

University of Alaska
ALASKA AGRICULTURAL EXPERIMENT STATION
in cooperation with

UNITED STATES DEPARTMENT OF AGRICULTURE

Palmer, Alaska

September 1956

FERTILITY STATUS OF ALASKAN FIELDS 1956

George D. Scarseth
Consultant, Alaska Extension Service

FORWARD Alaska's Extension Service was fortunate in again obtaining the services of Dr. George D. Scarseth, Director of Research for the American Farm Research Association. His task during the 1956 growing season was to review the fertility status of potato fields and to diagnose the potato malady that has reduced yields in recent years. Having familiarized himself with the symptoms during the 1955 season, he came back to Alaska in August of this year to study in greater detail the onslaught of this malady and to help interpret the results of studies designed to explore basic causes and possible corrective measures. Dr. Scarseth's report is here reproduced in full for the guidance of farmers and agencies dealing with food production in Alaska.

The Extension Service thanks the Chas. H. Lilly Company for their assistance in underwriting part of the cost of this work.- A. H. Mick, Director of Extension & Acting Director, Experiment Station.

In August 1955 a study was made of numerous farms in the Fairbanks, Matanuska and Kenai areas, accompanied in each area by the local agricultural agent. In August of 1956 we continued this study in the Fairbanks and Matanuska areas. In addition to the agricultural agents Walter Duffy (Fairbanks) and Lew Hanks (Matanuska), I was accompanied at various times by Dr. Winston M. Laughlin (Soil Scientist), Dr. C. H. Dearborn (Horticulturist), Dr. C. E. Logsdon (Pathologist) of the Experiment Station, and Dr. James G. Dickson, Pathologist (University of Wisconsin) who was serving as an Experiment Station consultant under the auspices of the Rockefeller Foundation. Mr. Lee Fryer of the Chas. H. Lilly Company, Seattle, Washington was with me part of the time.

METHODS USED The entire study was made in the field at the peak of the growing season. We visited with the farmer to learn the history of the crop and field being examined, with special attention to past fertilizer practices. Fields were selected at random to arrive at typical cases. Major attention was given the potato crop, but we included the forage crops and small grains (oats and barley).

A modification of the Purdue University soil and plant tissue tests was used together with those of Bray (University of Illinois) as well as those of Truog (University of Wisconsin). I was greatly guided by the experiments of Dr. Dearborn, Dr. Laughlin and Mr. Michaelson of the Experiment Station.

THE POTATO "BURN"

Potato growers in the Matanuska area have noted in recent years a blackening of the potato leaves and have called this condition fertilizer "burn". In 1955 I saw this malady widespread in the Matanuska and Kenai area, but not in the Fairbanks fields (It occurred in Fairbanks after Dr. Scarseth's survey - A.H.M.). In 1956 many fields in the Fairbanks area were affected as well as at Matanuska, where this malady appeared more severe in some fields than in 1955.

POTATO "BURN" SYMPTOMS The first symptoms are a slight up-turning and a wax-like luster of the leaves at the upper part of the plant. This is accompanied by a slight bronzing color, first developing on leaves near the middle of the plant. This bronzing resembles the abrasion that high winds sometimes cause. As the "burn" develops, black irregular areas form over different parts of the leaves, usually towards the lower portion of the plant. Soon these black splotches show through on the under side. Sometimes concentric rings form in these black, necrotic (dead) patches. In severe cases the growth is greatly retarded and in extreme instances the plant contains only blackened leaves. The stems and petioles, however, remain alive and green. Very little yellowing occurs, as is typical of potash starvation in many broad leaf plants as soybeans, clover or sugar beets. The onset of the "burn" seems to be accelerated by warm, sunny days about the time the tubers are starting to form.

POTASH STARVATION CAUSES POTATO BURN

This year's evidence conclusively indicates that potato "burn" is the result of potash deficiency. We made tests in dozens of potato fields and found in every instance of "burn" that the potato leaves were "low" to "very low" in potash. Leaves of healthy plants selected from the same fields were "high" in potash. This situation was true in several dozen tests, without a single exception. These findings confirmed several experiments designed to isolate the cause of this trouble.

At the Experiment Farm at College, three hundred pounds of potash (K_2O) per acre had been spread across several potato plots. Here the "burn" was markedly less than in non-treated areas. Tissue tests of the "burned" potatoes were "low" in potash but "very high" in the normal, healthy, potash treated plants. In the potash treated area there were a few isolated "burned" vines. These individual plants showed a "low" potash content.

At the College farm experiment we found the "burn" affected vines running about 100 parts per million in magnesium, whereas normal plants contained about twenty times less magnesium (5 p.p.m.). Normal plants were also about twice as high in calcium as those with the "burn".

From other sources we know that cations -- calcium, potassium and magnesium -- are present in healthy plants in a reciprocal balance and that if one or more of these three are abnormally high, the third ion will be deficient. This condition of high magnesium and high calcium by itself, without the confirmation of the low potash test, points to trouble from low potassium. This is significant support of the conclusion that "burn" is caused by shortage of potassium.

More confirmation comes from plots on the Crowther farm near Palmer. This experiment has many treatments, but for our point we call attention to the over-all basic fertilization of 1800 pounds per acre of 8-24-8 containing sulfate of potash applied at planting time in the row. This is the equivalent of 144 pounds of N, 432 pounds of P_2O_5 and 144 pounds of K_2O per acre. These plots lie beside an area which received only nitrogen-phosphate fertilizer (11-48-0) and no potash this season. Potatoes growing where 144 pounds of potash (K_2O) were spread appeared healthy and showed only a scattering few plants with any trace of the "burn", whereas the no-potash (11-48-0) vines were very seriously "burned" and stunted. Both tissue tests and soil tests for potash confirmed the treatment.

The final and most conclusive evidence that this potato "burn" is a potash deficiency comes from several short test rows in the highly "burned", no potash, 11-48-0 fertilized potatoes on the Crowther farm. These test rows were sprayed with a 2 per cent potash solution twice a week since early July. Potato vines receiving the sprayed potash were growing very well on August 29 showing almost no "burn". The field as a whole and rows beside the sprayed plants -- even immediately next to the sprayed plants -- were extremely affected with "burn". Here again the difference was confirmed by tissue tests.

EDITORIAL NOTE-When these sprayed rows were dug in early September, they yielded about four times more than the rows immediately adjacent which were not sprayed with potash. Yield differences were attributed chiefly to larger tubers on the sprayed plants. The unsprayed plants had about the same number of tubers but they were all very small. It is concluded that the potash deficiency became significant after the tubers were set. As the unsprayed vines deteriorated, they could not manufacture starch. The sprayed vines stayed healthy after the tubers were set and continued to manufacture starch which made the tubers grow.-A.H.M.

All of this evidence leaves us no choice but to conclude that potato growers can decrease the effects of this "burn" -- which is really a potash deficiency symptom -- by applying adequate potash in their fertilizers.

EDITORIAL NOTE-Although fertilizers may theoretically contain sufficient potash for a good harvest, the potash may nevertheless not become available to the plant when it is needed. Lack of soil moisture may prevent potash from being taken up by the plant. Dr. Scarseth deals with this point in the following paragraphs.- A.H.M.

HOW MUCH POTASH TO USE We found the potash content of virgin soils highly variable, tending towards "high" on freshly cleared ground. After two or three years of farming, and after the removal of some forage or straw crops, the soil potash levels drop fast. The potash level in a soil is also greatly influenced by fertilizers. These observations are confirmed by extensive Experiment Station soil test records.

On new land near Fairbanks (the Johnson farm, Mile 33) about 64 pounds of chloride potash (K_2O) was applied on each acre, in 800 pounds of 8-24-8. This field was planted to potatoes following two seasons of oats and some "burn" was showing on August 16. In some sites, as over old stump windrows potash was high in both soils and plants, and such places were free from the "burn". Evidently, 64 pounds of K_2O per acre was not enough where the soils did not contain ashes.

In the Dornath fields near Fairbanks, 60 pounds of sulfate K_2O was applied on each acre in 1,000 pounds of 6-30-6 we found no burn on August 16. Data on the amounts of potash added in previous years was not available but there was probably a good residual potash carryover from previous years.

On the Woods farm near Palmer potatoes had been planted the second year following a meadow. This field had received 64 pounds of sulfate K_2O in 800 pounds of 8-24-8 in both 1955 and 1956. Where irrigation was used, only occasional plants with "burn" were seen on August 23. Again the degree of "burn" and the levels of potash in the vines were directly parallel. Irrigated vines were excellent in growth, setting potatoes well, and were beginning to turn lighter color when we saw them, showing that the nitrogen was beginning to run out and the potatoes were being filled with starch for maturity and quality. We concluded here that some increase in the potash supply was desirable.

On the Evenson farm (near Anchorage) very heavy fertilizer applications were used. In past years he has spread about 200 pounds of K_2O in 2,000 pounds of 10-20-10 on each acre. In 1956 he used about 96 pounds K_2O in 1200 pounds of 9-28-8 per acre. No "burn" showed in a very heavy growth of vines that had a heavy set of good sized potatoes on August 28. Here we can be certain that there was a substantial carry-over of nutrients from the past years. While 96 pounds of K_2O per acre seemed adequate this year it may not have been sufficient if more had not been used in earlier seasons.

In the Reid potato fields near Palmer serious "burn" showed up on ridges, but not by old straw piles near the barn nor in stump windrows. Here only 50 pounds per acre of K_2O had been used.

We saw very little "burn" in mid-August in the fields of Bert Stimple, John Holm, or Paul Elbert (in the Fairbanks area). Some of these fields had received only 50 to 65 pounds of K_2O per acre in 6-30-6 and 8-24-8 fertilizers. In past seasons many of these fields had received 10-20-10 fertilizers which supplied relatively more potash.

All this brings me to risk drawing the following conclusions:

- (1) Where little or no "burn" showed up in 1956, the potato grower should supply about 100 pounds K_2O per acre.
- (2) Where the "burn" was serious in 1956, the K_2O application per acre should be 150 to 200 pounds.

This is the amount of potash (K_2O) contained in 300 to 400 pounds of potash sulfate as a simple carrier. One thousand or 1,333 pounds of 5-25-15 or 750 pounds and 1,000 pounds of 10-20-20, respectively, as mixed fertilizers contain the same amount of potash.

Where oats are planted on new land their need for nitrogen and phosphate are so great that these tend to overshadow their need for potash. We saw no case where forages and grains needed potash on new land, but on the older lands potash is also needed. This shows up at the forage experiments at Palmer.

BROADCAST THE POTASH There is plenty of research and experience in the States showing the advantages of having potash distributed well throughout the soil, as with broadcasting, over applying it in concentrated bands in the row. In this climate, I believe potash should be broadcast on top of the plowed ground and disked in, rather than plowing it under. Potash disked into the top part of the soil will be more readily available during the early growth of the plant than if it is placed in a concentrated band where its salt effect may be objectionable in dry periods. Another advantage of broadcasting potash is that there are substantial dollar savings over buying potash in mixed fertilizers.

When broadcasting the potash, some extra nitrogen can be conveniently applied by adding 50 to 100 pounds of ammonium nitrate in the broadcast hopper and mixing it with the potash. This is an easy way to add more nitrogen (especially nitrate nitrogen) than is contained in the popular 11-48-0. 11-48 is a good cheap source of both ammonia nitrogen and phosphate and is well used in a band application spread by the planter.

SAVE MONEY BY BROADCASTING THE POTASH If we compare the approximate costs of plant food, f.o.b. Palmer, in, let's say, 1,000 pounds of 5-25-15 (this is 50 pounds N, 250 pounds P₂O₅ and 150 pounds K₂O per acre) with approximately the same amount of plant foods in straight materials -- for example, 300 pounds of potash sulfate (50 per cent K₂O), and 50 pounds of ammonium nitrate (33.5% N) broadcast, in addition to 400 pounds of 11-48-0 in the row -- we find the mixed fertilizer costs about \$65 per acre as compared to \$50 for the simple carriers. This is a saving to the farmer of about \$15 per acre. This savings must pay for the extra work of broadcasting. Broadcasting also means more compaction of the soil by the passage of extra implements over the plowed ground.

POTASH AS CHLORIDE VS SULFATE As we observed in August 1955, again this year we found that where the chloride potash form (muriate of potash) was used, the phosphate level in the tissues of the potato vines was frequently "low". In such cases the stems of the vines were not robust and heavy as where tissue tests showed "high" levels of phosphates.

We found no direct comparison of the chloride versus sulfate forms of potash except on Stimple's farm in the Tanana Valley. Here 800 pounds of 10-20-10 containing chloride potash was compared with 800 pounds of 6-30-6 containing sulfate-magnesium potash. Both the plants and the phosphate levels in their tissues were much better supplied with phosphate where the sulfate potash had been used than where 10-20-10 had been used.

From the Fairbanks fields visited it appears that, for this season, the 800 pounds of 6-30-6 (sulfate-magnesium) was performing better than 800 pounds of 10-20-10 (chloride). Most of these fields were new fields having been cropped for only three years.

PHOSPHATE & NITROGEN

HOW ABOUT THE PHOSPHATE STATUS OF ALASKAN SOILS? All virgin soils in this climate are highly deficient in available phosphate and nitrogen. No new land will produce acceptable grains or potatoes or vegetables without liberal applications of phosphorus which must be accompanied with nitrogen.

The 11-48-0 carrier of phosphate, which is a mono-ammonium phosphate and very water soluble, is proving to have advantages over the older treblesuper-phosphates. It gets into the plants easier. Another phosphate carrier, di-ammonium phosphate (which is about a 21-53-0 fertilizer) is also an excellent phosphate source on some soils, but not on all soils.

Dr. Laughlin has proof of this with vegetables in the field. These experiments point out that on new soils, about 200 pounds of P_2O_5 -- as in a mixture of 20 per cent phosphate at 1,000 pounds per acre or in 11-48-0 at 417 pounds per acre -- is about right.

For the first years of farming this needs to be repeated annually, when properly balanced with nitrogen and potash. After several years of such fertilization, the phosphate will accumulate in the soil and then can be somewhat reduced in amounts added. We cannot say how many years this will take. My guess that after six to ten years, at 200 pounds P_2O_5 per acre per year, the rate may be reduced. Experiments are needed here as a guide.

NITROGEN: THE KEY AND MAGIC ELEMENT Since organic matter, which contains insoluble nitrogen, does not decay rapidly in these cool soils, nitrogen is always in short supply unless applied as soluble commercial nitrogen.

Small grains tend to lodge when over-supplied with nitrogen. For example, on the flat soils of L. M. Canaday's farm near Fairbanks 200 pounds of nitrogen (as 10-20-10) per acre was applied to potatoes in 1955. This year the field was planted to oats which were not fertilized. Even so they lodged badly from the high nitrogen carry-over.

On the Marvin Busby farm near Fairbanks oats were planted on new land and fertilized with 400 pounds of 11-48-0 per acre. They made very poor growth because of lack of water on this warm south-facing slope. On the Kellogg farm near Palmer, where the moisture had been more adequate, oats were not making satisfactory yields because nitrogen and phosphate were deficient. Where manure had been applied oats-and-peas were making very heavy yields.

THE BIG QUESTION ABOUT NITROGEN --- HOW MUCH? Where 48 to 50 pounds of nitrogen per acre has been used in the Fairbanks area, the vines did not close in over the row, but were making fair yields. Their color was starting to turn by August 15.

In the Matanuska area 64 pounds of nitrogen seemed to be doing very well, even on the Woods farm where potatoes were irrigated. On the Reid farm potato vines were "high" in nitrates and still very green by August 22 where 100 pounds of nitrogen per acre had been applied.

NITROGEN, VERSUS FROST AND YIELDS On one hand potatoes need enough to grow a big vine. If the other nutrients --- phosphate and potash -- are good, the "set" of tubers should be good. On the other hand, an unbalance of too much nitrogen may give too much vines and a poor set. In the warmer summers and earlier frosts of the Fairbanks area, a nitrogen level of about 48 pounds of elemental N per acre (as in 800 pounds of 6-30-6) does a good job. Bert Stimple used this rate with excellent results in 1956. Lew Hanks had potatoes almost ripe by August 28 near Palmer with about 36 pounds nitrogen. Although yields appeared somewhat low, his potatoes were ready for an early market.

Where as much as 100 pounds of N per acre was used in the Palmer area, in a balanced fertilizer program, yields promised to be very high, but only in the event of a late frost. Evenson (near Anchorage) with 108 pounds nitrogen in 1956 and 200 pounds in 1955 seemed sure of high yields.

The grower is, therefore, in the spot of gambling on the frost date as to the amount of nitrogen he uses. We saw no fields where 100 pounds of nitrogen had been used year after year. This amount of nitrogen (100 pounds per acre) may be a good gamble near Anchorage, but a bit high in the Matanuska area and too high in the Fairbanks area. However, Mr. L. M. Canaday had an exceptionally promising yield prospect on August 16 with 200 pounds of nitrogen (applied as 2,000 pounds of 10-20-10). My personal opinion is that 100 pounds of nitrogen would do as well as the 200 pounds.

THE FAIRBANKS FACTOR --- In 1955 -- a cooler, drier season in the Fairbanks
A MOLYBDENUM DEFICIENCY? area than 1956 -- we noted a general widespread plant
nutrient deficiency we called "The Fairbanks Factor"
since it was not known what it was. From several angles we now believe this
deficiency was molybdenum, although this is not confirmed by experiments.
Experimental proof is needed before recommendations can be devised.

This symptom was found on potatoes. It was especially marked on the Teton variety, yet no field was entirely clear of it. We also found this deficiency on cauliflower with the well known whip-tail as a deficiency symptom. We found this deficiency on rhubarb, stringbeans, corn (Experiment Station test plots) and on tomatoes and cabbage.

This past season (1956) I found almost none of these symptoms in the fields I looked at, even in Teton potatoes, where it was so prevalent in 1955.

Since molybdenum is a nutrient required by plants in extremely low amounts -- probably less than one ounce per acre -- the warmer and moister soils in the 1956 season may have increased soil organic matter decomposition and thus released more molybdenum and decreased the deficiency. The fact that these symptoms were so marked in 1955 and so rare in 1956 indicates that we are dealing with a nutrient that is needed in very trace quantities.

A FINAL WORD

Alaska is especially adapted to the development of dairying and livestock because of the high yields of grains and forages that can be produced under good management made possible by scientific guidance. These forages contain 18 to 20 per cent protein or more. Protein is the expensive ingredient in bagged feeds now shipped into the Territory.

It is better economy to import concentrated nitrogen as a fertilizer and convert this nitrogen on Alaskan farms into home-grown high protein forages and high energy feeds as oats and barley than to purchase from the Outside heavy feeds at high freight rates.

The "new-land" farmer finds the potato a good crop to use in his land-clearing stage. As he clears the land and builds up the soil fertility, he can gradually shift to dairying.

What Alaska needs the rest of the world has so often in excess -- that is, people. With dustless, hard surface highways to the States, Alaska could do like Mexico did in a matter of a few years in building a \$60 million tourist trade. More consumers is what the Alaska farmer needs -- amongst other things, of course. This is a prospect that would be good for all.

EDITOR'S NOTE- Many farmers no doubt recall Dr. Leach, who served as a consultant to the Experiment Station in 1955. His report contained the following comment: "On the basis of circumstantial evidence . . . I would be inclined to suspect potash deficiency of the type due to exhaustion of the available supply of potash late in the season at the peak of vegetative growth. This could occur even though considerable amounts of potash were applied to the soil, and the condition would be accentuated by over-fertilization with nitrogen and phosphorus.

Dr. J. G. Dickson, who assisted the Experiment Station this past summer through the help of the Rockefeller Foundation, was in the field on several occasions with Dr. Scarseth. Amplifying Dr. Scarseth's comments on potato nutrition and its relation to decomposition of soil organic matter, Dr. Dickson suggests that potato farmers make an effort to utilize legumes in their rotations. He believes that legumes might foster a beneficial microflora population which would help both nutrition and disease control. Specifically, he suggests planting sweetclover, alsike or similar crops. Some forage might be taken the first year. The important thing for the potato farmer is the root system, which should be plowed up in the following spring to prepare the potato seed-bed. Dr. Dickson suggests this management practice would help decrease scab infestations and might also improve potash utilization. Ample evidence from potato growing regions in the States bears out his suggestions.-- A.H.M.