D.N. Belevtsev, USSR

INCREASE OF YIELDING ABILITIES OF SUNFLOWER SEEDS BY THEIR BIOLOGICAL ENRICHMENT WITH MINERAL NUTRITIVE ELEMENTS

Results of our studies during 1963-1974 have shown for the first time that biological enrichment of sunflower seeds grown on phosphorus deficient soils with high rates of fertilizers ($N_{180}P_{240}$) makes it possible to raise the yield by an average of 2-3 c/ha on the seed production plot, to increase the absolute weight and the yield of high grade seeds, and what is most important to change substantially the chemical composition of seeds, thus considerably improving their sowing and yielding abilities. The seeds are enriched with essential nutritive elements: nitrogen and phosphorus. The content of nitrogen is increased by 10-15% and that of phosphorus by 20-30% and more. Seeds enriched with phosphorus show a marked increase in acid-soluble and protein phosphorus, phytin, sugar phosphates and phosphoric compounds rich in potential energy and playing an important role in the processes of organic matter metabolism.

High rates of nitrogen-phosphorus fertilizers with the predominant content of phosphorus have resulted in an increased uptake of nutrients on the seed production plot, mainly of phosphorus, and positively affected the moisture balance of sunflower. This can be considered as a very important factor especially in the zone of unsufficient precipitation. Plants grown at high rates of mineral fertilizers economically consume the soil moisture, have low water deficit and an increased amount of fixed water in the leaves. An improved nutritive and water balance of sunflower enhances its growth and development and allows to obtain stable good yields on seed production plots in the zone of unsufficient

moistening even in seasons with very unfavourable weather conditions.

An increased amount of phosphorus in the seeds is very important when growing sunflower on the soils with a deficit of phosphorus compounds easy available for the plants. Phosphorus accumulated in the seeds is completely consumed by plants at early phases of development thus compensating phosphorus deficit in the soil. That is very important for young plants which mostly need phosphorus at this stage but have an underdeveloped root system with a very weak uptake ability.

An increased amount of nutritive elements in kernels, especially of phosphorus, raises the seeds' germination ability, energy of power. In other words, this gives the young plant a vital stimulus later resulting in a better utilization of other environmental factors on the plots sown by seeds enriched with nutritive elements seedlings appear 1-2 days earlier, and are more uniform and powerful than on the plots sown by normal seeds. Flowering and maturation stages proceed more uniformly, being 2-3 days earlier than in the check plots.

The plants developed from the seeds enriched with phosphorus form 1.5-2 times more powerful root system and green mass at the early stages of development than the check plants. An increased phosphorus content of these plants leads to a more powerful root system. These plants are better supplied with water and elements of mineral nutrition, are able to form a large head with an increased number of flowers and well-filled seeds, are able to withstand adverse weather conditions and eventually give high yields.

The results of our studies show that biological enrichment of the seeds with mineral nutrition elements and high rates of nitrogen-phosphorus fertilizers give the possibility to increase the yield on the commercial fields by 2.0-2.5 c/ha on the average. The highest

yield gains (2.5-3.0 c/ha and more) are obtained following two years of seed enrichment with phosphorus against the same background of NP fertilization. In some cases yield gains amounted to 3-4 c/ha.

Enrichment of seeds with phosphorus also favourably influences oil formation processes and on commercial fields results in a 1.0-1.5% increase in seed oil content. Thus, biological enrichment of seeds with phosphorus allows a very high and economically effective utilization of mineral fertilizers.

It should be mentioned that barley the crop following sunflower, increases the grain yield by 6-10 c/ha. Here also, barley seeds harvested from the plots highly fertilized with NP also have increased yielding abilities, their progeny showing yield gains of some 2 c/ha.

Favourable action of high rates of fertilizers administered for sunflower can be observed on some other crops which follow barley in the crop rotation.

Thus, biological enrichment of sunflower seeds with phosphorus against the background of a high fertilization rate, especially under condition of undustrial seed production, should be regarded not only as a method of increasing the yields of this oil crop, but as a fundamentally new and multi-factor of agronomic management leading to a considerable increase in the yields of a number of crops.

At present this method of biological enrichment of sunflower seeds with elements of mineral nutrition has been successfully and widely introduced into agricultural production and gives high gains of seed and oil yield.

Studying the features in the formation of the seeds' yielding abilities, in 1966-194 we first observed a large biochemical diversity between individual bio-types in the existing varieties. This allowed to select plants able to form large seeds on unfertilized soils and to accumulate

large amounts of phosphorus and other nutritive elements. In these seeds the proportion of phosphorus is larger in per unit of nitrogen and potassium. Seeds with a larger phosphorus content form plants with a more developed root system and vegetative mass, develop more rapidly and uniformly and have bigger yields in progeny, the gains being about 1.7-2.2 c/ha in mass harvest, and 2.3-5.2 c/ha in individual harvest and retain high oil content in seeds.

Thus, when evaluating the sowing properties of sunflower seeds not only class, size and uniformity should be considered, but their chemical composition as well, above all the presence of the optimal amount of phosphorus.

We have found an ability of some groups of plants to consume larger quantities of phosphorus and other elements of mineral nutrition from the soil accumulate them on the seeds and give a larger yield in progeny. We consider this to be an important biological property of sunflower determining its potential productivity.

The utilization of our method of selecting plants according to their increased phosphorus content in sunflower seeds opens basically new paths of further increasing the productivity of this crop.