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RESULTS AND PROSPECTS OF BREEDING SUNFLOWER VARIETIES-POPULATIONS IN THE VNIIMK

Sunflower is the basic oil-bearing crop in the USSR. It is sown on nearly five million hectares and accounts for 75% of all vegetable oils and for two million tons of cake and oil-seed meal produced in the country, containing roughly one million tons of protein well balanced by the amino-acid composition. World areas under sunflower have markedly increased owing to the successes attained by Soviet selection of high oil and productive sunflower, now totalling over 9,100,000 hectares.

Though 80% of sunflower crops in this country are located in the semi-arid and arid zones, and in the last five-year plan period climatic conditions were unfavourable in four years out of five, average sunflower yields remain the world highest.

Sunflower breeding in Russia began in 1912 in three points: Krasnodar, Kharkov and Saratov. In Krasnodar the work was started by Academician V.S. Pustovoit, who elaborated the methods of selection and improved seed production, produced 38 sunflower varieties and devised the principal methods of cultivating this crop.

The method of breeding sunflower varieties-populations suggested by the VNIIMK is the basic and most efficacious in the USSR. This can be seen from the fact that during the whole of sunflower cultivation in the USSR the varieties-populations obtained through these methods have been sown on all productive areas in the country. The VNIIMK and its experimental stations can boast the best re-

sults in sunflower breeding. Suffice it to say that during the period the Institute has been in existence 92% to 95% of all sunflower areas in the USSR have been sown to the varieties selected by the VNIIMK.

Twelve institutions are engaged in breeding sunflower varieties-populations.

The bulk of the sown areas - 60% - are under the varieties of the central experimental base of the VNIIMK in the city of Krasnodar, and 30% are under the varieties produced by the VNIIMK's Armavir experimental station.

Of the 26 varieties zoned in the USSR 50% of the area is under improved Peredovik and improved Armavirsky 3497 (1,200,000 hectares each). Soviet varieties are cultivated abroad on the area of over one million hectares, while 33 countries buy in the USSR seeds of many sunflower varieties used as an initial material for selection.

The reserve method worked out in the VNIIMK is a variant of the periodic selection of families with an individual evaluation of their progeny and subsequent repollination of the best samples. This leads to gradual changes in the population and simultaneously tends to preserve genetic variability which is necessary for subsequent selections. The accumulation of positive features helps continuously improve the populations and obtain more productive genotypes. This method has been especially effective for raising the varieties' oil percentage which initially grew by 0.5% a year. The method is so effective because it has some elements of heterosis breeding making it possible to identify the best heterosis combinations.

The VNIIMK breeds sunflower for 24 characters the basic of which are yield, oil content, and the length of the vegetation period. The latter parameter relates to the varieties of the four biological groups, i.e. middle-ri-

pening, early ripening, quickly ripening and ultra-quickly ripening, each group having its own cultivation zone depending on its ecological features. Middle-ripening varieties are most productive and widespread in the USSR, covering 73% of all area under sunflower.

The middle group is typically represented by the Peredovik, VNIIMK 6540, Smena and other varieties. According to the five-year competitive strain testing, the seeds of this variety have 51-54% of oil, the yield being 30 c/ha and the oil yield 14 c/ha (Table 1).

In several regions in North Caucasus, the Ukraine and Moldavia the seeds' oil content grows to 53-58.7% and the yield to 30-38 c/ha, which gives 17 to 18 centners of oil per hectare.

Early varieties, typically represented by VNIIMK 8883, ripen four to six days earlier in Krasnodar conditions than middle varieties while their old yield per hectare is 10-15% less than in the latter group. Early varieties account for 18% of all sunflower crops in the country.

Quickly ripening varieties occupy 7% of sunflower areas in the north-eastern part of the country.

The last 12 to 15 years have seen the production of ultra-quick varieties ripening two weeks earlier than middle varieties in the Krasnodar conditions. This group is exemplified by Karlik 68, early ripening Tambovsky and Podarok. The latter two are under state strain testing. Podarok boosts oil yield by 23% per hectare as compared to the other varieties of this group.

All varieties selected by VNIIMK are marked by exceptional life longevity (20-40 years) which is facilitated by the improved seed-growing system closely linked with the breeding process.

The improved seed-growing methods are

Table 1

Characterization of Widespread Sunflower Varieties
Krasnodar, VNIIMK, Average for 1971-75

Varieties	Vegetation period	Weight of 1,000 seeds, g	Unit, g/l	Oil content of absolutely dry seeds, %	Seed yield, c/ha	Oil yield, c/ha
VNIIMK 8931, check	96	72	411	51.1	30.5	14.0
Peredovik	96	70	407	52.0	30.5	14.3
VNIIMK 6540	96	72	408	52.3	30.7	14.5
VNIIMK 8883	91	74	402	50.1	29.2	13.2
Salyut	87	73	415	49.3	26.2	11.7

based on the same principles as those governing selection; they are founded on the individual breeding of seed-growing elite with the assessment of progeny and re-pollination of the best samples (elite plants).

The use of polymorphism of sunflower varieties-populations coupled with further selection helped improve all genetic features selected. Moreover, roguing or culling of minus variants in seed production makes it possible to improve varieties in any direction. According to the production data and the Strain Testing State Commission, exemplary seed growing helped raise the zoned varieties' yield by 4 to 6 c/ha, oil content by 10 to 12%, and considerably increase oil yields. Additions in the basic productivity elements were so great that each improved variety could be claimed three or four times as a new variety. The productivity of the improved varieties grew by 20 to 51%, depending on the period of their productive use, with the overall effect sometimes surpassing even that obtained under heterosis breeding (Table 2). The main advantage of this method lies in the fact that the improvements are immediately seen on millions of hectares sown to improved varieties. On these grounds the Strain Testing State Commission recognised eight varieties of the VNIIMK breeding as improved and issued authors' certificates for them. These varieties now occupy more than 90% of all sown areas in the country.

Over the last five years oil yields per hectare has continued to grow largely thanks to the growing seed yields, whereas earlier productivity increased owing to the higher oil content. A mere one per cent growth in oil yields per hectare on the nation-wide scale gives more than five million roubles of net profit a year. During 12 years when improved seed production has been in effect, coupled with the annual renovation of varieties, the

Table 2

Improvement of Zoned Sunflower Varieties in the Process of Seed Production

Krasnodar, VNIIMK, competitive strain testing

Varieties	Year of zoning	Sown area in 1975, '000 hectares	Year of study	Seed yield, c/ha	Oil content of absolutely dry seeds, %	Oil yield	
						c/ha	%
VNIIMK 6540	1950	524.4	1945-1948	23.3	41.2	8.8	100
			1966-1968	28.7	51.1	12.9	146
			1973-1975	31.4	52.7	14.9	169
VNIIMK 8883	1955	575.7	1949-1952	22.2	42.5	8.6	100
			1966-1968	26.9	49.5	11.8	137
			1973-1975	31.4	50.6	14.3	166
Peredovik	1960	1,147.3	1957-1959	24.4	48.8	10.4	100
			1966-1968	28.5	51.8	13.0	125
			1973-1975	31.4	53.2	15.0	145

country produced 3,800,000 tons of oil extra, costing 5,700 million roubles.

As new varieties were introduced in production the oil content of marketable seeds grew steadily (it went up by 62% over 20 years in the country as a whole). The influence exerted by varieties with high oil content on sunflower productivity in the country as a whole can be exemplified as follows: seed yield grew 160%, kernel yield went up by 230%, oil by 300% and protein by 170%.

Varieties have now been produced in the USSR which have in potentia reached extremal oil content. For instance, in 1975 varieties of the VNIIMK breeding, such as Armavirsky 3497, Krasnodarsky, Kruglik, Reserv and Nakhodka-accumulated 55-58% of oil in absolutely dry seeds on variety testing grounds in several regions of the Ukraine and North Caucasus. A very high oil content of marketable seeds was first registered in the USSR when these were processed at oil and fat factories in the North Caucasus and the Ukraine. In the Millerovo oil-extracting factory which processed 34,500 tons of oil seeds in the fourth quarter of 1975, their marketable oil content being 50.6%, the oil output was 49.89% and the oil content of absolutely dry seeds 54.4%.

In the fourth quarter of 1975 all seven oil factories in the Ukraine processed 523,000 tons of seed with the oil content of 48.2-50.1%, the oil output being 47.5%, 48.4% and the oil content of absolutely dry seeds 52.8-54.1%. Such an unheard-of oil productivity was recorded for the first time ever. According to the State Commission and competitive variety testing, the zoned varieties have a steadily growing seed yield, and a very high oil content and oil yields per hectare.

A further rise in the seeds' oil content, however, considerably complicated their har-

vesting and storage. Nonetheless, there are no bounds to the selection to increase oil content per hectare by raising seed yields. The task of creating more productive varieties is now as important as ever. Each breeding institution affiliated to the VNIIMK has varieties on its testing grounds which surpass check figures by this index.

This can be exemplified by varieties of the VNIIMK's central experimental base (Table 3). In 1975, the oil yield surpassed that of the super-elite Peredovik variety by 8-14% per hectare, the oil content by 54-55% and seed yield by 37-35 c/ha.

The creation of varieties with a shortened vegetation period is a large reserve for raising sunflower productivity. During the preliminary variety testing in 1975 ultra-quickly ripening varieties were singled out whose oil yield is only 5-10% less than that of the middle variety VNIIMK 8931 (Table 4), and which ripen two weeks earlier.

It is as necessary as before to produce varieties with resistance to diseases, pests and new races of broomrape. The Armavir experimental station handed to the Strain Testing State Commission the Start variety which is resistant to new broom rape races. Interspecific hybridisation is successfully used to obtain comprehensive immunity.

Varieties are also produced having a high seed unit and varied qualitative compositions of oil coupled with a definite combination of fatty acids.

We believe that the methods suggested by Academician V.S. Pustovoit will be as topical and promising in the future as they are now because they contain the elements of heterosis breeding at their base, which makes it possible to produce populations with a high heterosis. This can be borne out by the fact that the VNIIMK and its institutions created

Table 3

Characterization of Promising Middle-Ripening Sunflower Varieties

Krasnodar, VNIIMK, 1975

Variety	Vegetation period, days	Weight of 1,000 seeds, g	Seed unit, g/l	Seed yield, c/ha	Oil content of absolutely dry seeds, %	Oil yield	
						c/ha	%
40155	94	65	424	37.1	54.3	18.14	123
40066	93	66	416	35.5	55.4	17.71	120
39979	95	69	417	35.4	54.1	17.23	117
Peredovik	95	70	420	33.0	53.6	15.91	108
VNIIMK 8931, check	95	70	422	30.8	53.0	14.70	100
m%				2.96			
$NSP_{0.95}$				1.85			

Table 4

Best Ultra-Quickly Ripening Varieties of Preliminary Testing

Krasnodar, VNIIMK, 1973

Variety	Vegetation period, days	Weight of 1,000 seeds, g	Unit g/l	Oil content of absolutely dry seeds, %	Seed yield, c/ha	Oil yield	
						c/ha	%
39573	83	75	447	51.3	30.4	14.03	95.4
120	82	69	452	51.7	28.0	13.03	88.6
39543	81	77	436	51.5	28.5	13.22	89.9
VNIIMK 8931, check	95	70	422	53.0	30.8	14.70	100
m%					2.6		
$NSP_{0.95}$					1.7		

17 sunflower varieties, six with original features, in the past five-year plan period alone (1970-1975). Moreover, all the VNIIMK's breeding laboratories have rather promising breeding material at their disposal, which gives hopes that still more productive and original varieties will be obtained.