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Effect of plant size on the number of caryopses in barnyard grass, *Echinochloa crus-galli* (*Poaceae*)

Vliv velikosti rostliny na produkci obilek u ježatky kuří nohy, *Echinochloa crus-galli* (*Poaceae*)

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K e y w o r d s : *Echinochloa crus-galli*, plant size, production of caryopses, quality of caryopses

Production of caryopses in barnyard grass, *Echinochloa crus-galli* (L.) P. Beauv. was investigated. Sixteen plants of different size growing within a maize crop were marked, and their panicles harvested and number of caryopses recorded in 10 day intervals, between July 20 and August 31. Total production of caryopses over the whole period of seed production was proportionate to plant size. The plants produced 650 caryopses per 1 g of above ground dry mass, regardless of the number and size of tillers and panicles. The average number of caryopses per panicle increased with average mass of the tillers, and decreased in the course of the season. The mass of mature caryopses also decreased toward the autumn.

Introduction

Estimating production of caryopses in *Echinochloa crus-galli* (L.) P. Beauv. includes several difficulties. Mature caryopses are produced over a period of 2-3 months, and the late panicles appear long after the early ones had ripen. The size of plants and panicles varies considerably and the estimates of caryopses production are therefore often uncertain (Krippelová et Krippel 1955, Lhotská 1957, Hron et Zejbrlík 1974). The authors, who have made direct counts of caryopses, estimated the minimum production in small plants at a few caryopses, whereas the maximum production in large plants at as much as 40,000 caryopses (Hejný 1957, Holm et al. 1977, Barrett et Wilson 1981, Maun et Barrett 1986).

In this paper we investigate the quality and timing of caryopsis production of *E. crus-galli* plants in relation to plant size. Variation in panicle size and caryopses quality in the course of the growing period were also evaluated.

Material and methods

Sixteen plants whose shoots had no contact with surrounding plants were marked in a natural stand of *E. crus-galli* growing within a maize crop in Odolená Voda, 15 km north of Praha. The plants were selected to cover evenly the range of variation in plant size and number of tillers which occurred in the locality. They were marked on July 20, 1990, before mature caryopses became to drop from ripening panicles. Ripening panicles were then removed in ca 10 day intervals, and the number of caryopses was counted. On August 31, the plants were harvested and the number of tillers and dry (at 110°C) mass of above-ground parts (including dry panicles collected on earlier dates) determined. The young panicles collected on August 31 would ripe during September.

A few panicles might appear in October, but their contribution to total production of caryopses and plant mass would not be significant. The removal of unripe panicles may stimulate the growth of additional panicles which would not appear on intact plants, and cause an increase of seed production. According to a crude estimate on intact plants, the number of panicles may be maximum 1/3 higher in treated than in intact plants and the number of caryopses in the last (provoked) panicles 1/2 of the average over the whole season. The fraction of caryopses produced as a consequence of stimulation by harvesting the panicles (0.3 x 0.5 = 0.15) may be maximum 15% of the total production of caryopses.

In parallel, mature caryopses were collected from plants growing in the near surroundings of the marked plants, in 14 day intervals between August 1 and September 14. The caryopses were sampled by sweeping with entomology net made of dense tissue (calico). The sweeping net collects a part of mature caryopses of different size with the same probability. Hence, the sample collected in this way contains caryopses of different mass in the proportion similar to these released spontaneously from the plants at the time of collection. The caryopses were stored for 2 months at 25 °C and 40% relative humidity, and then weighed with 0.1 mg accuracy.

Results

Total number of caryopses produced per plant varied between 3,500 and 60,300, and was directly proportionate to above-ground dry mass of the plants which varied

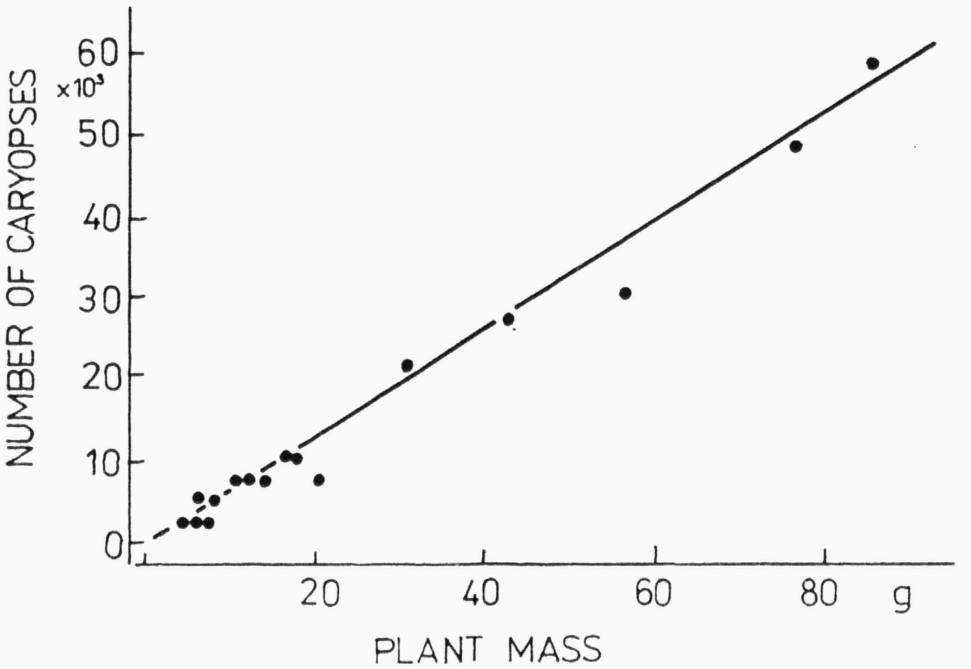

Fig. 1. - The relationship between dry mass of above ground parts of the plant and number of caryopses (thousands) produced throughout the period of maturation.
Reggression: $y = 645.7x + 824.9$, $r = 0.992$, $p < 0.001$, $df=14$.

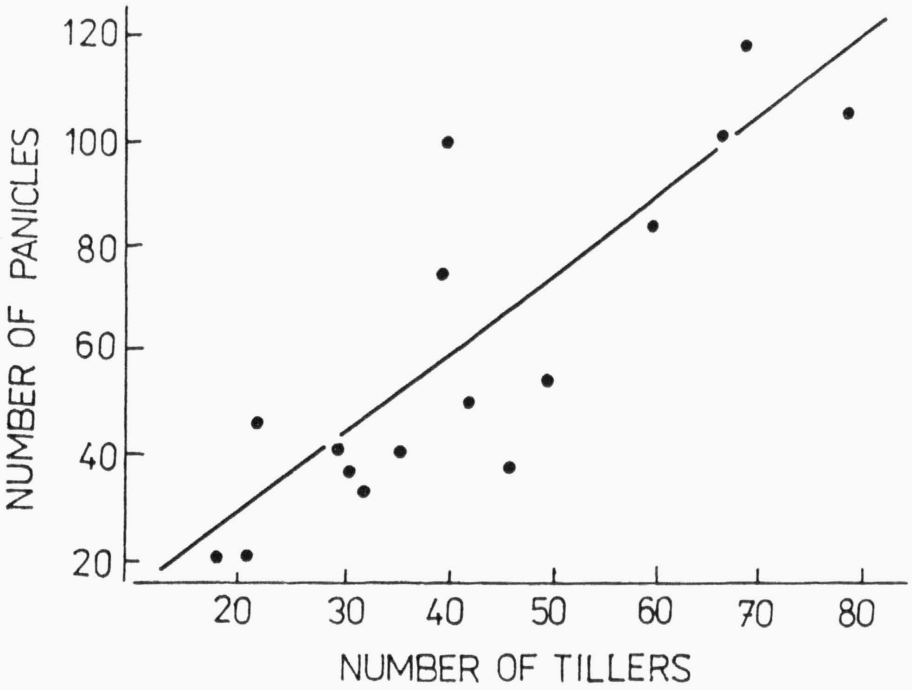

Fig. 2. - The relationship between number of tillers and number of panicles produced by a plant in the course of the season.
Regression: $y = 1.47x - 0.49$, $r = 0.843$, $p < 0.001$, $df = 14$.

between 3.9 and 86.5 g (Fig.1). The average production was 650 caryopses per 1 g of above-ground dry mass. The total production of caryopses was determined by the number of panicles and the number of caryopses within panicles. The number of panicles correlated with the number of tillers per plant (Fig. 2) but the number of tillers per plant was poorly related to plant size ($r = 0.513$). A plant of 76.6 g had 40 tillers, another plant of 30.0 g had 79 tillers. The number of panicles was correlated with tiller size and the large tillers produced up to four panicles during the period of caryopses maturation. The big plants had large tillers and these produced large panicles. First panicles on big tillers of large plants contained up to 1840 caryopses. The average number of caryopses per panicle on a plant was determined by mean dry mass of tillers, but the number of panicles per tiller had a small effect (Fig. 3). The early produced panicles were large, and the average number of caryopses in panicles harvested from three large plants on July 20 was 910-1325. Then, in the course of the growing period, the average size of panicles on different plants decreased from 228-726 caryopses on August 2 to 58-263 caryopses on August 31. The seasonal changes were greater in large plants where the average size of panicles decreased by (maximum) 5.1 times, than in small plants where the respective decrease was (minimum) 3.1 times.

The mass of caryopses which ripened and were collected on particular dates also decreased in the course of the growing period (Fig. 4), from average 2.15 mg on August 1 to average 1.20 mg on September 14.

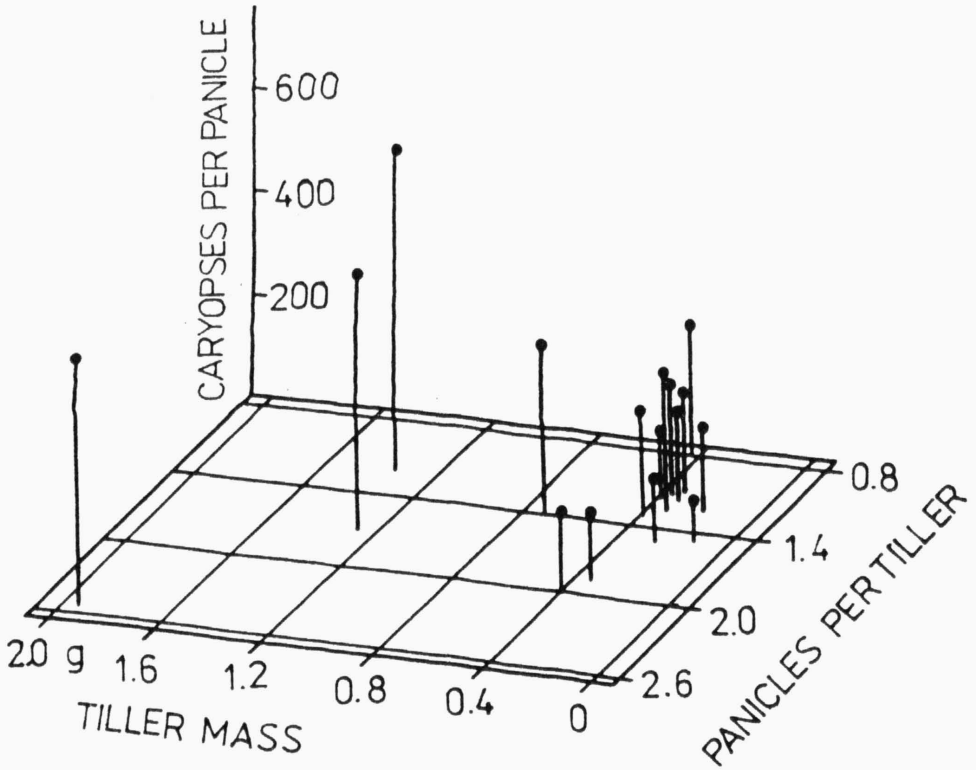

Fig. 3. - The relationship between average dry mass of tiller (g) and average number of panicles per tiller on a plant to the average number of caryopses in the panicles. Both dry mass of a tiller ($t = 14.23$) and number of panicles per tiller ($t = -5.21$) affected significantly ($p < 0.001$) the number of caryopsis per panicle. Multiple regression: $y = 347.5x - 147.9z + 274.9$, $R = 0.71$, $df = 13$.

Discussion

E. crus-galli is a species in which the plant size and other characters (e.g. root/shoot ratio) may vary enormously in response to environmental stress (Gebauer et al. 1987, Honěk et Martinková in press). However, production of caryopses per unit of dry above ground mass was similar in all experimental plants, regardless of the plant size. Production of caryopses is an important component of plant fitness. *E. crus-galli* is rather insensitive against different kinds of environmental stress which might influence its fitness by affecting the plant size. This plasticity is possibly an important factor contributing to the competitive success of *E. crus-galli* in competition with cultural plants.

The mass of mature caryopses varied in the course of the growing period. The largest caryopses were produced at the very beginning. The later decrease of the size of caryopses was perhaps due to difference between large panicles which matured early and may produce larger caryopses, and of small panicles which matured later and may produce smaller caryopses. Also the size of early and late ripening caryopses within the

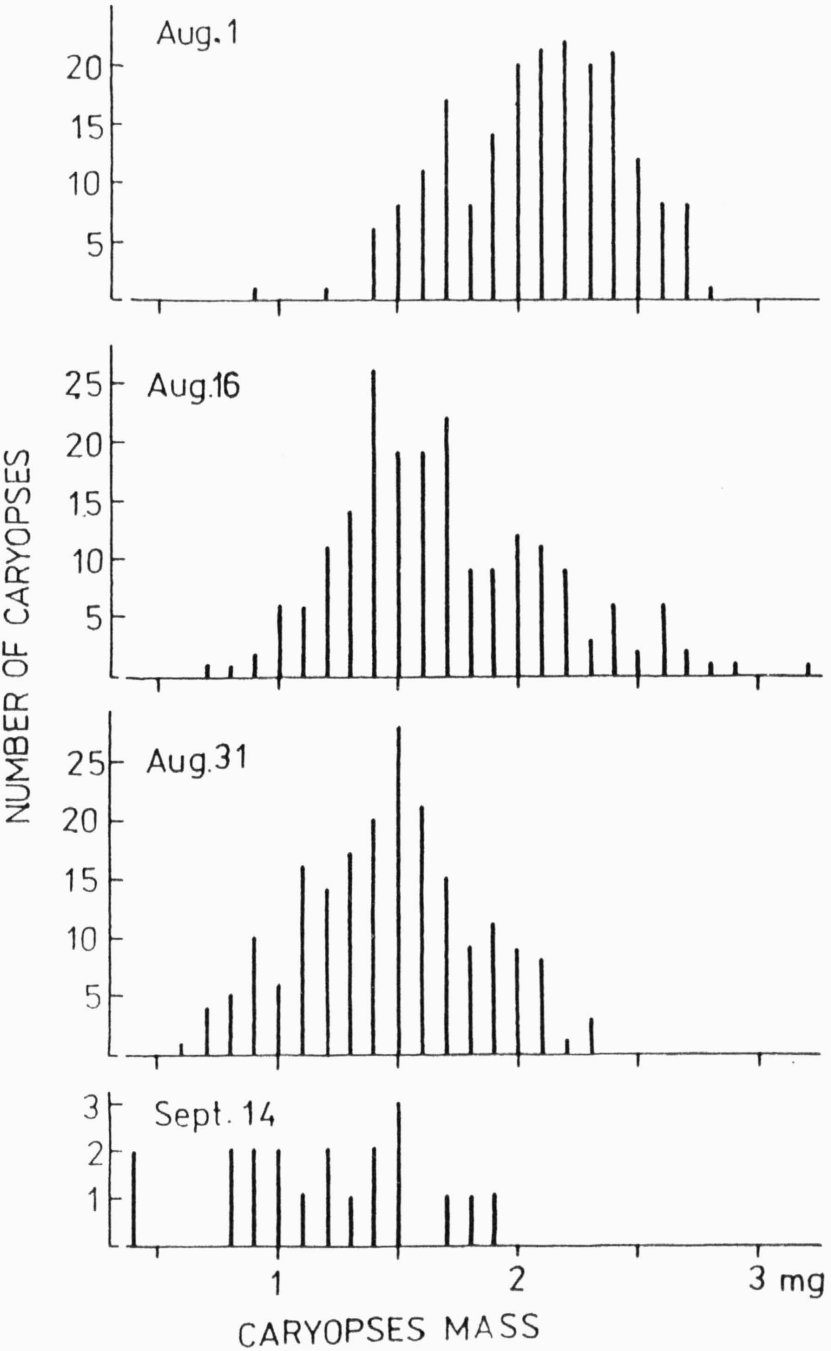

Fig. 4. - The distribution of the individual size of mature caryopses collected by sweeping with an entomology net on four dates during the period of caryopses maturation.

same panicle may decrease with time. The variation may have some significance in regulation of the annual cycle of this species. Seed dormancy in *E. crus-galli* is very plastic (Barrett et Wilson 1983, V. Kohout, pers. comm.). The duration of dormancy is partly determined by the size of caryopses (Honěk et Martinková in press). A fraction of early produced large caryopses may germinate shortly after they ripened, and a new cohort of seedlings may be established in the same year.

Souhrn

Sledovali jsme produkci obilek u ježatky kuří nohy, *Echinochloa crus-galli* (L.) P. Beauv, v závislosti na velikosti rostliny. V porostu kukuřice bylo označeno 16 rostlin různé velikosti, jejichž suchá nadzemní hmota (na konci pokusu) byla 3,9 - 86,5 g. Nezralé laty byly sklízeny v desetidenních intervalech v období od 29.7. do 31.8. Byl zaznamenán počet lat a počet obilek na latu. Ve čtrnáctidenních intervalech byly rovněž sbírány zralé obilky z rostlin rostoucích v nejbližším okolí sledovaných rostlin a zjišťována jejich hmotnost. Suchá hmotnost nadzemních částí rostlin (včetně dříve sebraných lat) byla zjištěna na konci sezóny. Celková produkce obilek na rostlinu závisela pouze na její hmotnosti. Sledované rostliny vytvořily za celé období v průměru 650 obilek na 1 g suché hmoty nadzemní části. Počet obilek na jednu rostlinu kolísal mezi 3500 a 60300. Průměrná velikost lat klesala se snižující se váhou odnoží a se stoupajícím počtem lat na odnož. Velikost lat klesala v průběhu sezóny. Hmotnost zralých obilek se rovněž snižovala během sezóny.

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