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Short Communication

IMBIBITION AND GERMINATION RATES OF SUNFLOWER (*HELIANTHUS ANNUUS* L.) SEEDS ACCORDING TO FRUIT SIZE

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ABSTRACT

Hernández, L.F. and Orioli, G.A., 1985. Imbibition and germination rates of sunflower (*Helianthus annuus* L.) seeds according to fruit size. *Field Crops Res.*, 10: 355—360.

The influence of size and pericarp structure of sunflower (*Helianthus annuus* L.) fruits on imbibition and germination rates of the seed was investigated.

The results show a positive correlation between fruit width, pericarp thickness and fruit weight.

Germination rate was not affected by fruit size. Nevertheless, although large fruits (more than 4.5 mm width) have a rapid imbibition rate there was a significant lag in the start of their germination in relation to that of the smaller fruits (less than 2.5 mm width).

INTRODUCTION

The ability of seeds to absorb water from the soil after sowing has been related to their structure (Hegarty, 1978). Therefore, to get a good stand of seedlings under mild soil water stress conditions it is important to know how the morphology of the sunflower fruits (e.g. pericarp thickness and fruit size) affects their ability to imbibe water, which, in turn, affects their germinating capacity.

We have shown that weight, density, volume and the ratio of seed weight to pericarp weight are closely related to fruit size (Hernández and Orioli, 1982). Thus, the size of sunflower fruits is related to the morphology of their parts and large fruits normally have a thick pericarp and gaps between the pericarp and the seed. Small fruits have a thin pericarp which adheres to the seed (Knowles, 1978).

The purpose of this work was to study how the morphology and size of the pericarp affects the imbibition and the germination rate of sunflower seeds.

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MATERIALS AND METHODS

Pericarp thickness

Sunflower fruits of the hybrid cultivar Dekalb G-90 were classified according to their size by passing them through sieves of different sizes (2.5—4.5 mm) as previously described (Hernández and Orioli, 1982).

Fifty fruits of each size were selected, weighed, embedded in paraffin according to standard procedures and transverse sections were prepared from the widest part using a sliding microtome.

The mean pericarp thickness was calculated by measuring it at 6—8 points in each one of the fifty transverse sections for each size. The gap between seed and pericarp was estimated on the same sections.

Imbibition and germination rates

Twenty large fruits (more than 4.5 mm width) and twenty small fruits (less than 2.5 mm width) were weighed and put over filter paper, saturated with distilled water, in a Petri dish. A plastic screen was placed between the fruits and the paper to avoid direct contact with the water. Ten replicas were made. The Petri dishes were put in a growth chamber under dark conditions and at constant temperature of $10 \pm 1°C$. This relatively low temperature was selected on the assumption that at higher temperatures imbibition might be so rapid to mask differences between large and small fruits.

At predetermined times the fruits were taken out of the Petri dish, blotted on paper towels, weighed and immediately returned to the growth chamber. Finally, fruits were dried at 70°C to provide dry weights.

Germination tests were conducted as described above but at a constant temperature of $20 \pm 1°C$ given that the range of optimal temperatures for the germination of sunflower was determined as 17—25°C (Orioli, unpublished data). A seed was considered to have germinated when the radicle was clearly visible.

Pericarp anatomy

Pieces of pericarp from small and large fruits were embedded in paraffin and sectioned at 20 μm on a rotary microtome. Sections were examined with a light microscope.

RESULTS AND DISCUSSION

As fruit size increased the larger fruits exhibited a wider gap between seed and pericarp (Table 1). Large fruits also have a lower density than smaller ones (Hernández and Orioli, 1982). Thickness of the pericarp in-

TABLE 1

Gap area percent calculated from transverse sections of sunflower fruits of different sizes

Fruit width (mm)	Gap area (%)
less than 2.5	3.8 a
2.5—3.0	4.2 a
3.0—3.5	7.9 b
3.5—4.0	10.6 c
4.0—4.5	16.3 d
more than 4.5	21.8 e

Means followed by the same letter are not significantly different ($P < 0.05$).

increases with both fruit width and fruit weight (Fig. 1). Results from microscopic observations not presented here show this to be mainly due to the large size of the scleroid cells in the middle layer, and not to differences in cell number. This is in agreement with the explanation presented by Cichan and Palser (1982) for the abnormalities found in the development of the pericarp in seedless fruits of chicory.

Many of the pericarp cells in small fruits are small or collapsed. The reason for this is unknown. However, the fact that small and seedless fruits are always obtained from the centre of the sunflower capitulum (Knowles, 1978), indicates that cell development is affected by a hormonal control, or competition for the available carbohydrates, imposed by the fruits of the periphery (Yegappan et al., 1982).

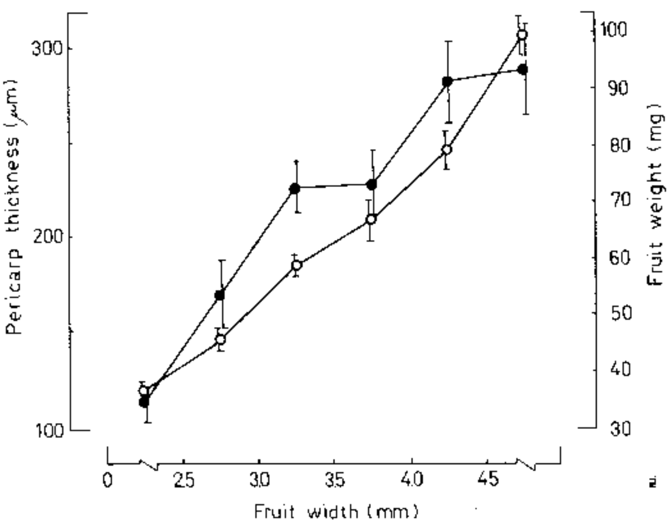

Fig. 1. Relation among fruit width, fruit weight (○) and pericarp thickness (●) in sunflower fruits of cultivar Dekalb G-90. Vertical bars = ± S.E.

The protrusion of the radicle in large fruits is delayed for more than 12 h (Fig. 2) even though 100% germination was reached after 50 h by both small and large fruits. On the other hand, during the first 8 h the rate of water absorption per unit of fruit weight was more rapid in large than in small fruits (Fig. 3). After 8 h the difference remained fairly constant.

The faster rate of water absorption shown by the larger fruits could be due to the greater efficiency of pericarp as water-absorbing tissue. Al-

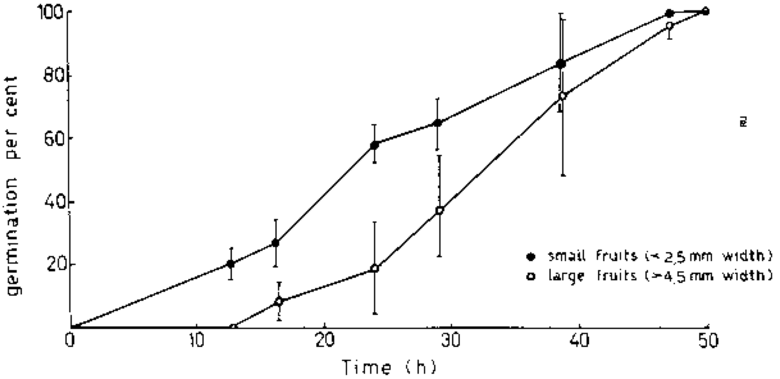

Fig. 2. Germination percent of sunflower fruits of different size. After 38 h the differences are not significant ($P < 0.05$). Vertical bars = ± S.E.

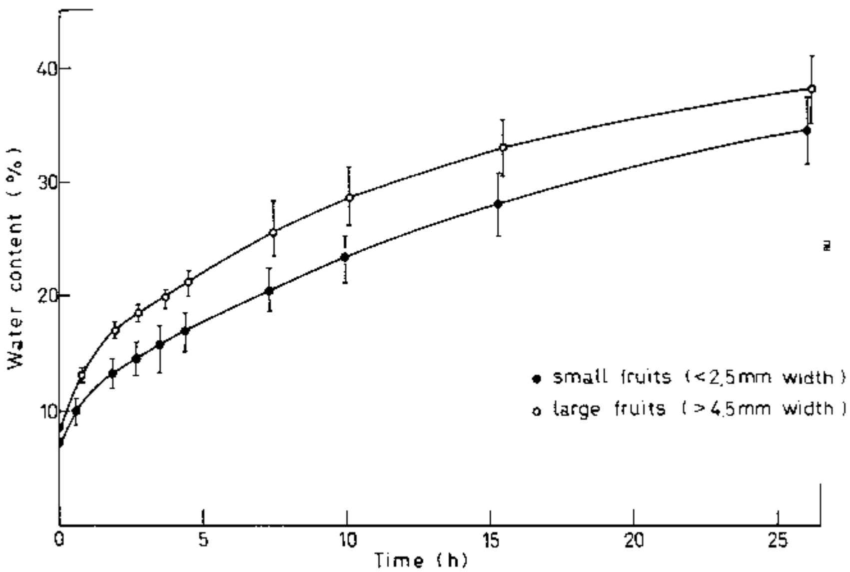

Fig. 3. Water content of sunflower fruits of different size. After 15 h the differences are not significant ($P < 0.05$). Vertical bars = ± S.E.

though the pericarp holds less water per unit volume than the seed, it constitutes a greater proportion of large fruits. However, the fact that the rate of water absorption per unit of fruit weight is rapid does not necessarily mean that the rate at which the water reaches the seed is also rapid. Therefore, the differences in germination rate could be related not only to the pericarp structure but also to its ability to transfer water to the seed.

In this sense, in small fruits with a thin pericarp in close contact with the seed, water transfer to the seed would be more efficient than in large fruits in which the contact between seed and pericarp is much less close.

The water pathway in the fruits of some Compositae is mainly through the hilum (Sheldon, 1974). However, we found that in sunflower this scar area was the same in small and large fruits and, therefore, it cannot account for differences in the rate of water absorption among fruits of different sizes.

The pericarp must, therefore, be considered as an important route, via which water can reach the seed, bearing in mind also that under natural conditions the seed-bed soil will not be saturated with water and only part of the fruit surface is likely to be in contact with it.

From the point of view of evolution, the permeability of the seminal envelope, and the germination rate, are important characters that guarantee the perpetuation of species under unfavourable climatic conditions such as water stress (Williams and Elliot, 1960). The ability of small fruits to absorb water rapidly can be considered as an ecological adaptation, and in this sense Heiser (1978) pointed out that small fruits of sunflower are characteristic of wild species while large fruits are more representative of domesticated species.

Therefore, it may be inferred that small sunflower fruits will make better use of the soil water under low water potential conditions. However, this favourable character cannot alone guarantee good emergence and establishment of seedlings.

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