at Forthside Vegetable Research Station (FVRS) (41?10'S, 146?40'E) on the western part of Tasmania's north coast. Seed was sown in mid September, October, November and December of 1995. The trial was laid out in four randomised complete blocks, Plots were 18.0 m long and beds were 1.6 m wide. Four rows per bed were sown with a between-row spacing of 300 mm. Preparation of the field included mouldboard ploughing in September, drill application of 750 kg/ha of 14:16:11 (N:P:K), and subsequent incorporation. Sowing was conducted on 5/10/95 using a tractor mounted Ojoid trial drill. Seed was provided by British Oxygen Company (BOC) was Pyper 3A95F and was reported to have a germination capacity of above 80 per cent. Two to three months following sowing, when plants were rosettes of approximately 40 mm diameter, an attempt was made to thin treatments thin to a common density of 10 plants/m2.

The trials were irrigated using solid set micro-irrigation sprinklers and a commercially recommended plant protection regime was employed. Data were analysed using Systat 5.2.1™ software. Analysis of total pyrethrins (1) was conducted on the stored samples after a period of storage. Storage of dried pyrethrum flowers (capitula) even at room temperature does not result in decreased pyrethrins (6).

Harvest was conducted in late January, 1997, some 14 to 17 months after sowing. Plants from two middle row lengths (each 3.0 m) were harvested at ground level and the plant density was recorded. Flowering tiller number per plant was assessed from each harvested plant. Plants were stripped of flowers, weighed and bulked with flowers from other plants from the plot. Before stripping flowers, one third of the plants were randomly selected and six tillers were again randomly selected from each to obtain data on mean flower number per tiller. Flowers from the selected tillers were subsequently stripped and returned to the bulked flowers sample. Mean flower dry weight was determined by obtaining a 200 flower sample and drying at 70?C for 24 hours. Approximately 200 g of fresh flowers were sub-sampled and dried at 50?C before being placed in sealed plastic bags and stored at -18.0?C ready for pyrethrins assay (1). A further sample of 200 g of fresh flowers was taken from each plot for analysis of mean flower maturity as measured by FMI (4). Harvesting plots as described above allowed for both assessment of actual plot yield and calculation of yield from yield components. Yields "calculated from components" were generated by the multiplication of individual plot dry matter yield components and then multiplying that figure by a common pyrethrins assay. The resultant 'plot products' were then subject to ANOVA.

RESULTS AND DISCUSSION

By late January, plots were ready for harvest and treatments had been in the ground for between 14 months (Dec.) and 17 months (Sept.). The highest yields were achieved in the October and November sowings and lower yields in the September and December sowings (Table 1). Lower yield in the September treatment was due to lower plant densities (Table 2). Although the plants responded to the lower density by increasing tiller number (Table 2), this was not sufficient to compensate for the lower density. The number of flowers/tiller did not vary from the September to the high yielding October and November treatments whereas mean flower weight did, with weights increasing with sequentially later sowings. Pyrethrins concentration and mean flower maturity did not vary between sowing times. Therefore low plant density and lighter flowers were responsible for low yield in the September sowing.

The low yield in December (the treatment in the ground for the shortest period of time) could not be explained by low plant density or low dry weight per flower. The dry weight per plant (125 g in December) was significantly less than in the preceding two sowings and the tillers/plant was the yield component responsible for lower yield in the December treatment. Counteracting the influence of lower tillers/plant was a significant increase in mean dry weight per flower. In summary, low yield in December was due to smaller plants producing a lower number of flowering tillers. Determination of whether plants can compensate for low tiller numbers by increasing mean flower weight, or whether the observed flower weight increase is due to some other mechanism, is worthy of further investigation.

Table 1. Actual and calculated pyrethrins yields from time of sowing trial, January 1997.

Assessment type	Spring trial pyrethrins yields				Statistical significance
	Sept	Oct	Nov	Dec	
Actual yields (kg/ha)	49.5	82.0	86.3	57.4	p < 0.0001, LSD = 12.8
Yields calculated from components (Table 2)(kg/ha)	61.2	94.7	95.9	64.0	p < 0.027, LSD = 27.2

Results presented in Table 1. indicate that calculated yields overestimate, but follow the same trend as actual yields. Least significant differences were consistently higher for the calculated yields owing to the multiplication of error from each yield component. The comparison provided confidence that yield component data were truly representative of the plants sampled.

Table 2. Yield components, plant dry weight, and flower maturity from sowing treatments.

Parameter	Sowing time				Significance, LSD(0.05) or mean and SE
	Sept.	Oct.	Nov.	Dec.	
Density (plants/m^2)	7.6	10.1	11.0	12.0	
Mean (DW) per plant (g)	188	214	204	125	P < 0.05, LSD = 68.5 g/plant.
Flowering tillers/plant	49	43	37	20	P < 0.0005, LSD = 9.71 tillers/ plant
Flowers per tiller	4.28	4.51	4.16	4.48	(NS) mean 4.36+/-0.32
Dry weight per flower (g)	0.21	0.24	0.28	0.30	P< 0.0005, LSD = 0.033 g/flower
Pyrethrins assay (% DM)	1.90	1.94	2.00	1.91	(NS) mean 1.94+/-0.08
Flower maturity index	678	660	657	659	(NS) 664+/-15

Plant density in the September sowing was variable and lower than in the other treatments. Mean dry weight per plant data demonstrates a reduction in the December treatment. Dry weight per flower increased with lateness of sowing. Flowering tillers per plant declined significantly from November to December. Flower number per tiller and pyrethrins assay were not found to vary with sowing time.

The study indicated that choice of sowing time could have a profound influence on yield and its components. Data indicate that there would be little advantage in sowing crops earlier than mid-October and the opportunity for high yield may decline if sowings are attempted after mid-November. High yields in crops sown after mid-November would be limited by the small plant size and the inability to generate high numbers of flowering tillers. The decrease in flowering tillers per plant reported to be responsible for the decrease in yield in December is compensated to some extent by the increase in mean flower weight.

Since some yield components are now known to vary with respect to time of sowing and density, whereas others remain relatively constant, more effective measures of yield for both trials and commercial crops may be developed. Evidence presented in the above trials indicate that tiller number per plant, and mean flower dry weight are yield components that vary significantly with time of sowing, while pyrethrins concentration and mean flower number per tiller varied little.

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