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# Image analysis to determine vegetative cover of leafy spurge

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## Introduction

Ocular plant canopy cover is useful to describe trends following certain treatments (Brown 1954). However, ocular estimates of cover can be highly biased and influenced by the subjectivity and judgement of the observer (Bonham 1989). Image analysis offers technology which could be useful to determine vegetative cover with less bias. In image analysis, a video image is digitized into pixels which are assigned numeric values. The pixels can then be quantified. Comprehensive personal computer based software packages for image analysis have recently been developed.

The objective of this study was to determine if an image analysis program could separate leafy spurge from other component species in a quadrant and measure leafy spurge cover, and to compare the image analysis method of estimating leafy spurge cover to the ocular cover method.

## Materials and methods

### Image generation

In 1993, leafy spurge canopy cover was measured ocularly in the field at forty $0.1m^2$ sampling loci in each of eighteen plots. Plots were located near Glasgow, MT, Grassrange, MT and Mackay, ID. At a later date, color print photos one meter above ground level were taken at the sampling loci using a 35mm camera. Two independent observers determined ocular cover for each photo. A cover value was also determined for each photo using Jandel Video Analysis Software.

### Image processing

To obtain cover values using Jandel Video Analysis Software, each photo was converted to a digital image composed of pixels with grey values that could range from 0

to 255. Leafy spurge cover was estimated by selecting the grey value range that corresponded to leafy spurge in the image, producing a binary image where all pixels in the selected range were white and all pixels outside the range were black, and determining the percentage of white pixels.

### Data analysis

To compare the precision of the ocular and image analysis cover estimates, 10 photos were selected which ranged in cover from 0 to 95 percent. Four independent observers ocularly estimated leafy spurge cover ten times for each photo on different days. Similarly, leafy spurge cover was estimated ten times for each photo using image analysis. Precision was defined as the relative measure of the reliability and repeatability of the estimates. The variable used to measure reliability was the mean cover value for each photo. The variable used to compare repeatability was the variance of the repeated measures for each photo. Analysis of variance procedures were used to compare the means and variances. The reliability of the image analysis method was also tested by comparing the image analysis cover estimates to the ocular cover estimates made in the field and by the two observers from the photos using analysis of variance procedures for all the sampling loci together and for the sampling loci at each of the eighteen plots. Tests for correlation were used to further compare the ocular and image analysis estimates.

## Results and discussion

Image analysis was capable of separating leafy spurge from other component species in a quadrant. This is attributed to leafy spurge's significantly higher reflectance measurements which result in different digital values from those of associated vegetation and soil (Everitt *et al*. 1994).

Image analysis could estimate leafy spurge cover with the same level of precision as the ocular cover method. The means and variances of the repeated measures made on the ten photos by image analysis and ocularly by four observers did not differ ($P > .05$). The image analysis method had a lower variance than the three of the four observers. Nutter *et al*. (1993) found image analysis estimates of percent disease severity of bentgrass more precise than ocular estimates of disease severity.

Comparison of the means for the image analysis versus ocular cover methods for all the sampling loci together revealed that the ocular estimates of leafy spurge cover made in the field and from the photos by one of the two observers did not differ from the image analysis estimates ($P > .05$). The mean of the ocular estimates of the second observer differed ($P > .0001$) from image analysis by 4.2%. The correlations between image analysis and ocular estimates of cover produced r-values (P values >.0001) of 62%, 2) 77%, and 91%.Other researchers have calculated coefficients of determination (R ranging from 75 to 99% when image analysis was compared to other assessment methods (Meyer *et al*. 1988, Meyer and Davison 1987).

Comparison of the means for the image analysis versus ocular cover methods for the sampling loci at the eighteen plots revealed no differences between the image analysis

estimates and any of the ocular estimates in at least 13 of 18 or 72% of the tries (P>.05). When image analysis did differ from the ocular estimates it was not consistently higher or lower than the ocular estimates for any given plot.

## Conclusions

Image analysis can separate leafy spurge from surrounding vegetation and soil and quantify leafy spurge cover. The image analysis method of determining leafy spurge cover is as precise as the ocular method and in this study agreed with the ocular method at least 72% of the time. An advantage of the image analysis method is that the photographic images provide a permanent record. Disadvantages are the cost of the system and the additional time taken to process the photos. Further research will compare the image analysis method to biomass estimates of leafy spurge.

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