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Effect of grain size and shape on some characteristics of the development of young stage corn

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Abstract

In previous work (Bourdu and Gregory 1983), we showed that several parameters of the beginning of maize growth could be used for an intervarietal comparison. The same type of analysis was used to compare the effect of grain size and shape of the same corn variety (LG 11) on the characteristics of early growth. Seedlings from larger grains are found to exhibit higher growth rates; it is the same for those from round grains. However, if most characters are affected, there is one that remains constant: it is the one that measures the efficiency of use of seminal reserves for the construction of functional photosynthetic equipment. This characteristic can therefore be considered as a varietal constant.

The effect of seed size and shape on early development in maize.

In a previous paper in this series, we showed (Bourdu and Gregory 1983) that several parameters of early growth could be useful for intercarietal comparisons. We have used the same type of analysis to study the effect of grain size and shape in a variety of maize (LG 11). We found that large grains are associated with higher growth rates and that production forms better seedlings than flat ones. Most of these characters are affected by grain size and shape, but they are constant in the four-dimensional grain categories, ie the efficiency of utilization of maternal reserves for the photosynthetic apparatus. Thus this criterion can be considered as a genotypic characteristic.

Keywords: zea mays, germination, germination vigor, Zea mays, germination, seedling vigor

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INTRODUCTION

There is a fairly broad consensus in the literature to admit that the size of a seed has a favorable influence on the qualities of the young plant resulting from germination, or even on growth and final production. Published studies, some of which are very old (Jethro Tull 1733, Kiesselbach and Helm 1917), mainly - but not exclusively - concern cultivated legumes such as clover (Black 1957, Williams et al. 1968). or soybean (Fehr and Probst 1971, Fontes and Ohlrogge 1972, Ries et al. 1973) or cereals such as wheat (Kittock and Law 1968, Austenson and Walton 1970, Ries and Everson 1973, Puri et al. 1978, Hampton 1981), sorghum (Abdullahi and Vanderlip 1972), barley (Demirlicakmak et al. 1963, Kaufmann and Guitard 1967) or maize (Hammes 1969, Hunter and Kannenberg 1972, Burris 1977, Georgiev et al. 1979). The Correlations are established between seed weight or volume and early manifestations of young plant development such as germination and germination rate or seedling vigor at early planting. When the correlation is significant, we can say that the size of the seed is part of the description of this concept often used although ambiguous "quality of the seed".

But there is more, to the extent that certain works (Ahmed and Zuberi 1973, Clark and Peck 1968, Fehr and Probst 1971, Hunter and Kannenberg 1972, Puri and Quaiset 1978, Georgiev et al. 1979) show that the size of the initial investment (the seed) is reflected at the end of the chain, that is to say at harvest, we must consider that the effect "quality size" may exceed in its consequences the only manifestations physiological juveniles. The explanations must then take into account the lasting effect of an early manifestation.(Dadvar-Khani, and Ghanian 2016)

We have described in a previous work (Bourdu and Gregory 1983) a series of physiological events which occur during the germination, emergence and growth phases at the young stage of maize grown under controlled conditions. These quantified events make it possible to understand general metabolic characteristics. Variations intervarietals were shown. We hypothesized that some of these characters marked their direct or indirect influence on the subsequent properties of the plant (precocity, resistance to stress, productivity ...).

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The results presented here were obtained using the same methodological approach but, this time, to make an intravarietal comparison (LG 11), the variable being the weight and shape of the grains. It is shown that the weight of the seeds imposes an initial growth kinetics specific to each size with a reduced growth rate for the smaller sizes but that other characteristics such as the speed of setting up an efficient photosynthetic apparatus do not seem not affected. However, within the limits of the experiment, the qualities "size" and "initial form" of the seeds weigh of an increasingly heavy weight as a function of the time translating an obvious cumulative effect.

MATERIAL AND METHODS

The work was carried out on the genotype of corn "LG 11" whose seeds were divided into 4 lots characterized by their weight and shape:

- Small and flat seeds (= PP), average weight of 215 mg.
- Small and round seeds (= PR), average weight of 243 mg.
- The large and flat seeds (= GP), average weight of 313 mg.
- The large and round seeds (= GR), average weight of 352 mg.

These seeds were provided by the Plant Improvement Station, I.N.R.A., of Mons-en-Chausses. The experiment uses the modalities described in the work of Bourdu and Gregory (1983); only the principles will be recalled here. The individually weighed seeds were put for germination and development in individual pots filled with vermiculite soaked in nutrient solution (BB 'solution of Colic). The cultures were placed in conditioned enclosure (25 ° C the day and 22 ° C During the dark period of 8 am / 24h). The illumination maintained at the level of the apexes during the photoperiod (16 h / 24 h) was 220 j...12tMs.m-- From the 3rd day after the beginning of the imbibition (time 0) and every day, 6 plants were taken at the same time each day and according to a plan of The seedlings, on the one hand, and the rest of the seed, on the other hand, were separated and weighed before and after complete dehydration (80 ° C for 48 h). The culture experiments were repeated 3 times except for the GR batch which was the subject of only 2 experiments.

RESULTS AND DISCUSSION

When we consider the growth kinetics of the seedlings from the 4 seed lots (**Fig. 1A**), we find that there is a clear and significant difference between seedlings from large seeds and those from small seeds. The differences between round shapes and flat shapes in the 2 size categories are not significantly.

Marked only from the 6th or 7th day. However, it can be noted that throughout the curves the representative points of the round lots are systematically, although slightly, above the values obtained from the flat lots. This difference may not be due simply to the shape but prolong the difference due to the weight since in the lots of "big seeds" and "small seeds", systematically; the round shapes are heavier than the flat shapes. The linearity of the adjustments in **Fig. 3** would go well in this direction.

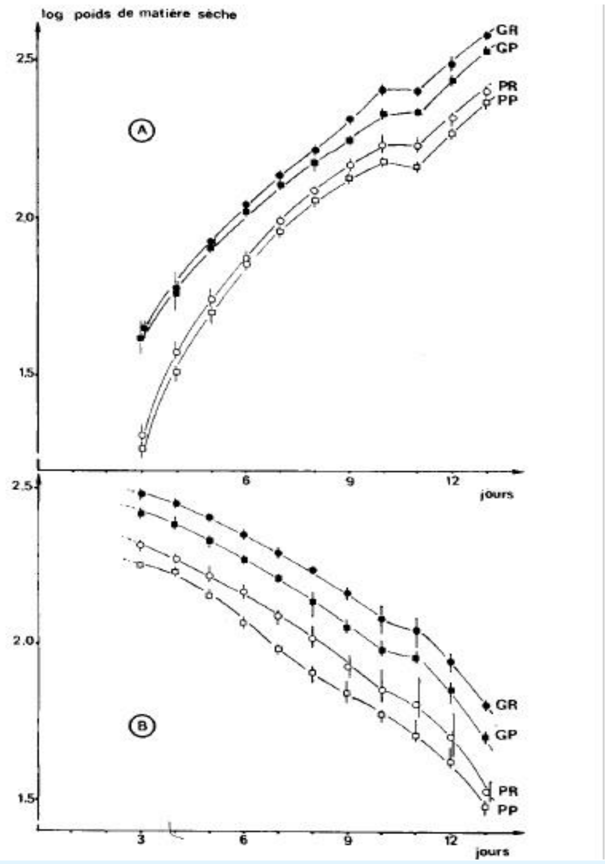

Fig. 1. Growth kinetics of the seedlings

We find, perfectly illustrated, the crisis that, in our experimental conditions, is here today. At this date, growth stops temporarily. This event was observed by Bourdu and Grégory (1983) and analyzed physiologically by Deléens et al. (1984). This is the moment when, during the development of the young plant, the translocation system is established which ensures the carbonaceous nutrition of the roots from the assimilated carbon in the young leaves. This crisis in growth seems to affect equally the 4 batches of plants. Quantitative verification is possible; one can, indeed, have an approach of the importance of this break in the kinetics of growth by calculating the difference which exists between the value actually recorded the day of this crisis (the 11th day, here) and a theoretical value obtained in averaging between the previous day and the next day, i.e. as if this crisis did not exist. We then assume a linear growth between the 1 st and the 1 st day, which is acceptable taking into account the values

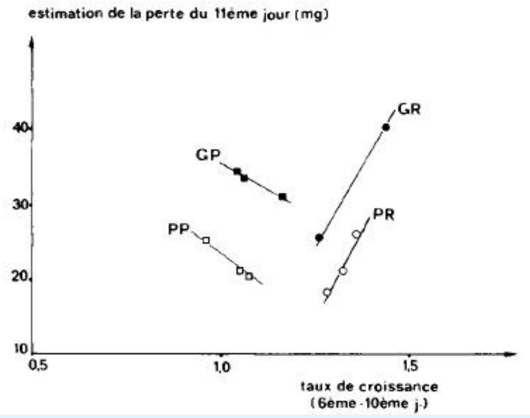

Fig. 2. Further clarification

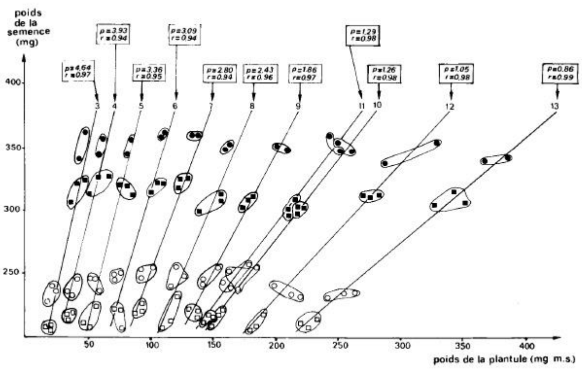

Fig. 3. The impact of the seed weight variable on seedling size

recorded just before and immediately afterwards. The "loss of profits" during this 1 day is always higher for plants from large seeds than for plants from small seeds.

However, **Fig. 2** provides further clarification. Since the limited number of experiments allows a conclusion, one might think that a correlation exists between the growth rate recorded just before the accident and the importance of this accident. This correlation would be negative in the case of flat seeds and positive in the case of round seeds. This remark, if confirmed by more observations, would undoubtedly find its explanation in the different structure of the embryos situated in the two types of grains.

The impact of the seed weight variable on seedling size can be assessed using the graph in **Fig. 3**. In this figure, the weight of the seedling at a given age, 3, 4, 5 days, etc. (Abscissa) is correlated with the initial weight of the seed (ordinate); each of the 4 lots is bounded by a closed curve and a linear adjustment line is drawn for each day taking into account all 11 cultures (3 repetitions per lot except 2 for the GR batch).

It can be seen, but this was already noticeable in **Fig. 1A**, that growing older, the seedling benefits more and more from the initial gain in size. During the first days (e3 and 4th days), the slope of the correlation line simply reflects the weight ratio between the albumen and the

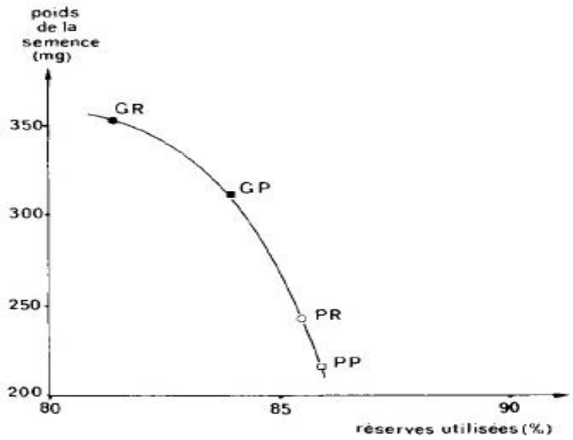

Fig. 4. Within the limits of experience, the use of reserves is deeper for small seeds than for large ones

integuments, on the one hand, and the embryo, on the other hand, but by afterwards, we observe a summation of the effects and the advantage is amplified in favor of the young plants from the larger seeds. We can notice that at day 1, day of the crisis, the correlation line has an origin whose shift simply reflects the slight regression of growth, but its slope is strictly identical to that of the first day, which means that the growth crisis marks a delay in the evolution of growth Development.

Fig. 1B shows the kinetics of decay of seed reserves. It shows the significant differences between the lots as well as the Lejolur accident where the slowdown of the depletion of the reserves is more marked for the big seeds than for the small ones. Within the limits of experience, the use of reserves is deeper for small seeds than for large ones (**Fig. 4**).

We had shown that another representation of growth could bring new information (Bourdu and Grégory 1983). This representation illustrated in **Fig. 5** gives, for each day, the ratio between the total weight of the germination (seedling + Reserves) measured to date and the initial weight of the seed. The duration of the phase during which this ratio remains less than 1 and the concavity of this phase were emphasized. We see in **Fig. 5** that there is a difference between lots, mainly between large and small seeds. While large seeds produce plants that gain weight equal to or greater than the initial weight (ratio> 1) on day 9, the others only exceed this limit between day 1 and day 1. This delay is due to the fact that the growth crisis, which is clearly visible on this kind of representation, keeps the young plants from small seeds longer in the ordinate part <1. This aggravation of the initial delay can be harmful. Important and sustainable to the subsequent development of the plant**.**

It is observed that in the concave portion of the curves, in the zone <1, the decrease in the ratio corresponding to the period during which the respiratory losses are not compensated by effective photosynthetic activity ceases very exactly at the same time.

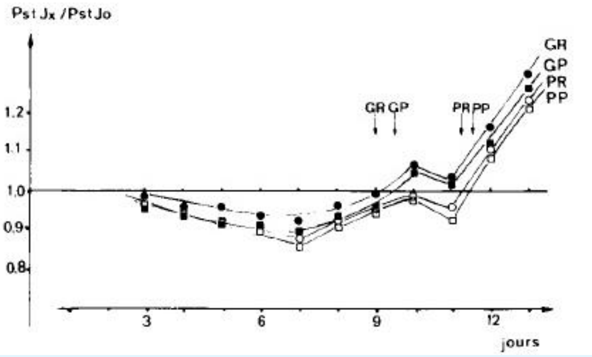

Fig. 5. Another representation of growth could bring new information

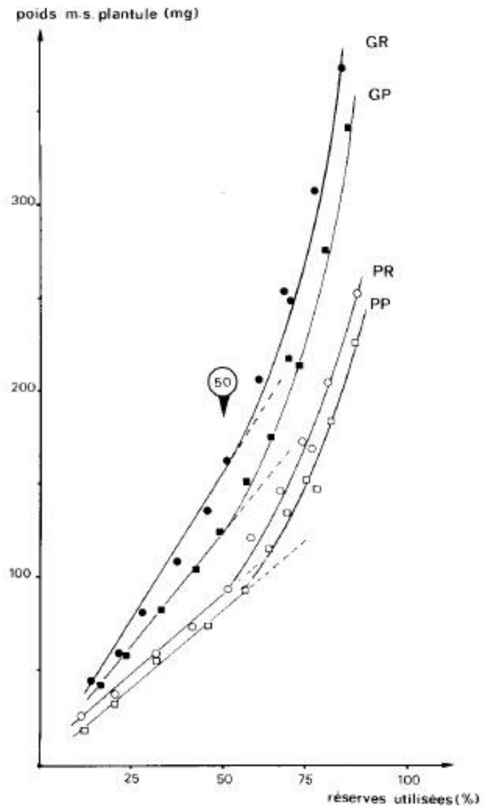

Fig. 6. The dry matter weight of the seedling over time as a function of the quantity

Moment for all batches, the 7th day in our experimental conditions. This means that the time required to create a photosynthetic device capable of compensating for carbon loss activities is independent of the size and shape of the seed.

When graphing the dry matter weight of the seedling over time as a function of the quantity (relative or absolute) of the reserves used, it can be seen that the graph possesses 2 parts (**Fig. 6**): a 1st part where there is a linear correspondence between the reserves used and weight gain of the young plant and a 2nd part where the weight growth escapes this connection and where there is no more constant relationship between loss of reserves and seedling gains. It may be thought that then autotrophic activities took over and advantage over heterotrophic nutrition at the expense of seminal carbon reserves. **Fig. 6** illustrates these relationships for the 4 lots of experience. There are differences and a constant. The differences relate to the r part of the graphs. The slopes of the straight lines are much higher for seedlings from large seeds to those from small ones. The slope reflects the efficiency of use of the reserves, a steep slope indicating a high yield of transfer and use for the construction of the new tissues. Large seeds are favored in this respect.

But **Fig. 6** shows a constant for the 4 lots. It is always for the same proportion of reserves used that the connection between the coordinates escapes linearity. This value is equal to 50%. 100. This same value was found for “LG 11” in previous work (Bourdu and Gregory 1983). We had shown that this value could vary from one genotype to another. The fact that, regardless of the qualities of the seed, it’s always 50%. 100 of the reserves consumed that the growth of the young plants of “LG 11” escapes the seminal control confirms that it is about a genetic character.

The differences in weight and size between maize seeds, for a given genotype and for a given crop, depend on the position of the grain on the ear, of course, where the ear sampling does not introduces interplant variability in the fertilization rate and thus the grain richness of the ears. The interplant homogeneity was assured by the supplier of the biological material. If this is so, the position of the grains imposes two types of constraints or controls on their development: a limit of the space available for expansion (flat grains and tablets or round grains) or a limit of the supply of metabolites during filling (favored grains at the base from the top). Of these 2 types of constraints, arise 2 kinds possible answers: in the first case, the expansion of the embryo can be slowed down compared to the filling of the reserve tissues, in the other case the nature, the quality and the quantity of the reserves can be more affected than the establishment of embryonic structures. The small seeds (flat or round) are located at the top of the cob and therefore disadvantaged in the accumulation of reserves; they always give less heavy seedlings and this handicap initially gets worse. Flat seeds (small or large) have an unbalanced development between the 2 compartments (reserves and seedlings) and these results in a disadvantage in the initial development of the plant compared to round seeds. This is apparent from the results presented here. That thereafter the lag between plants from different types of seeds fades is another problem. But the differences we have shown relate to a period of corn life where any penalty can be increased by the effect of an unfavorable microclimate. The effects may then be cumulative.

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