Knowledge of stand variability aids interpretation of hand-thinned experiments

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Summary. Plant stands with reduced plant density and uneven plant spacing may reduce grain yield of sunflower *(Helianthus annuus L.).* A field experiment was conducted to quantify yield compensation patterns in suboptimal plant stands. The data set was used to demonstrate the variation which may exist within hand-thinned treatments. Frequency distributions of the area per plant and coefficients of variation of plants within treatments showed the presence of outliers which were unrepresentative of the intended treatments. The elimination of these individuals improved the pattern of treatment response. A knowledge of this variation may aid interpretation of field experiments, where some stand variation is observed.

Introduction

Poor crop establishment may cause major loss of grain yield in sunflower *(Helianthus annuus* L.) (I). Sub-optimal plant density and unevenness in plant spacing reduce yield in sections of the crop because the available resources are not fully utilised (2). However, sunflower plants can compensate for gaps in the plant stand, so the benefit of replanting may not be clear. This project aims to quantify the compensatory ability of sunflower plants. to define the yield reduction expected from poor plant stands and to identify when replanting may be beneficial.

A field experiment was conducted to study the effect of sub-optimal plant density and uniformity on grain yield and the ability of neighbouring plants to compensate for gaps and clumps in the plant stand (3). Variable plant stands were created in the field by hand-thinning. These data provided the opportunity to examine the variation which may exist within treatments in hand-thinned experiments. This paper discusses the accuracy of hand-thinning techniques, the implications for interpretation of data and a method of recovering useful results from a variable data set.

Methods

A field experiment was established at Emerald, central Queensland (23? 30'S, 148? 10'E) on a black cracking clay soil (Ug 5.12), with a preplant fertiliser application of 100 kg N/ha and 30 kg P/ha. Sunflower (cv. Hysun 33) was planted on 12 February 1992 at greater than 100,000 plants/ha in 0.8 m rows and hand-thinned 2 weeks after emergence. Pre-marked dowel (length 1.25 m) was used for evenly spaced treatments, and ropes (length 18 m) marked with plant positions used for variable spacing treatments (3). The trial was furrow irrigated to preclude moisture stress. The crop suffered from some weed competition prior to thinning; these weeds were controlled by 28 days after sowing by two applications of a post-emergent herbicide.

Treatments comprised four levels of plant density (10,000, 20,000, 30,000, 40,000 plant/ha) and three levels of uniformity in plant spacing (coefficient of variation (c.v.) = 0%, 43% and 85%) in a randomised complete block design with three replicates. Distances between plants within the row were measured, and plants were individually harvested and weighed at maturity. Grain weights were obtained for about 25% of heads and the remaining grain weights were estimated by regression from head weights. Area and c.v. of the distance to nearest neighbours (within row) were calculated for each plant. Yield data were subjected to analysis of variance. Frequency distributions of area per plant and c.v. of plant spacing were then constructed for each density and uniformity treatment, respectively. Individual plants greater than one standard deviation from the treatment mean were removed and the data re-analysed.

Results

The response to density and uniformity was difficult to interpret in the initial analysis of variance. Plant density increased grain yield between 10,000 and 20,000 plants/ha, but uniformity of plant spacing and its interaction with plant density had no significant effect (Fig. 1). Frequency distributions of area per plant showed that some treatments contained individuals whose area was not representative of the intended treatment (Fig. 2). Frequency distributions of c.v. of plant spacing showed a similar pattern (Fig. 3). When outliers were removed, the statistical significance of treatment combinations did not change. However, the pattern of yield response to plant density was clarified. In the initial data, the density response may have been affected by the greater yield of the c.v.= 85% treatment at 20,000 and 30,000 plants/ha. In the adjusted data, the yield response did not change between 20.000 and 40,000 plants/ha (Fig. 4).

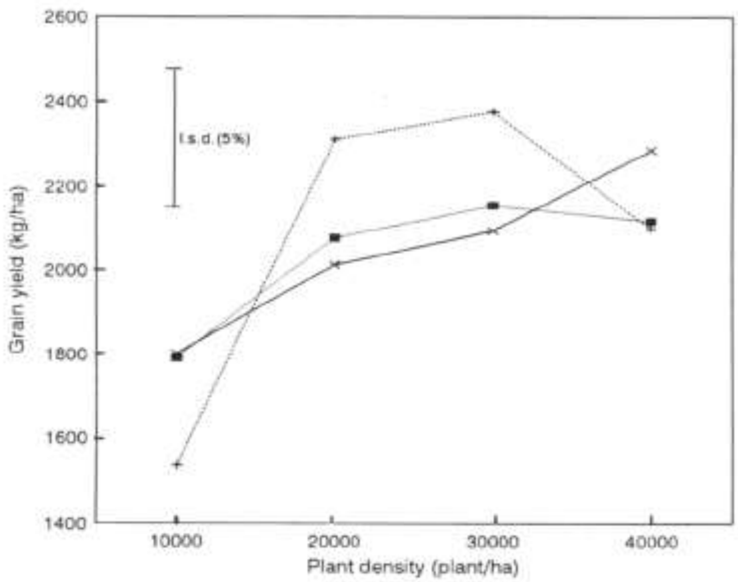

Figure 1: The effect of plant density (10000, 20000, 30000, 40000 plant/ha) and uniformity in plant spacing (c.v.=0 ? , 43 ■ , 85% +) on the grain yield of sunflower (cv. Hysun 33) at Emerald, Queensland.

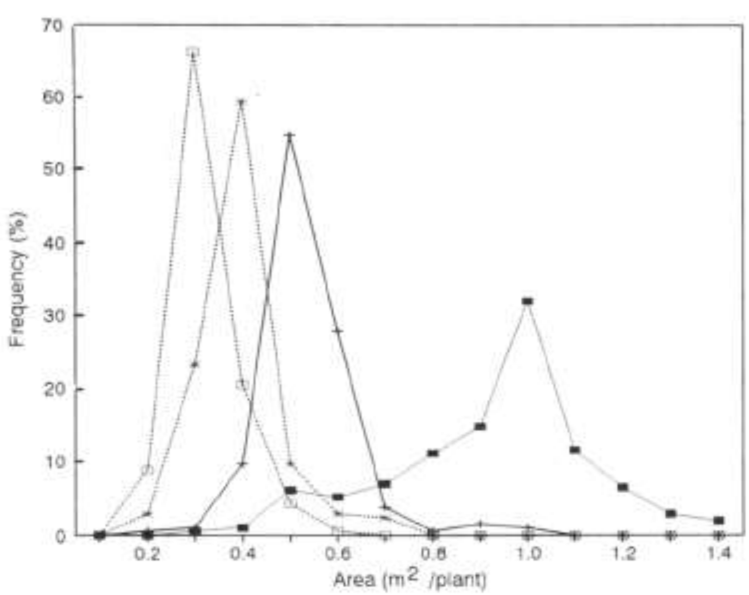

Figure 2: Frequency distribution of area per plant in four plant density treatments (10000 ■ , 20000 + , 30000 ?, 40000 □ plant/ha), following hand-thinning of a field experiment at Emerald, Queensland.

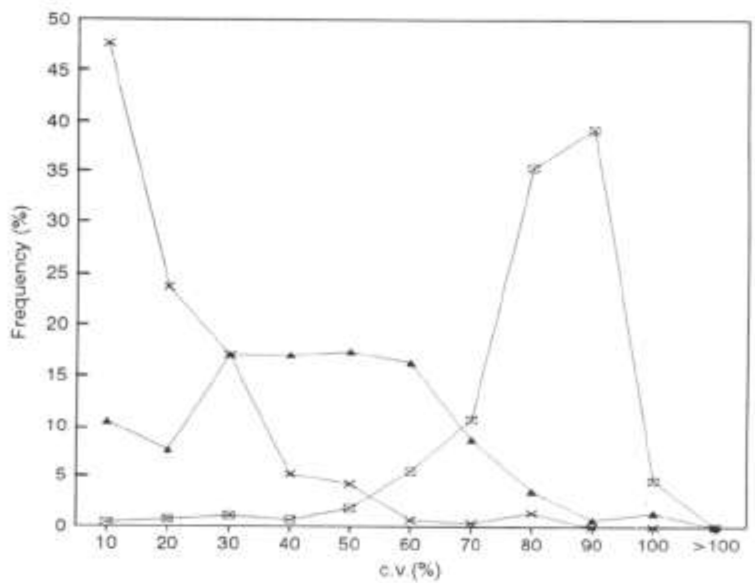

Figure 3: Frequency distribution of coefficient of variation (c.v.)of plant spacing in three uniformity treatments (c.v. =0 ? , 43 Δ , 85% □) following hand-thinning of a field experiment at Emerald, Queensland.

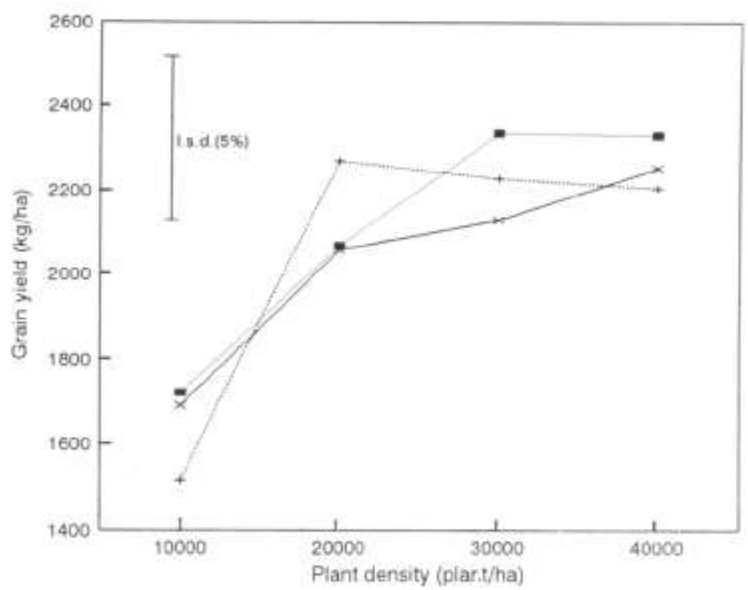

Figure 4: Effect of plant density and uniformity (c.v. =0 ?, 43 ■, 85% +) on yield of sunflower, after removal of individuals with area or c.v. > 1 standard deviation from treatment mean.

Discussion

The frequency distributions of area and c.v. per plant demonstrated the variability which existed within treatments, even in a hand-thinned experiment. Some data points may not be representative of the intended treatment and may bias the results. In this case, the density response was easier to interpret, even though statistical significance did not change.

Variability within treatments may have been caused by the inaccuracy of the hand-thinning techniques. Pre-marked dowel seems suitable for plant population treatments where uniformity of plant spacing is not critical. Ropes marked with plant positions may be more suitable where complex plant distribution patterns are required. Early weed growth may also have hidden some emerging plants during the thinning process. This emphasises the importance of establishing a good plant stand and ensuring that treatments are accurately implemented.

Interplant spacing data can be used in trials to give a measure of the variation which exists within treatments. A knowledge of stand variation will allow better interpretation of data and in some cases may explain unexpected results. Interplant spacing data can be used to modify the original data set, by removal of unrepresentative individuals. This ensures that sampled data are more typical of the intended treatment, simplifying the analysis and interpretation of-results.

Acknowledgements

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References

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