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PRODUCTION AND AGRICULTURAL USE OF SODIUM NITRATE

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CONTENTS

NATURAL SODIUM NITRATE

All fertile soils contain small quantities of nitrates, mainly as a result of bacterial nitrification processes. More or less concentrated accumulations of nitrates have been found in various parts of the world, but, with one exception, none of these have been of such size and richness as to allow continued working for fertilizer use. In Tarapaca, Atacama, and Antofagasta, northern Provinces of Chile, however, are located large deposits of sodium nitrate, along with other salts, the exploitation of which commenced before Liebig's invention of superphosphate in 1840. Exportation of sodium nitrate from these deposits to Europe began in 1830, and they have continued to supply sodium nitrate for agricultural use to the present. Sodium nitrate, or nitrate of soda, also known as Chilean nitrate and Chile saltpeter, is, therefore, the oldest of the inorganic commercial fertilizer materials. Although the early development of the Chilean nitrate industry was slow, growth became rapid after about 1880, and Chile soon enjoyed a monopoly of the world's fixed-nitrogen supply, the price of which was controlled by the Chilean producers. This control was destined to last until modern processes for fixing atmospheric nitrogen were established on a commercial basis.

The Chilean deposits lie in the desert region between the Andes and the coastal range along the Pacific Ocean and occur mainly on the eastern slopes of the latter mountains, the deposits actually worked lying at elevations between 4,000 and 7,500 feet above sea level. They are not continuous but are located over an area almost 450 miles long and from 5 to 40 miles wide. The origin of these nitrate deposits has been attributed to the decomposition by nitrifying bacteria of ancient accumulations of seaweeds or guano, of the manure of vicuñas and llamas, or of the organic matter in the soil between the Andes and the locations of the deposits, as well as to the oxidation of atmospheric nitrogen to nitric acid during electrical storms in the Andes, to nitrogenous fumes from volcanoes, and to the fixation of atmospheric nitrogen by alkali carbonates in the presence of oxidizable matter. None of the theories proposed, however, account for all the conditions associated with the deposits. The salts are usually intermingled with sand, gravel, and clay, which they cement together, and the hard cemented material usually lies beneath a loose aggregate consisting of clay, gypsum, and other materials. The cemented material and the overburden may vary from a few inches to several feet in thickness. The sodium nitrate content of the cemented material also varies greatly. The richer material is called caliche. The cementing salts consist of nitrates, chlorides, borates, perchlorates, chlorates, sulphates, and iodates of sodium, potassium, calcium, and magnesium.

All the ore was formerly mined by hand, the operations consisting of blasting the cemented material into large blocks by means of explosives, breaking these into smaller pieces with sledges or crowbars, and sorting out those pieces that were considered of sufficient richness in nitrate to warrant further treatment at the refinery. The older method of refining required an ore with at least a 15-percent nitrate content for economical operation. In recent years, however, drag lines to remove the overburden and electric shovels for excavation of the ore have partially displaced manpower, and the introduction, in 1927, of an improved refining process allows the working of ore of much lower grade at certain plants.

The older of the refining procedures, or Shanks process, involves leaching the ore with boiling water, crystallizing the sodium nitrate from the hot liquor by cooling, and draining the mother liquor from the crystals. The material, as shipped, contains about 2 percent of water. In the newer, or Guggenheim, process, the ore is extracted at temperatures not exceeding 40° C., and the sodium nitrate is crystallized from the solution by refrigeration to about 5° C. The crystals obtained are centrifuged to remove mother liquor, melted in a furnace, and the molten nitrate finally pumped through spray nozzles, the spray solidifying in the form of pellets as it cools.

SYNTHETIC SODIUM NITRATE

Sodium nitrate is now produced synthetically at several nitrogen-fixation plants. In the arc process for fixing atmospheric nitrogen, the oxides of nitrogen formed by passage of air through an electric arc are led upward through towers down which water flows. The oxides of nitrogen are absorbed in the water and form nitric acid. The residual oxides of nitrogen that escape absorption in these acid towers are passed to alkali towers where they are absorbed in a solution of sodium carbonate (washing soda). The liquor that flows from these alkali towers is a solution of sodium nitrite, together with smaller quantities of sodium nitrate, sodium carbonate, and sodium bicarbonate (baking soda). Upon treatment of this liquor with the nitric acid obtained from the acid towers, a solution of sodium nitrate is formed which is then evaporated, to crystallize out the nitrate. Additional sodium carbonate may also be treated directly with nitric acid, to increase the output if desired.

Sodium nitrate is also produced at some plants that employ the synthetic ammonia process for fixing atmospheric nitrogen. At such plants, one of which is located in the United States, the ammonia is oxidized to form oxides of nitrogen which are then used to produce sodium nitrate in the manner just described. The nitrite solution formed by absorption of the oxides of nitrogen in the alkali towers may be treated with higher oxides of nitrogen, instead of with nitric acid, to convert the sodium nitrite to sodium nitrate. The production of synthetic sodium nitrate on a commercial scale by this method commenced in this country in 1929. The sodium carbonate employed in the process is manufactured from sodium chloride (common salt).

A procedure has been very recently introduced in Norway in which limestone is first treated with nitric acid to form a solution of calcium nitrate which is then passed through a sodium zeolite to obtain a sodium nitrate solution, the sodium zeolite being simultaneously converted into calcium zeolite. The calcium zeolite is reconverted into the sodium zeolite for reuse by passing sea water through it. In this process, the comparatively cheap naturally occurring materials, limestone and sea water, are used instead of the manufactured sodium carbonate required in the above-mentioned procedures. Another method that avoids the use of sodium carbonate was introduced in this country during 1936. In this process, sodium chloride is treated directly with nitric acid obtained from the oxidation of ammonia for the production of sodium nitrate.

Sodium nitrate is used for the manufacture of potassium nitrate, explosives, glass, sodium nitrite, nitric acid, and other chemical products and for curing meat, but its principal use is as a fertilizer material.

Although statistics on the total domestic production of synthetic sodium nitrate are unavailable, exports (none prior to 1930) amounted to 28,630 tons in 1930, 73,700 tons in 1931, 185,000 tons in 1932, 102,000 tons in 1933, 177,000 tons in 1934, and 153,000 tons in 1935. Imports of sodium nitrate into this country, from 1916 to 1935 inclusive, are given in the following tabulation:

Year	*Short tons*	*Year*	*Short tons*
1916	1, 364, 463	1926	1, 024, 014
1917	1, 728, 399	1927	838, 636
1918	2, 066, 615	1928	1, 156, 860
1919	456, 354	1929	1, 042, 113
1920	1, 480, 519	1930	636, 825
1921	413, 474	1931	616, 687
1922	607, 560	1932	56, 482
1923	998, 680	1933	137, 610
1924	1, 105, 001	1934	328, 750
1925	1, 245, 693	1935	437, 635

COMPOSITION

The composition of commercial sodium nitrate varies somewhat according to whether it is of natural or synthetic origin. The composition of the natural, or Chilean, nitrate is also dependent upon whether the Shanks or Guggenheim process was used in its recovery. Chilean nitrate produced by the Shanks process usually contains about 1 percent of moisture and 0.2 percent of water-insoluble matter. The metallic, or basic, elements present are usually about 26 percent of sodium, 0.75 of potassium, 0.2 of calcium, and less than 0.1 percent of iron and aluminum. The nonmetallic, or acidic, elements present are customarily about 16 percent of nitrogen in the form of nitrates, 1 of chlorine, mostly as chlorides but partly also as chlorates and perchlorates, 0.1 of sulphur as sulphates, 0.02 of iodine, mostly as iodates, and 0.02 percent boron as borates. The total nitrate content, calculated as sodium and potassium nitrates, varies from approximately 94 to 96 percent. In table 1 are given the analyses of four samples of Shanks-process Chilean nitrate.

TABLE 1.—*Composition of Shanks-process Chilean nitrate*

Sample no.	Nitrogen	Sodium	Potassium	Calcium	Magnesium	Chlorine	Iodine	Sulphur	Boron	Moisture	Insoluble
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
1	15.92	26.43	0.45	0.21	0.04	1.17	0.017	0.08	0.017	0.36	0.20
2	15.98	25.75	1.10	.24	.07	.55	.011	.12	.01	.40	.30
3	16.03	26.19	.36	.21	.04	.49	.032	.06	.058	1.24	.20
4	16.06	26.28	.54	.01	.06	.36	.019	.04	.03	1.26	.10

Chilean nitrate produced by the Guggenheim process has a lower moisture content than the product of the Shanks process. Probably most of the moisture in the Guggenheim-process nitrate is absorbed from the atmosphere subsequent to the manufacturing process. The chlorine and potassium contents are also less, but the sodium content is somewhat greater. The total nitrate content, calculated as sodium and potassium nitrates, varies from about 98.3 to 98.8 percent. Analyses of three samples of Guggenheim-process Chilean sodium nitrate are given in table 2.

TABLE 2.—*Composition of Guggenheim-process Chilean nitrate*

Sample no.	Nitrogen	Sodium	Potassium	Calcium	Magnesium	Chlorine	Iodine	Sulphur	Boron	Moisture	Insoluble
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
1	16.27	26.79	0.16	0.07	0.04	0.35	0.009	0.08	0.005	0.14	0.10
2	16.22	26.60	.16	.07	.06	.27	.09	.05	.012	.12	.23
3	16.18	26.61	.13	.21	.04	.36	.024	.10	.005	.08	.26

Synthetic sodium nitrate of domestic origin is practically moisture-free, the water content being less than 0.05 percent. The metallic elements contained therein are approximately 26.8 percent of sodium and less than 0.1 percent each of calcium and magnesium. The nonmetallic elements present are about 16.3 percent of nitrogen as nitrate, 0.15 of chlorine as chloride, and 0.07 percent of sulphur as sulphates. The insoluble matter is usually less than 0.1 percent. The total nitrate content, present as sodium nitrate, is approximately 98.8 percent.

The crystalline product of the old (Shanks) process sodium nitrate may vary in color from pure white to yellowish, pinkish, gray, or even violet tints. The products of the new (Guggenheim) process and of the synthetic process are white. The old process product is somewhat deliquescent, due to its impurities. As a result, it tends to absorb water from the atmosphere and to cake. The Guggenheim process and the synthetic process yield products that are less deliquescent. The granular pelletlike form of the Guggenheim product decreases its tendency to cake.

COST OF NITROGEN IN NITROGENOUS FERTILIZER MATERIALS

As previously indicated, the price of nitrogen was formerly controlled by that of Chilean saltpeter. This control, however, ceased with the establishment of the synthetic nitrogen industry. The decided influence of synthetically produced nitrogenous products in decreasing the cost of nitrogen is clearly shown in table 3, which compares the wholesale prices of nitrogen in a number of fertilizer materials from 1885 to 1935, inclusive.

Table 3.—*Wholesale prices of a unit (20 pounds) of nitrogen in fertilizer materials in stated years*

Year	Sodium nitrate	Ammonium sulphate	Anhydrous ammonia	Cyanamid	Year	Sodium nitrate	Ammonium sulphate	Anhydrous ammonia	Cyanamid
1885	$2.75	$3.03			1925	$3.28	$2.65		$2.20
1890	2.33	3.18			1930	2.49	1.79	$1.40	1.65
1895	2.36	2.75			1931	2.36	1.34	1.36	1.38
1900	2.37	2.79			1932	1.86	1.02	1.34	1.08
1905	2.97	3.01			1933	1.53	1.12	1.15	1.13
1910	2.76	2.64		$3.43	1934	1.54	1.18	1.09	1.20
1915	3.04	3.09		2.54	1935	1.47	1.13	1.09	1.20
1920	4.44	4.08		3.40					

SODIUM NITRATE IN RELATION TO CROP PRODUCTION

NITROGEN AN ESSENTIAL PLANT-FOOD ELEMENT

The fundamental growth processes of plants are vitally concerned with nitrogen, a number of its compounds playing an important part in plant nutrition. Without an adequate supply of available nitrogen in the soil, plants fail to grow and to produce well; their foliage is apt to be pale, and the plants themselves become stunted in growth and appear undernourished. This particular element promotes growth and gives the crop a good start which enables it to utilize other nutrient materials advantageously, and to approach maturity in much better condition than with a low nitrogen supply. While all arable soils contain some available nitrogen, frequently the supply is considerably below the needs of the growing crop, more especially during early growth when an ample supply of available nitrogen is very important.

Sodium nitrate is one of the outstanding sources of available nitrogen, readily utilizable by plants. This compound has been used extensively as a fertilizer in the United States for a long time, having been introduced into this country nearly a century ago. As the result of a great many experiments and the broad experience of farmers and gardeners, it has ga ned the reputat on of being a very satisfactory source of available nitrogen for plants.

While plants utilize other combinations of nitrogen, including the ammoniacal and organic, these are to a considerable extent changed over to nitrate nitrogen through the action of soil organisms before the plant completely utilizes them as nutrient material. It is recognized, however, that ammoniacal nitrogen compounds are utilizable by plants, some plants doing so to a much greater extent than others, without first undergoing change to the nitrate form. This appears to be true also of certain organic nitrogen compounds, although less pronounced than with the ammoniacal form.

PROPERTIES OF SODIUM NITRATE IN RELATION TO THE SOIL

Sodium nitrate is readily soluble in water and is one of the most quickly available sources of nitrogen for plants on account of the ease with which it dissolves in the soil moisture and its direct utilization by plants without having to be changed by the intervention of soil bacteria. Owing to its ready solubility, sodium nitrate, in common with other nitrates, possesses a high degree of diffusibility, which enables it to move rapidily in the soil in accordance with either upward or downward movements of soil moisture.

The ready solubility and diffusibility of nitrates enable them to pass easily through the soil after a rainfall. This is commonly referred to as leaching. The leaching of nitrates is much more serious on light sandy soils with pervious subsoils than on heavy, less open soils; also it is much greater from bare land than from land occupied by crops. The effect of the crop is to utilize the nitrates. The plants decompose and the absorbed nitrogen is returned to the soil. Th's method is a good way to avoid unnecessary losses of valuable nitrogen compounds. Capillarity, unlike ordinary leaching, is instrumental in concentrating the nitrates more heavily in the upper layer of soil, until either removed by the growing crop or again leached downward by rainfall.

Sodium nitrate has been found to have a deflocculating effect on heavy soils possessing a high content of fine material—principally clay and fine silt particles—when applied to such soils continuously. This is ascribed to the ultimate formation of sodium carbonate in the soil, a compound which tends to break up the so-called "crumb structure" of a soil and thus leads to poor mechanical condition, as evidenced by increased stickiness and greater difficulty in plowing and in cultivating. While this result may follow the use of sodium nitrate under the indicated soil conditions, it rarely occurs in the United States because sodium nitrate is not applied in large enough amounts to seriously affect the average heavy soil, and when used in complete fertilizer it is usually combined with materials which tend to counteract such a reaction.

Soils are either acid, neutral, or alkaline in reaction, conditions brought about by various influences including applied fertilizer salts, such as sodium nitrate, ammonium sulphate, and other inorganic nitrogen compounds. The ultimate effect of sodium nitrate when applied to the soil is to make it less acid if already possessing an acid reaction, and more alkaline if the soil reaction is alkaline. If the soil reaction is neutral the addition of sodium nitrate would tend to change the reaction to alkaline. While the quantity of sodium nitrate applied, usually not over 200 pounds to the acre, will decrease soil acidity or even render soils alkaline, it would be uneconomical to attempt to lower soil acidity with sodium nitrate. When the control of soil acidity becomes necessary the most economical method of accomplishing this would be to apply some form of lime.

RESIDUAL EFFECT

While its immediate availability and loss from leaching would seem to imply that there would be little residual effect of this fertilizer on the soil, as a matter of fact it so stimulates plant growth that the increased plant residues thus given to the soil under some conditions continues the effect of the nitrate to a certain degree for several years.

AGRICULTURAL USES OF SODIUM NITRATE

The principal ways of using sodium nitrate from a crop-production and fertilizer standpoint are (1) direct application to the soil as side dressing, (2) in commercial and home-mixed fertilizer preparations, and (3) special uses, such as the growing of greenhouse crops. The most extensive use, however, is with the first two, although the third may be expected to assume greater importance in the future.

APPLICATION TO SOIL

The application of sodium nitrate to the soil must be considered in the light of its properties. As it is very soluble, large amounts should not be applied at one time as any excess not used by the plants would be lost as a result of leaching. If a large amount of nitrogen is to be used in this form, it should be applied in divided applications at intervals sufficient to allow the plants to use up the nitrate. Losses of this character are most likely to be felt in open sandy soils. In making mixed commercial fertilizers, it is often felt advisable to include sodium nitrate, for immediate availability; ammonium sulphate or some similar material, for continuing the action of the fertilizer; and some form of organic nitrogen carrier, such as fish scrap, cottonseed meal, or tankage, to still further forward the crop.

The quantity of sodium nitrate to be applied to crops varies with so many conditions that it is difficult to make any general statement. Considering its price as compared with that of the products grown, it will normally pay to use only from 50 to 200 pounds an acre for general farm crops, but for special crops it may be possible to use larger amounts to advantage. The amount of sodium nitrate to use depends not only on the type of soil and of crop grown, but also on the previous history of the soil and the amount of manure or compost that is available.

Sodium nitrate is often applied in the early spring before nitrification has taken place in the soil, because a light application at this time will give the plant a start and later when the soil warms up the nitrogen already in the soil tends to become available for the crop. For example, in the southeastern part of the country, an application ranging from 75 to 100 pounds an acre of sodium nitrate applied to corn when it is a few inches high will give it a good start and more than justify the cost of the fertilizer, but the same amount of nitrogen applied later in the season may not be profitable.

It must not be forgotten also that an excess of sodium nitrate applied at the wrong time will often delay maturity of the crop, and from the business point of view do more harm than good. Sodium nitrate is considered one of the most efficient carriers of nitrogen, but it must not be considered a general cure-all for bad soil conditions. Care must be exercised both in the amounts applied and in the time of application. However, in the future, if agriculture becomes more intensified in this country, and more attention is given to the individual plant and soil type, there probably will be a more careful use of sodium nitrate, especially in solution as now practiced by some specialists.

SPECIAL USES

Sodium nitrate is often used in solution, especially among florists. Diluted at the rate of 1 ounce to 2 gallons of water, it has been recommended for the growing of flowers in greenhouses. It has also been used in the irrigation water for growing truck crops, such as cucumbers. Generally the nitrate is used most advantageously at a rate not exceeding 50 pounds to each 7,000 or 8,000 gallons of irrigation water. When dissolved in the irrigation water, sodium nitrate gives a very quick response.

SOIL BACTERIA

The application of sodium nitrate under some conditions influences the bacterial flora of the soil. This is partly due to the quickly available plant food supplied and may also in part be influenced by the change in the soil acidity. Where large amounts of organic material, such as straw or similar products, are turned under, the initial bad effect of this practice may be minimized by adding sodium nitrate to the soil as a nutrient for the bacteria which are instrumental in breaking down the straw. This gives a supply of quickly available nitrogen for the bacteria which otherwise would compete with the crop itself for available nitrogen in the soil.

NITRATE IN MIXTURES

When nitrogen is the limiting factor, as is the case on many soils, an application of sodium nitrate alone may give very profitable returns, but with the increase in the amount of nitrogen it may be necessary to add carriers of phosphoric acid and potash to balance the nitrogen. In this way larger amounts of sodium nitrate may be used successfully. Inasmuch as it is difficult to distribute evenly small amounts of sodium nitrate, if phosphate is also needed, it is often advisable to mix the sodium nitrate with superphosphate. This will not only insure more even distribution of sodium nitrate but add phosphoric acid in quickly available form. This applies also to potash where needed.

COMPLETE FERTILIZERS

Sodium nitrate is a satisfactory material for use in complete mixed fertilizers, and it has been widely used for this purpose in commercial fertilizer mixtures. However, due in large measure to its higher price per unit than competing products, there is a tendency to substitute for it other fertilizer materials which may be obtained at lower prices. Since the fertilizer-control laws of many States do not compel either the use of sodium nitrate in fertilizers or a statement of the nitrogen in nitrate form in fertilizers, the farmer or gardner must either apply it as a top dressing, or home-mix his fertilizer, if he desires to be certain of getting sodium nitrate.

HOME MIXING

Home mixing of fertilizers enables the farmer to make certain not only that he is getting the actual materials he desires, but that he can duplicate the mixture the following season if it gives satisfactory results. Another reason that sodium nitrate is widely used in home-mixing operations is that it is not only a standard product but is procurable at practically all points in the fertilizer-using sections. The following formulas, using sodium nitrate for home mixing, are given for examples:

MIXTURE 1

	Parts
Nitrate of soda	1
Cottonseed meal	3

This mixture has been used as a top dressing for lawns.

MIXTURE 2 (5–10–5[1])

	Pounds
Nitrate of soda (15.4 percent N)	200
Sulphate of ammonia (20.8 percent N)	200
Tankage (7.5 percent N and 9 percent P_2O_5)	400
Superphosphate (17.4 percent P_2O_5)	946
Muriate of potash (51 percent K_2O)	196
Filler[2]	58
Total	2, 000

[1] Percentages, respectively, of nitrogen, phopshoric acid, and potash.
[2] Sand is often used as a filler. From the viewpoint of soil fertility, other materials, such as ground raw phosphate rock, pulverized limestone, prepared peat or garbage tankage, are preferable.

This fertilizer formula has been used for vegetables.

MIXTURE 3 (2–8–8)

	Pounds
Nitrate of soda (16 percent N)	200
Cottonseed meal (5.76 percent N)	139
Superphosphate (16 percent P_2O_5)	1, 000
Muriate of potash (50 percent K_2O)	320
Filler	341
Total	2, 000

This mixture has been suggested for corn, small grains, and grasses on soils high in humus.

MIXTURE 4 (5–8–4)

	Pounds
Nitrate of soda (16 percent N)	207
Ammonium sulphate (20.5 percent N)	161
Cottonseed meal (7.5 percent N)	442
Superphosphate (18 percent P_2O_5)	889
Muriate of potash (50 percent K_2O)	160
Filler	141
Total	2, 000

The nitrogen in this formula is one-third from organic sources, one-third from ammonium sulphate, and one-third from sodium nitrate. This mixture has been used for cotton.

MIXTURE 5 (3–8–8)

	Pounds
Nitrate of soda (16 percent N)	125
Ammonium sulphate (20.5 percent N)	97
Cottonseed meal (7.5 percent N)	266
Superphosphate (18 percent P_2O_5)	889
Muriate of potash (50 percent K_2O)	320
Filler	303
Total	2, 000

This mixture has been used for sweetpotatoes in the South.

Many other combinations might be cited. Any farmer desiring more complete information on home mixing should write to his State agricultural experiment station or the United States Department of Agriculture.

USE ON INDIVIDUAL CROPS

On cotton, in addition to the application of a balanced complete fertilizer before planting, it is a common practice to side-dress the crop about the time the cotton is chopped with sodium nitrate at the rate of 75 to 150 pounds an acre.

Beneficial results are often obtained on corn, in the Southeastern States, by applying sodium nitrate before the cultivation of the crop ceases, at the rate of 100 to 200 pounds an acre.

Good results are obtained on small grains, when the nitrate is used in the spring as a top dressing, at the rate of 75 to 100 pounds an acre.

When well-balanced complete fertilizers are used on truck crops at planting time, sodium nitrate gives good results and stimulates growth when applied periodically during the growth of the crop.

Sodium nitrate is widely used on fruit trees, especially apples. The amount to use and whether phosphoric acid and potash should also be used will depend on many factors, such as the soil, its cultivation, and the use of cover crops or sod. In orchard sections where it has been found desirable to fertilize, the following amounts of sodium nitrate, or their equivalents in other nitrogen carriers, have been recommended for annual application to apple trees: One-fourth pound on 1- and 2-year trees, one-half to 1 pound on 3-year trees, 2 to 4 pounds on 6- to 10-year trees, and 5 to 10 pounds on 15- to 30-year trees. These amounts are given only as a general guide and must be modified to suit conditions. Nitrate is usually applied in early spring—about a month before the blooming period. Since fertilization is only one of the factors to be considered in fruit production and the use of fertilizers is so closely related to proper methods of pruning, cultivating, spraying, and other practices, careful study of the orchard should be made before fertilizers are applied, and the best horticultural authorities who have knowledge of local conditions should be consulted.

Sodium nitrate is satisfactory as one of the sources of nitrogen in mixed fertilizers for use on tobacco. On average soils in the Southeastern States a complete fertilizer containing 3 percent of nitrogen, 8 to 10 percent of phosphoric acid, and 6 percent of potash has been recommended. One-third of the nitrogen should be from nitrate and one-third from a high-grade organic source. For seedbeds a complete fertilizer containing nitrate is applied before planting, and often one or more applications of a solution of sodium nitrate is applied later to hasten the growth of seedlings.

QUALITY OF CROPS

Aside from the question of increasing the yield of crops, sodium nitrate is often used because of its effect on quality. While insuring the steady growth of many vegetables sodium nitrate may also improve their quality, making them more tender and of better color. This especially applies to leafy vegetables, such as lettuce and spinach. Applications to meadows and pastures have been shown not only to improve yield but also to increase the protein content of the crop.

PROPER USE OF SODIUM NITRATE

In dealing with a plant food, such as sodium nitrate, it must be realized that there is also a certain amount of risk involved. Too much nitrogen frequently delays maturity and also may force leaf growth when a larger quantity of fruit is desirable. There is also the danger of injuring the carrying qualities of certain fruits and vegetables. This indicates that agriculture is an art as well as a science and that the farmer and gardener should make a study of his own conditions carefully before applying fertilizers. In handling concentrated fertilizer salts, such as sodium nitrate, certain precautions are essential. For example, in top dressing partly grown garden vegetables with sodium nitrate, it is often desirable that it be mixed or diluted with some inert material, such as dry sand or earth. In top dressing lawns, a mixture of 1 part of sodium nitrate with 3 parts of cottonseed meal may be used. The cottonseed meal not only acts as a diluent for the sodium nitrate but also contains slowly available nitrogen in organic form which continues growth stimulation begun by the sodium nitrate.

USE IN SMALL GARDENS

In making surface applications, sodium nitrate should not be applied too near the growing plant, and it should not be allowed to touch the foliage nor stems of the plant, especially when wet, as serious burning of the tissue may result. After applying sodium nitrate, it is advisable to work it in lightly. When the first rainfall comes the material will be dissolved and distributed throughout the soil. Generally, it will be better to make several small applications than one heavy dressing. Sodium nitrate is especially useful for early spring applications to crops that need a prompt early start. It should seldom be applied late in the growing season since maturing of the crop may be delayed. Crops, such as lettuce, early cabbage, spinach, kale, early tomatoes, and others are benefited by early applications of sodium nitrate, especially those crops that are eaten raw or as salads, and in general when rapid growth insuring succulence is desirable. It is well to consider that sodium nitrate furnishes nitrogen alone, and it may be desirable to use some phosphoric acid and potash in addition for garden or truck crops. As a rule complete fertilizers for these crops contain some sodium nitrate.

METHODS OF APPLYING

Often sodium nitrate is applied by hand, especially in small gardens, but to treat large areas fertilizer distributors make application easier. Special attachments to planters and cultivators are sometimes used. Probably the use of nitrate in solutions or in irrigation water insures the most even distribution. At present, this last method is largely limited to greenhouse culture, although if desirable its use could be extended.

As the use of sodium nitrate varies so widely with the soil, the locality, and the crop, it is advisable to write to the United States Department of Agriculture and to consult the county agent and the State agricultural experiment station for specific information in special cases.

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