Leaf Area, Solar Radiation Interception and Dry Matter Production by Soybeans

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The dependence of dry matter (DM) production rate of crop communities on quantity of leaf surface has been well established (2, 4, 8, 10). The relevance of leaf area has been shown to be due to its influence on radiant energy interception. Thus, Brougham (2) found that both percent solar radiation interception and rate of DM production increased with leaf area development and approached a maximum at similar leaf area indices (LAI). However, there is disagreement concerning the nature of the photosynthetic response at LAI exceeding that required for maximum interception and production. Whereas some species have been shown to describe an "optimum LAI" (i.e., rate of DM production is a maximum at a particular LAI and is less at LAI below or exceeding this value), the mixed, forage community investigated by Brougham (3) and the maize communities of Williams et al. (11, 12) continued to produce DM at maximum rate at LAI above that required for maximum interception. Since both rate of DM production and radiant energy interception approached a maximum asymptotically, Brougham (3) defined an arbitrary maximum, the "critical LAI", which is the LAI required to give 95% interception at local noon.

Assuming that there is little difference between the "optimum" and the "critical" LAI in defining maximum energy interception, the significant difference between them is the response of the community at LAI exceeding the "optimum" or "critical" value. Since there are several indications

1 Joint contribution of the Iowa Agricultural and Home Economics Experiment Station, Ames, Iowa (Journal Paper Nos. 1487 and 1179) and the Crops Research Division, ARS, USDA (Paper No. 415 of the U. S. Regional Soybean Laboratory). Received June 18, 1965.
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3 Subterranean clover (Trifolium subteranneum) (1, 4, 9); kale (Brassica sp.) (10); rice (Oryza sp.) (8).

4 Cumulative LAI from the community surface to the compensation point, and, since in leaves below the compensation point respiration was expected to exceed photosynthesis, the LAI of maximum photosynthetic rate of a community (7).

5 Mixed sward of "short-rotation ryegrass" (Lolium sp.), red clover (Trifolium pratense) and white clover (Trifolium repens).

6 Differential planting pattern might be expected to influence solar radiation interception, especially in the earlier stages of plant development. To minimize this effect a single planting pattern adaptable to varying populations was required—i.e., a pattern providing the same relative spatial relationships between plants while, simultaneously, permitting variation in plant population and, therefore, in LAI. Moreover, for the data to have theoretical significance, an optimum arrangement of plants must be realized—permitting equal competition from all sides and, thus, a pattern in which, at any given population, all the interplant spaces are likely to be filled in at the same time. An equidistant spacing pattern is compatible with these requirements. Plants, thus arranged, form a hexagonal pattern, within which the simplest repetitive unit is a rhombic or "diamond-shaped" pattern.

Soybeans (Glycine max (L.) Merr.) variety 'Hawkeye', were planted on May 17 and thinned at the unifoliate stage to give a hexagonal pattern with populations of approximately 17,5, 31 and 52 thousands of plants per acre (hereinafter referred to as E-1, E-2 and E-3, respectively—E for equidistant). The treatments were replicated three times, and were kept weed-free.

Samples for LAI and DM determination were taken at 6 stages of development, 2, 3, 4, 5, 7 and 9 (6), briefly described as: 3 trifoliolate leaves, 5 trifoliolate leaves, mid-bloom, full bloom, beginning seed formation, and maximum DM. LAI was determined from 3, 4, and 6 plants, while DM was determined from twice this number for E-1, E-2, and E-3.

Dry matter accumulation was taken as the weight after drying to constant weight in a forced-air drier at approximately 70 °C.

Leaf area was measured with an optical planimeter. Leaves were pressed between two plastic sheets and inserted into a light field. The reduction in light transmission was linearly proportional to leaf area in the field. The optical planimeter was calibrated with soybean leaf-punch samples (1 microamp. red'n = 25.12 ± 0.77 cm²).

MATERIALS AND METHODS

Published November, 1965