89-541-J

Reprinted from *Agronomy Journal*
Vol. 82, No. 6

RAPID MEASUREMENT OF CROP CANOPY COVER

D. V. ARMBRUST*

Abstract

Studies of photosynthesis, transpiration, water erosion, and wind erosion can require measurement of crop canopy cover, the percent of the soil surface covered by plant foliage. This study was conducted to evaluate the meter-stick method and an electronic method of measuring canopy cover for accuracy, speed, and ease of use. Canopy cover of winter wheat [*Triticum aestivum* L.], corn [*Zea mays* L.], and soybean [*Glycine max* (L.) Merr] was measured weekly in 1988, using a meter stick and a DECAGON Ceptometer. Canopy cover ranged from 74 to 97% for wheat, 2 to 95% for corn, and 2 to 65% for soybean. There were no significant differences in canopy cover determinations by the two methods. The Ceptometer was faster, simpler, and as accurate as the meter stick.

CANOPY COVER, the percentage of the soil surface covered by plant foliage, is often measured in studies of photosynthesis, transpiration, and wind and water erosion. Measurement of canopy cover has been done by visual estimates (Richardson et al.,1975), light interception (Adams and Arkin, 1977), overhead photographs (Mannering and Johnson, 1969), and meter sticks (Miller, 1969). Adams and Arkin (1977) evaluated two electronic sensors [spatial quantum sensor (SQS), and traversing quantum sensor (TQS)], overhead photographs, and the meter stick for canopy cover determination in cotton [*Gossipium hirsutm* L.], soybean, corn, grain sorghum [*Sorghum bicolor* (L.)], and sunflower [*Helianthus annus* (L.)]. They placed the meter stick, SQS, and TQS parallel to the row and took readings every 5 cm across the row. One reading perpendicular to the row with the meter stick and the SQS were also compared. Adams and Arkin (1977) concluded that the meter stick perpendicular to the row was as accurate, simpler, and more economical than the other methods. Electronic sensing rated lower because no equipment was commercially available at that time. This study reports a comparison of the meter stick method and a commercial meter.

USDA-ARS, Room 105-B East Waters Hall, Kansas State Univ., Manhattan, KS 66506. Contribution from the USDA-ARS in cooperation with Kansas Agric. Exp. Stn., Contribution no. 89-541-J. Received 4 Aug. 1989. *Corresponding author.

Published in Agron. J. 82:1170–1171 (1990).

Materials and Methods

'TAM-105' winter wheat was planted 28 Sept. 1987 in 0.2-m rows. The final stand was 185.9 plants m^{-2}. 'Desoto' soybean was planted 13 May 1988 in 0.76-m rows. The final stand was 12.3 plants m^{-2}. 'B73 × Mo17' corn was planted 10 May 1988 in 0.76-m rows. The final stand was 5.9 plants m^{-2}. Rows were oriented north-south. Three sample areas, each 2 by 0.76 m for corn and soybean and 2 by 1 m for wheat, were selected immediately after planting, and five positions in each sample area were marked as locations for canopy cover measurements. Readings were taken weekly, perpendicular to the row from row center to row center, at those sites using the meter-stick method and a DECAGON Sunfleck Ceptometer[1] (Decagon Devices, Inc., Pullman, WA) near solar noon (1134 CDT + or − 1 h), if the sun was shining. Corn was sampled from plant emergence to physiological maturity, wheat from spring greenup (10 Mar. 1988) to physiological maturity, and soybean from emergence until the access between rows to read the meter stick became impossible without damaging the canopy (1 July 1988). Measurements from the five positions were averaged and these averages were used in correlation analysis using SAS (SAS Institute Inc., 1985).

The Ceptometer is a light sensing bar 0.82 m long, 10 mm wide, and 15 mm high, containing 80 sensors 10 mm apart. During operation the Ceptometer is placed directly on the soil surface as level as possible, although exact leveling is not required. The microprocessor scans the sensors, finds the highest light reading on the bar, sets the threshold at one-half this value, counts the number of sensors above the threshold, divides by the total number of sensors, and displays the reading as a percentage. Canopy cover is 100 minus the display reading. In our study ten individual readings were averaged by the microprocessor.

The shaded area on the meter stick was measured to the nearest 10 mm at each site and divided by the row width (0.76 m) in corn and soybean and by 4-row widths (0.80 m) in wheat.

[1] Trade names are given for information purposes only and do not indicate an endorsement by the USDA.

Results and Discussion

Canopy cover measurements taken with the Ceptometer were slightly higher than those obtained with the meter stick for all three crops (Fig. 1), but the slopes and intercepts of the regression lines did not differ at the 0.05 level from the 1:1 lines. The relationship for wheat was the poorest, but samples were taken only after canopy cover was >74%. The corn and soybean relationships were very good, $r^2 > 0.98$.

The meter stick is extremely hard to read when the wind is moving the leaves. The estimation of the edge of the leaf shadows on the meter stick at a particular time may account for the lower readings with the meter stick. Small shadows of the wheat leaves can be detected and integrated very rapidly and more accurately with the Ceptometer.

Both methods of determining canopy cover require full sunlight to make accurate measurements. The Ceptometer was approximately 30 times faster than the meter stick, especially on windy days. Ten readings or more at three sites could be taken, averaged, and recorded, in the time needed to read the meter stick once. The Ceptometer does not require a reading be taken above the canopy, as does the SQS (Adams and Arkin, 1977). With the Ceptometer, obtaining canopy cover of small grains and other grasses is as simple as obtaining it for row crops.

The Ceptometer and the meter stick measure sunflecks or shadows in plant canopies. The two methods produce equivalent estimates of plant canopy cover, however the Ceptometer is much faster than the meter stick method, especially for canopies of small grains and grasses. If rows are orientated north-south and sun angles are high, near solar noon, both methods should be accurate as overhead photographs for estimating canopy cover (Adams and Arkin, 1977).

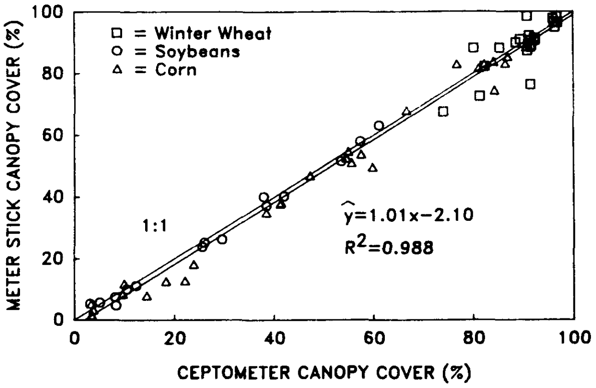

Fig. 1. Comparison of canopy cover of winter wheat, corn, and soybean measured by the meter-stick method and an electronic method.

References

Adams, J.E., and G.F. Arkin. 1977. A light interception method for measuring row crop ground cover. Soil Sci. Soc. Am. J. 41:789–792.

Mannering, J.V., and C.B. Johnson, 1969. Effect of crop row spacing on erosion and infiltration. Agron. J. 61:902–905.

Miller, P.C. 1969. Tests of solar radiation models in three forest canopies. Ecology 50:878–885.

Richardson, A.J., C.L. Wiegand, H.W. Gausman, J.A. Cuellar, and A.H. Gerbermann. 1975. Plant, soil, and shadow reflectance components of row crops. Photogramm. Eng. 41:1401–1407.

SAS Institute, Inc. 1985. SAS/STAT guide for personal computers. Version 5 ed. SAS Institute, Inc., Cary, NC.