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PLANTING OF SPRING WHEAT IN THE NORTH

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The possibility of raising in the Far North comparatively variegated crops, including spring wheat, was demonstrated not long ago by a pioneer in northern agriculture, A. Zhuravskiy, corresponding member of the Academy of Sciences USSR and founder of the first experimental station in Pripolyar'ye [literally, Polar Region: however may be specific place name] on the Pechora. The Polar Experimental Station of the All-Union Institute of Plant Growing demonstrated this possibility under the conditions prevailing in the Transpolar Region. However, spring wheat, the most valuable grain crop, is not very widely distributed in northern European USSR. Sowing is limited as far south as the 60th parallel, and it is found even less frequently as one moves farther north. In certain years some spring wheat may be found in kolkhoz fields almost all the way to the Arctic Circle.

The All-Union Agricultural Exposition displayed some beautiful samples of polar agricultural products; the spring wheat was not inferior to that of many other regions where it is the chief crop.

North of 60 degrees latitude in the territory which we have provisionally made a separate agricultural zone, barley predominates among the spring grain crops: the two-rowed variety in the southern part of the zone and the multi-rowed, local, northern varieties in the northern part. Oats are grown almost on an equal footing with barley at the southern boundary of this provisional zone. Wheat is grown here only on very small plots. In higher latitudes the proportion of barley is greatly increased and oats extend up to the polar regions, but wheat scarcely reaches the 62d or 63d parallel.

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The period from sprout to waxen maturity in the early-ripening varieties of spring wheat, two-rowed barley, and oats is almost equal. Although in the northern part of the zone the growing period of the early-ripening varieties of wheat is 6 - 7 days longer than that of local northern barleys, it can be considerably shortened by a system of agrotechnical measures.

Even at a latitude of 65.5 degrees north (Mezen') the average number of days with a temperature of 5 degrees and over is 120, and an average of 69 days has a temperature of 10 degrees. The average total of heat from 15 May to 15 September amounts to 1,300 degrees; the sum total of the average daily temperatures for the warm period is 1,384 degrees; the average duration of a frostless period is 79 days. At the 62d to the 63d parallel (Onega-Troitsko-Pechorskoye), which may be considered the provisional boundary between the northern and southern parts of the zone, there are 88 to 102 days with a temperature of 10 degrees and over, and the average duration of a frostless period is from 82 to 95 days. The total heat in these latitudes is more limited, but this heat deficiency is appreciably reduced by the length of the northern summer day and by more intensive assimilation. This has been indicated by Kostychev, Lyubimenko, Obolenskiy, and other researchers.

Timiryazev wrote: "The amount of solar energy assimilated by our crops must be considered virtually the best single exact measurement of productiveness for these crops." From this viewpoint wheat and certain other agricultural plants in the north have adequate conditions for a high degree of productivity.

According to data of the Ust'-Tsilemsk Experimental Station (65.5 degrees north) the maximum daily growth of barley reaches 8 centimeters, and of rye, 11 centimeters.

Late spring and early fall frosts may have an unfavorable effect on crops in the northern zone, even in the southern part of it. However, agrotechnical measures, taking into account northern agricultural conditions and the biological peculiarities of wheat, can be used to combat the negative action of possible frosts at individual seasons.

Our observations and research for many years in the northern zone have demonstrated that spring wheat and barley in the first stages of development endure almost without trouble a frost of minus 5 - 6 degrees centigrade. The early dates of this phase arrive during the first 10 days of June. According to data from the Mezen' Meteorological Station, the minimum temperature for June is not usually below 4.7 degrees centigrade. The negative effect of short frosts during the ripening period shown by cell desiccation, the deforming effect of ice formed in the intercellular spaces, and, consequently, the irreparable coagulation of the colloid matter of the plasma, depend upon the strength and duration of the frost and the water content in the grain.

Our studies under field conditions in the northern zone (61.5 - 65.5 degrees north) permit us to assert that in the period of waxen maturity, with the moisture of the ripening grain about 25 percent, the short frosts of the intensity mentioned (minus 5.5 - 6.0 degrees centigrade) had no unfavorable effect on the quality of the seed and the technological qualities of the wheat. From data covering a period of years, such minimum temperatures during this period may almost be excluded. In the northern part of the zone they are possible in the ripening period, but it is entirely possible to lessen or even eliminate their adverse effect.

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Our research work in the northern zone with different seeding dates and varied feeding programs established the fact that with a phosphorus and potassium regimen, a grain of spring wheat in the beginning phase of waxy ripening, with more than 25 percent moisture, was not injured by frost.

These experiments in Pripolyar'ye showed that a grain of spring wheat (Garnet, Northern variety), overtaken at the beginning of its waxy ripening by a frost of minus 6.0 degrees centigrade had 93 - 95 percent germination, while on a control plot the germination did not exceed 76 - 80 percent.

Chemical analysis of grains produced on different feeding programs showed that phosphate potassium fertilizers contributed to an increase in the crude fat content of the grain. It is possible that this will prove to be a protection against frost. Meanwhile, analysis of the bread-making qualities of this grain showed sufficiently high indexes.

In the north the postharvest ripening is also of great importance. The comparatively low temperatures during winter storage do not hasten the postharvest ripening, and the increased moisture in the seeds does not eliminate their possible injury from freezing at temperature which sometimes reach minus 50 - 55 degrees centigrade.

In this connection, of course, the problem arises of hastening the postharvest ripening process and obtaining physiologically ripened seeds before they are put into winter storage. In the past, according to old kolkhoz members in the northern zone, barley grain, reserved for the next year's sowing, was dried in barns and then threshed and stored until spring.

We obtained more precise data on the dates and temperature at which the grain achieves its normal ripening, and we also determined the germination of seeds after thermal drying.

The results of our studies of seed germination at different dates, after harvesting and drying the seeds under varying conditions, indicated that there was an advantage in drying them in sheaves in the barns for 1 - 2 days at an average temperature of 30 - 40 degrees centigrade, with a maximum of 45 degrees. After drying, the seeds had normal moisture and germination,

Completing the postharvest processes up to the time of winter storage is is of extraordinary importance in the north, particularly in the northern part of the zone. Natural drying of the seeds in spring is extremely difficult because of the comparatively low temperature and the high percentage of moisture in the air.

Obtaining high-quality seed acquires special importance in the north in connection with new crops like wheat. High quality contributes to stability even in the face of possible unfavorable conditions. Thus, as a result of the continued reproduction of spring-wheat seed in the northern zone, subjected every year to lowered temperatures, the fifth reproduction with minus 5.5 degrees of frost at the beginning of the waxy ripening has produced seeds with good germination -- 14 percent above the standard.

The old arable land in the northern zone (Arkhangel'sk Oblast, Komi ASSR) satisfies conditions necessary for spring wheat. The medium to light loams prevailing here (according to mechanical composition) are not highly acidic and are comparable in humus, nitrogen, free phosphorus, and potassium to the soil of the central regions of the northern non-chernozem strip. The comparatively high fertility of Mezen' soil must ... note.

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also be noted. Individual soil inspections conducted by us in the kolkhozes at Mezen' showed that clayey soils contained 2 - 3 percent humus and, 0.2 - 0.3 percent nitrogen. We often noted a sufficiently high content of free phosphoric acid, but a comparatively low content of free potassium.

The average yield of grain crops in the fields we inspected was not less than 10 - 12 centners per hectare.

Mineral and organic fertilizers had a sufficiently strong effect on the yield and quality of the spring wheat in the old arable ground of the northern zone. Nitrate ferilizers in our field experiments increased the yield 2 - 2.5 times over a comparatively high standard yield (11 centners per hectare); phosphate and potassium fertilizers increased it 50 - 60 percent. However, the increased standards of nitrate fertilizers under the conditions of the northern zone (especially the northern part of it) caused a heavier growth of suckers and made the grains on the main and secondary spikes ripen at different times. In this connection, a fractional introduction of nitrogen is preferred (before sowing and vegetation periods) as this produces a better yield of higher quality.

Local fertilizers also proved to have an excellent effect on the spring-wheat crop. To be specially noted among them is peat, of which there is an unlimited supply here. In our experiments, peat prepared during the previous summer and well decomposed increased the yield 20 percent; moreover, the total albumen content of the grain surpassed the standard by 2 percent.

There are also beds of high-grade phosphites which can be successfully used in cultivating spring wheat and other agricultural crops.

Our studies provided us with a sufficient basis for considering that the reasons for the limitations on spring wheat were not so much the climate and soil as the agrotechnical measures, which did not always correspond to local biological peculiarities.

The whole system of such measures must be directed toward shortening the vegetation period, accelerating maturity, and obtaining stability under possible unfavorable meteorological conditions in individual years as well as toward inbreasing productivity. For example, the use of early-ripening varieties, vernalization, early sowing dates, sowing standards, and certain agrotechnical procedures should be included among these measures.

Testing of varieties was not included in our research task. We did, however, make a comparative estimate of two varieties in the northern part of the zone: Garnet (V. Lutestens) and Northern (V. Milturum). The indexes favored the latter. Comparative sowings in the southern part of the zone showed that the Garnet variety was preferable to Lutestens No 62. Vernalization of the early varieties (Garnet, Northern) in the north shortened the period of vegetation by 2 - 3 days (and increased the yield), very important for the northern part of the zone.

It was necessary to sow spring wheat earlier than other grains in the northern zone.

The earlier date for wheat sowing depends directly on the soil's being worked over before sowing and preparing it for the seed.

Expeditions for inspection of grain crops and field experiments in the northern zone provide reason for believing that, even in its northern part, according to the times, it is entirely possible, by shallow plowing and tilling to work the soil after the grain harvest. This makes it possible to limit the spring work before seeding in average and light loams to harrowing two or three times. Heavier work -- with a cultivator or gang plow -- may be necessary only in individual cases.

A spring plowing to full depth is often done for spring grains in the north. Such plowing delays the sowing date and turns up to the surface weeds which have not been able to grow since fall. In our experiments with spring plowing to the full depth, the number of weeds in spring wheat sowing amounted to 176 per square meters, but in spring work with a gang plow to the depth of 8 - 10 centimeters the number did not exceed 78 per square meter.

The upper layer of the soil is considerably less broken up in less vigorous, shallow plowing before seeding. Deep presowing plowing produces unequal distribution of the seed and increases the difference between the laboratory yield and total field yields. With full-depth spring plowing the number of sprouts per square meter was 302, with 8 - 10 centimeter plowing, 329. In the former case the yield of spring wheat was 14.9 centners per hectare, in the latter 16.3.

Uniformity in the distribution of seeds at the stipulated depth also has, both in general and in particular, an enormous importance in the northern zone because it creates the conditions for a more even later development of the plants and the ripening of the crop.

Because of the peculiarites of climatic conditions in the northern and southern parts of the zone, different sowing standards are used. With the higher standard of sowing -- for smaller areas of supply -- more plants are obtained with primary spikes, from which the harvest in the northern part of the zone must be produced. In the southern part where the frostless periods are longer and the secondary spikes yield rich crops, the area of supply can be increased and, therewith, the sowing standard can be reduced. If the amount of seed for the northern part of the zone must lie within the limits of 7 - 7.5 million per hectare, in the southern part, where the fields are free of weeds and the sowing dates are early, this norm can be reduced to 5 million. These conclusions were reached by studying the problem from every side, both in very small and very large land allotments. In our tests we obtained the following yields for the northern part of the zone depending upon the sowing norm: with a 5.5 million norm the yield was 20.9 centners per hectare; with 6.5 million, it was 23.0 centners. In the southern part, with a sowing norm of 5 million, the yield was 23.3 centners, and with 6 million, it was 23.5 centners. This norm reduction in the south is possible also because here spring wheat disease caused by the Fusarium culmorum is rarely noted. This is one of the principal causes for cutting-in young crops in the central section of the northern nonchernozem strip.

Many years of investigation did not reveal any important troubles in early varieties of spring wheat in the northern zone either through disease or pests.

We must consider the ripening of grain and straw at different times, as a special feature of spring-wheat planting in the northern zone (its northern part). This may be the result of the lower air temperatures during the ripening period and its greater dampness, as well as of the later periods for seeding. Obviously, a slower disintegration of the chlorophyll takes place under such conditions of shortened northern summer days.

Morphologically, such a state is characterized by the fact that the grain has all the signs of waxy ripeness -- 27 - 28 percent yellow, soft, pasty moisture -- while the straw (primary stalk) still has all the signs of immature ripening in its color.

In harvesting the wheat in this condition, with subsequent disposal of racks in sheaves, the straw acquires the normal color of the waxy phase of ripeness and the grain becomes less moist.

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In determining the quality of the crop it was shown that the quality of the grain in the waxy state of ripeness when the straw displayed signs of immature ripeness was not inferior to that ascertained for grain and straw ripening simultaneously.

In connection with the fact that, when frosts are forecast, it might become necessary to harvest the wheat at earlier dates, analyses were made of the grain crop harvested at the beginning and at the stage of complete waxy ripeness (Pripolyar'ye, 1940). Approximate indexes were obtained for both cases.

Something remains to be said about arranging the rotation of spring-wheat crops in the northern zone. Winter rye is preferred to barley here as the first crop, especially where it is cultivated on cleared fertilized fallow. The late gathering of the potato crop is one of the factors ruling out this vegetable as a first crop since it is not always possible to plow on time after it is brought in. Without exception, the best first crop of all for wheat is perennial grass. Sowing spring wheat after perennial grass on a foundation of phosphate potassium fertilizer should ensure a high quality of grain and extremely stable yields. Thus, in our experiments in the southern part of the northern zone (1942) the yield in wheat sowed after clover on a phosphate potassium foundation amounted to 36 centners per hectare (without fertilization, 23.4 centners per hectare), while the yield in sowing after oats, with fertilization, reached a total of 21 centners per hectare.

In conclusion, we cite the comparative data obtained on the yield of spring wheat in various latitudes: at 55 - 56 degrees (1934 - 1947) the yield amounted to 16.6 centners per hectare; at 61 - 62 degrees (1937 - 1938 - 1942) to 32.7 centners per hectare; at 65.5 degrees (1940 - 1941) to 19.0 centners per hectare. As this data shows, the southern part of the northern zone merits special attention.

The ratio of heat and light is more favorable here, and the soil conditions, and the amount and distribution of precipitation permit the most productive use of fertilizer and its fractional introduction, ensuring not only stable harvests but high quality.

In the Fourth Five-Year Plan, spring wheat in the southern part of the northern zone must occupy a pre-eminent place among grain crops in crop rotation and must take a considerable advance in the northern part of the zone.

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