Procedure. Add to 1 ml of the digest 3 ml of the diluted mixed reagent I and 1 ml of reagent II. Mix after each addition and measure the absorbance after 1 hour at 880 nm. The colour is stable for at least 10 hours.

Discussion. For a number of different soils the results of the determination of 'total' N and 'total' P with the proposed procedure were compared with the separate digestion procedures (as mentioned earlier). The values obtained in the single digest agreed well with those obtained by the standard methods (see Table 1).

In practice we use Aerosol 22, because it is available as a solution.

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This synopsis is based on internal analytical methods used in the Department of Soil Science and Plant Nutrition. A copy of the detailed method 'Determination of 'total' N and 'total' P in soils' is available free as a paper copy from: Dept. of Soil Science and Plant Nutrition, Agricultural University, De Dreyen 3, 6703 BC Wageningen, Netherlands.

Netherlands Journal of Agricultural Science 32 (1984) 324-327 SYNOPSIS

Competition between a maize crop and a natural population of *Echinochloa crus-galli* (L.) P.B.

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Abstract. In a field exeriment, competition between a maize crop and a naturally established weed population, dominated by *Echinochloa crus-galli* (L.) P.B. (barnyard grass), was studied. At the average *Echinochloa* density of 100 plants m^{-2}, the yield of maize was reduced to only 18 % of that of the weed-free control. This yield reduction strongly varied with years and the observed variation was probably related to differences between crop and weed in time of emergence. Experimental results were compared with the results of a simulation model for competition for light and water in crop-weed associations.

Key-words: competition, simulation, maize, weed, *Echinochloa crus-galli.*

Introduction. Weeds compete with a crop for the growth limiting resources like light, water and nutrients. Competition processes can be studied by following the distribution of the main resources over the species and the resulting growth of the species in course of time. Spitters & Aerts (1983) approached this with a deterministic model, named WEED-CROP, which simulates competition for light and water between a crop and weeds. They validated the model using the results of two field experiments. In this study, a third field experiment was carried out and results were compared with the performance of an improved version of the model.

Experimental design. Maize, cv. LG11, was grown at 30 × 30 cm^2 $plant^{-1}$ with and without a natural vegetation dominated by *Echinochloa crus-galli* at a sandy soil in Wageningen in 1983. The time course of the biomass of the species was followed by frequent harvesting. For each of the harvests, the yields in mixture were interpolated to the average density of 100 *Echinochloa* plants m^{-2} by means of a weighted multiple regression procedure (Spitters, 1983). *Echinochloa* gave a statistically significant reduction of maize biomass at all harvests ($P < 0.05$), whereas the other weeds did not affect maize significantly. Therefore, only *Echinochloa* was considered further.

The model WEED-CROP. In the model WEED-CROP, competition between a crop and weeds for light and water as growth-limiting resources is simulated. Daily assimilation, respiration and transpiration of the species are calculated and from that their daily dry weight increment in dependence of available soil moisture. Light is distributed among the species according to their share in total leaf area, with an adjustment for differences in plant height. Water is distributed among the species according to their demand.

The following improvements were introduced in the version as described by Spitters & Aerts (1983). In modelling the light distribution over the species, allowance is made for differences in light absorption per unit leaf area by weighting the leaf area of each species with its extinction coefficient. In the simulation of the reduction of water uptake caused by soil moisture shortage, account is made for the influence of the evaporative demand by the procedure presented by Doorenbos & Kassam (1979).

Around Day 225 (1 January being Day 1), soil moisture was depleted down to wilting point over the entire rooted profile. As in these C_4 species, on the average 100 kg water was transpired for each kg of dry matter produced, each additional

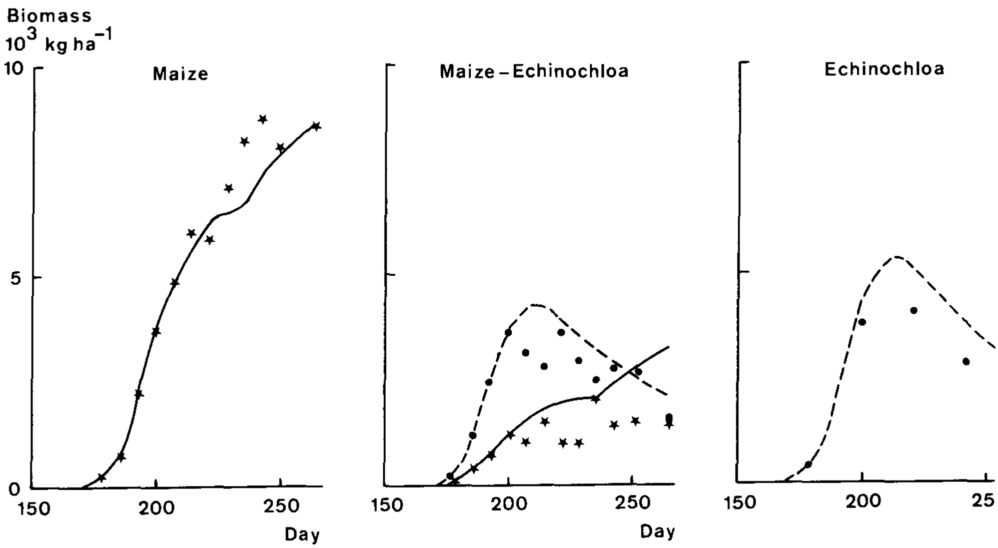

Fig. 1. Simulated time course of above-ground biomass of maize and *Echinochloa* in monoculture and mixture. Asterisks and dots represent data points.

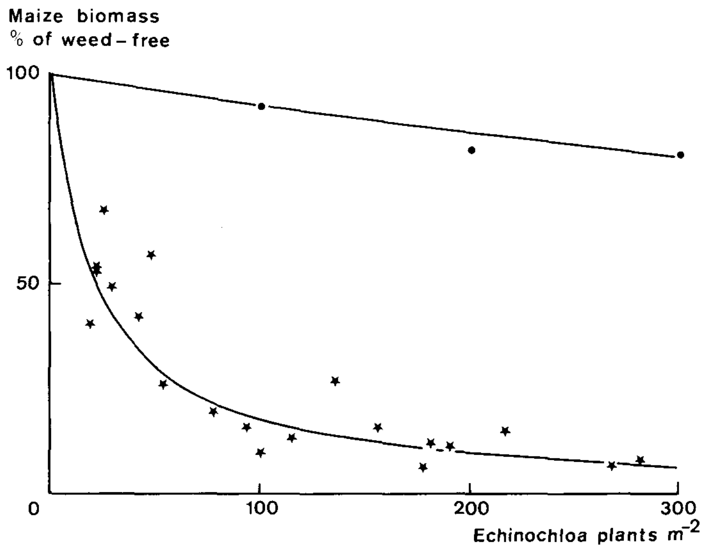

Fig. 2. Final above-ground biomass of maize in 1982 (●) and 1983 (*), expressed as % of weed-free control, in dependence of initial density of *Echinochloa*. Curves were based on a regression of the reciprocal per-plant weights of maize on weed density, including yields of weed-free maize plots.

mm of soil moisture available for the vegetation gave an additional production of 0.1 t/ha^{-1}. Therefore, the simulated biomass appeared to be very sensitive to the simulation of the water balance. For example, an exact input of field capacity and wilting point over the rooted depth was of prime importance.

Results. The simulation results agreed well with the observed dry weight increments (Fig. 1). Only the growth of maize in mixture after Day 205 was overestimated, which was due to the extreme water stress experienced by the maize plants in mixture. After Day 205, they did hardly grow any more probably because of a deterioration of their photosynthetic apparatus, a phenomenon that was not accounted for in the model.

The results of this experiment were compared with those of a similar experiment, carried out by G. Coster in 1982 at the same site (Fig. 2). The large difference in yield reduction of maize between both experiments was probably confined with the difference in time of emergence of the species. In 1983, maize emerged at Day 156 and *Echinochloa* at Day 154, while in 1982 emergence was at Day 135 for maize and Day 140 for *Echinochloa*.

In the 1983 mixtures, the growth of maize was reduced already early due to competition with the earlier started *Echinochloa*. The early and severe competition reduced also the height growth of maize considerably so that the maize plants were not able to overtop the weed. This contrasted with the 1982 situation where maize took advantage of its earlier emergence. Moreover, due to its poor competitive ability in the very dry 1983 situation, even dying of leaf tissue occurred in the maize in the mixtures. A sensitivity analysis with the model emphasized the prime importance of differences in time of emergence in competition.

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