A preliminary evaluation of in-season variations in sprinkler irrigation application patterns

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Summary

Sprinkler irrigation uniformity varies substantially between irrigation events and single irrigation event evaluations should not be extrapolated to whole season performance. The spatial pattern of low uniformity applications appear reasonably consistent and are likely to be dominated by design and maintenance issues. The frequency distribution of high uniformity applications are more normally distributed than for low uniformity applications.

Introduction

The pattern of sprinkler irrigation applications is a function of both the system characteristics (e.g. sprinkler head design, spacing, height and nozzle size) and the operating conditions (e.g. operating pressure, wind speed and direction). Thus, both the pattern of irrigation application and the measure of uniformity would be expected to vary within the irrigation event (Dechmi *et al*. 2003) and throughout the season (Martinez *et al*. 2003; Mateos 2006). However, irrigation performance evaluations are commonly conducted over only a single irrigation event and there is little local published information on the size and nature of seasonal variations in irrigation application patterns.

Methods and Materials

Trials were conducted over two seasons to evaluate the in-season variation of sprinkler irrigation application uniformity and the pattern of distribution. In each season, grids were established to measure the spatial pattern of a "control" sprinkler area (each sprinkler operating at the design pressure) and two "poor" uniformity areas where the sprinkler heads and/or operating pressures were modified to reduce the uniformity. The uniformity (Christiansen 1942) of water application in each area was measured using 42 catch cans arranged in a square grid pattern (spacing 1.50 x 1.56 m). Only the uniformity data for the last five irrigation events in each season (i.e. ~ 5 week period) is reported here.

Results & Discussion

The uniformity of water application in the poor grids was generally less than 60% while the uniformity of the control grids was approximately 80%. However, substantial variations between the uniformity of individual irrigation events were observed (Table 1).

Table 1: Coefficients of uniformity measured over five irrigation events in each season.

Season	Control	Poor 1	Poor 2
Autumn	76-89%	53-67%	66-82%
Winter	80-88%	37-65%	46-64%

Substantial variations were found (data not shown) in the spatial patterns of irrigation application with the patterns being relatively consistent during the season when the Christensen's coefficient of uniformity (CU) was low. However, there was low consistency in the spatial patterns of application for the higher uniformity control plots. This suggests that for low uniformity systems the patterns are likely to be dominated by system infrastructure characteristics (e.g. nozzle discharge due to operating pressure, nozzle type or wear) while for relatively high uniformity systems (i.e. CU > 75%) the spatial pattern is more greatly influenced by environmental (e.g. wind speed or direction) conditions.

Frequency plots of the normalised water depth (Figure 1) show a wide variation in the range of water volumes applied within the grids. The frequency plots vary from irrigation to irrigation throughout the season and presumably reflect the changes in the spatial pattern of applications. The frequency plots of the application depths were generally bimodal or skewed for the low uniformity grids but were more normally distributed as the uniformity increased (Figure 1). For high uniformity applications, while the specific spatial water application pattern may be difficult to predict, the normal shape of the frequency plot suggests that estimates of water applied at grid and whole field scales should be consistent.

These results suggest that it is generally inappropriate to extrapolate single irrigation event performance evaluation data to whole season responses. The dominant spatial features of the application pattern may be consistent between events where low application uniformity is observed. However, with high uniformity, the spatial patterns will vary but water application and variance measured at the grid scale should be consistent.

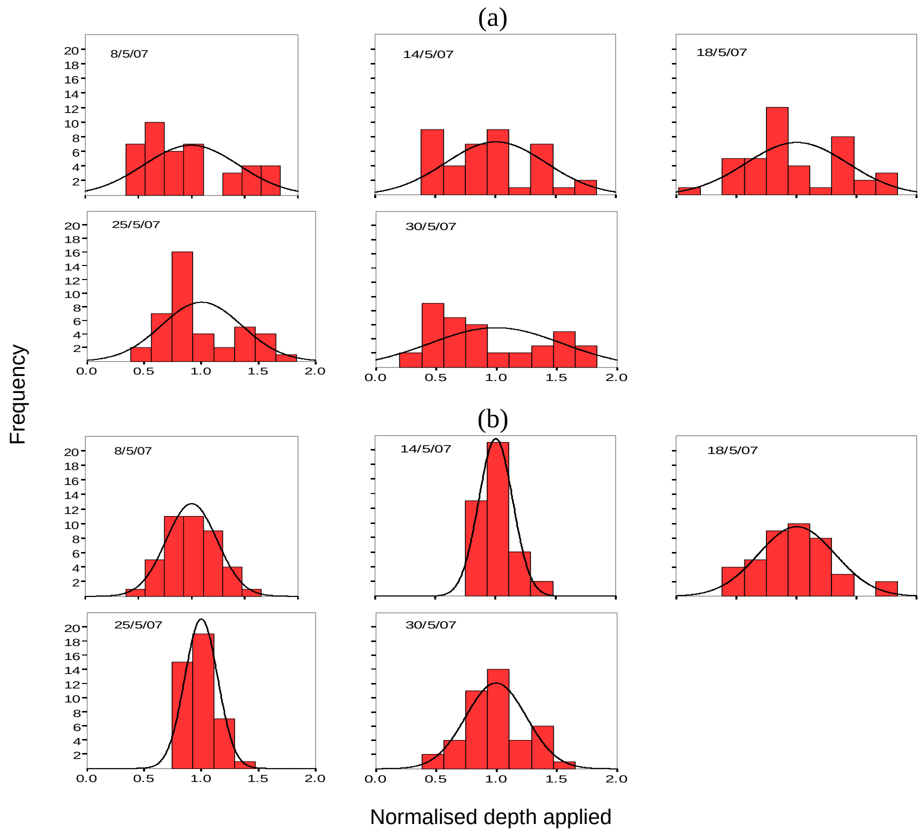

Figure 1: Frequency plots of the normalised depth of water applied to the (a) Poor-1 and (b) Control grids during the autumn trial. Solid line shows a normal distribution for comparison.

References

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