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BIOLOGICAL PECULIARITIES OF GERMINATION OF SUNFLOWER SEEDS

The germination of seeds is a crucial period in the life of plants. How and in what conditions this process takes place can lay the future course for plants' growth and development and in the final analysis determines their productivity. It is therefore of certain interest to study the biology of seed germination.

VNIIMK investigations have helped to find that powerful forces appear in sunflower seeds during upswelling. Measurements with the help of a special apparatus we designed have shown that sunflower seeds swell with the force exceeding their individual mass 60,000 and more times, i.e. one achene with a mass of 85-90 mg is capable of lifting a load of up to four or five kg. In addition, mature, healthy, large and well-developed seeds swell with a greater force than immature and small ones that are affected by disease or damaged.

Water is a key limiting factor during germination. It comes into sunflower seeds evenly, through the whole surface of the husk. The highly hydrophile pericarp hinders the absorption of water by the seeds only at the beginning of the process. In the first hours water absorption is also slowed down by the hull and the endosperm that has been inosculated with it and reduced to one or two cell layers (see Table 1).

Yet subsequently water comes intensively into seeds covered with hull, whereas in dehulled seeds this is not observed, and in 15 days they may even lose water. Consequently the hull and endosperm help water to be absorbed regularly and subsequently store it in the seed.

Soil moisture is directly proportionate to the amount of water present in germinating sun-

Table 1

The Impact of the Hull and the Endosperm on the Absorption of Water by Sunflower Seeds (% of dry seeds mass)

Length of water absorption, hours	Age of seeds from flowering, days			
	21		98	
	hull	no hull	hull	no hull
1	38.8	101.8	21.1	37.7
5	106.6	108.7	44.8	42.1
15	127.4	104.4	55.8	49.1

flower seeds. When the soil is moistened to 40%, seeds begin to germinate in it with a less amount of water in them than they do when planted in the soil with 80% of moisture. This happens because the amount of water in the seeds decreases and much water is lost through the pericarp (Table 2).

In such a comparatively dry soil, germination is not full as a rule, which is necessary to take into account in selecting the time and method of sowing. The content of water in germinating seeds increases under the influence of temperature reduction to 6-8°C from the normal 20°C. When there is a shortage of moisture in the soil, temperature does not affect the amount of water contained in germinating seeds.

The amount of water during germination also largely depends on the maturity of seeds. When the soil is moistened enough the water content in the fraction of 20-day seeds is as high as 20% of the dry substance weight in the sprouting phase, which mainly stems from their poor development. In the process of ripening the seeds' weight grows and the amount of water in them during germination is on the

Table 2

Changes in the Amount of Water in Germinating Sunflower Seeds (% of the mass of the dry seeds' gel fraction. t 20°C)

Objects investigated	Age of seeds from flowering, days		
	2o	30	41
	40% of soil moisture		
Achene	143	117	89
Seeds	252	169	118
Pericarp	53	62	52
	80% of soil moisture		
Achene	250	166	119
Seed	323	198	131
Pericarp	202	147	113

decline. Unripened seeds are more sensitive to reduced moisture and temperature of the soil than ripened seeds and during sowing they must therefore be planted into a sufficiently moistened and warmed soil. There is little difference between the germinating seeds of modern quickly-ripening and middle-ripening varieties in respect of the amount of water contained in them.

During germination sunflower seeds are especially sensitive to aeration, because even at the beginning of the process they step up oxygen intake. In the phase of the achenes' sprouting under the temperature of 25°C the intensity of oxygen intake more than doubles in 24 hours as compared to the intensity that sets in 10 hours. After 48 hours of germination (during the sprouting phase) the

breathing level grows almost eight times over (Table 3).

Table 3

Influence Exerted by Pericarp on the Intensity of Gas Exchange in Germinating Sunflower Seeds (mcl per 10 units during 30 minutes)

Length of germination, hours	Achene	Seed		
		hull	damaged hull	no hull
		O_2 taken in		
10	72	96	135	160
24	179	332	204	438
48	576	700	965	1275
		CO_2 excreted		
10	61	90	129	140
24	157	279	193	356
48	460	600	826	856
(BC in 48 hours)	0.81	0.86	0.85	0.67

In the breathing exchange of germinating sunflower seeds, oxygen intakes prevail over carbon dioxide excretion.

The intensity of gas exchange is also substantially affected by the husk. When the pericarp is removed from the seeds, gas exchange becomes more intensive. The ratio of the exuded carbon dioxide to the oxygen taken in does not change because of that; the breathing coefficients (BC) are 0.81 and 0.86, respectively, in 48 hours of the germination period. The breathing level, without affecting the BC as a rule (0.85), is also on the upgra-

de when the hull is damaged. Seeds germinating without the hull and the endosperm have very high levels of gas exchange. During germination such seeds take more oxygen than exude carbon dioxide and that reduces the BC to 0.67. Thus unlike the pericapr the hull and endosperm not only hinder gas exchange but also reduce the intensity of the biochemical disintegration of reserve substances, thereby exercising an important biological function during germination.

A decisive factor during germination is temperature. Under 5°C, seedlings grow very slowly reaching approximately one cm height in 20 days. In these conditions the main root grows less intensively than hypocotyl, while at 10°C and more the root system grows more vigorously than the hypocotyl. With the temperature rising to 20°C the roots' sizes vary from 25-30% to 40-48% and with 25-30°C the coefficients of their length grow to 65-80%.

With the temperature of more than 25°C there is an increase in the variations of the hypocotyl's length, i.e. the seedlings', growth is depressed. For the period of germination and the appearance of sprouts 25°C is apparently critical, since the further temperature increase leads to an intensive lengthening of the seedlings accompanied by the loss of dry substance and the underground part of the hypoccotyl. This must be one of the reasons behind the weakening of the seedlings under high temperatures.