

THE
FUTURE OF OUR WINE INDUSTRY
AND THE
RESULTS OF MANURING
VINEYARDS
IN EUROPE AND AUSTRALIA.

BY

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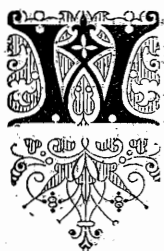
BOTH the Victorian and the South Australian Governments have, some years ago, issued Handbooks on Viticulture, but neither of these has dealt with the important subject of manuring the vineyards. I determined, therefore, to obtain as much information as possible from Australian vignerons who had tried manures as a desirable supplement. Before giving these reports, I furnish also others from European sources, that may be valuable as a hint, where there is yet so much uncertainty and so little Australian experience that can be fully relied on, or so positive and instructive as I had hoped. How to develop your vineyard, so as to obtain the largest yields without injury to the quality of the wine, and at the lowest cost, is too important a matter to be left undecided much longer. Whatever information I have collected on these points should be of some value to our vinegrowers, and lead them to make their own observations. After a number of trials, and a cycle of years, final conclusions may be reached. To make these experiments Australian vignerons need an incitement; hit or miss methods are, however, seldom satisfactory. This is now given by this pamphlet, and, since I wrote it, by the excellent paper lately read by our viticulturist, Professor Perkins, before the South Australian Vinegrowers' Association. He has taken, to some extent, the wind out of my sails; but the information I give is somewhat different, and from other sources, and therefore supplementing the above paper. The great divergence in the opinions of the several experts, which my readers will find in the following pages, will after all be of some benefit, as it will lead to independent investigation. Those pages dealing with manurial treatment of diseases and of phylloxera will also be found interesting. I have, since I finished my pamphlet, received further information, which I have added in the form of three appendices; also, twelve blocks for plates, which show clearly the effect of full or partial manuring, kindly sent to me by the German Kali Works and the Thomas Phosphate Union.

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One Morgen	-	-	-	Somewhat more than $\frac{1}{2}$ acre or $\frac{1}{4}$ hectare.
One Hectare-	-	-	-	About $2\frac{1}{2}$ acres.
One Litre	-	-	-	$1\frac{1}{4}$ pint, or 0·88 quart.
One Hectolitre	-	-	-	22 gallons.
One Kilogram	-	-	-	2·085 lbs. ; 135 kil. = $\frac{1}{4}$ lb.

THE FUTURE OF OUR WINE INDUSTRY.



WHILE all admit the special adaptability of the soil and climate of South Australia to vinegrowing, and it is gratifying to notice that our export of wines did lately increase year by year, while it is probable that the actual quantity exported is considerably in excess of the figures given by the Customs Department, it seems also as if our wine industry, as was prophesied by myself and many other old vinegrowers, had again received a check similar to the one about 1865. At the former time there was no market, either abroad or in the colony, for the quantity of immature and frequently badly-made wine by inexperienced hands. Now, after the forced increase in the acreage of newly-planted vineyards, there is a difficulty to find a paying market, except for the very best varieties of grapes, or for the young must. The reason for this is the want of cellarage and capital to purchase large quantities with a view of keeping the wine some years, and blending it to a uniform type, which can be supplied year after year. Of course a few of our vignerons do this to a limited extent, and have been able to supply 50,000 or 100,000 gallons of a fairly uniform type to customers abroad; but for all that it is quite true what Mr. G. Sutherland says in his book, "The South Australian Company":—"It is a great pity that more of our own people in South Australia don't have their capital free for putting into things that will benefit the producer. At the very time when outside capital was urgently needed for the building of cellarage, or for setting free local capital to go towards the same object, it suddenly became the adopted national policy to discourage the flow of investment from England." And while vignerons in a better season than the last may say to the owner of a winery "For goodness sake take my crop of grapes!" the reply too often has been, "I cannot store another gallon!" In fact it is the same state of things here, and also in Victoria and New South Wales, as is mentioned by Signor Cerletti in his "Descriptive Account of the Wine Industry of Italy" of Sardinia in 1887:—"Large establishments for preparing wines for exportation do not exist, and, the trade in them being without organisation, the wines are depreciated by the abundance of the surplus, although they possess qualities which, if proper organisation existed, would claim for them a splendid future and large sale. If the must from the small vignerons were at once bought, the great variations in the flavor could be prevented. Now wines sell lower than their good qualities merit, at from 9 to 18 lires per hectolitre (22 gallons), while on the contrary special wines command from 80 to 100, and even 150 lires per hectolitre." It is a national calamity if many more of our young vineyards are uprooted. This was the case about 1865, and the same course has

been lately followed by not a few of the smaller proprietors of vineyards. The Government and the Parliament have, a few years ago, encouraged the planting of these vineyards. The natural consequence is now that the cellarage must be found. I have supported, and have nothing to say against the London Depot; but it is, and was, of as great importance to provide cellarage in South Australia, and the same in the other colonies, as to hire it on the docks of London. Our Depot, under the care of Mr. Young, has, and is still, opening up markets for our matured wines, by actually claiming the support of 500 new wholesale buyers, and of Messrs Spiers & Pond; but unless the State here, and also in the other colonies, assists to keep up a supply of these, our inability to meet the demand which is likely to be made for them will make the efforts of Mr. Young, and of others for the other colonies, useless. Once disappointed in obtaining again what a purchaser was induced to try, he will turn to other brands, and perhaps never change again. Our output of these matured wines of uniform type must steadily increase, and not remain even stationary for a few years. It is no small praise from a firm like P. B. Burgoyne & Co when they say "The Australian wine industry is no weakling that requires special nursing, it needs no molly-coddling, or leading strings. There is a force behind it which is fast raising it to the level of the foremost wine countries of the world;" but at another time he "regrets ever and ever again that he is unable to get as much of the necessary standard excellence as he would take and could easily sell." And what shall we say if now already Mr Young advises, "that at times during the year nearly every mark, except recent arrivals, has been sold out, and for a while we had to hold over orders for particular wines." Such a firm as Blandy Brothers & Co. point out the paramount importance of sending over wines that are fully matured, not green. Mr. Bagenal also, of Pownalls & Co., says that slightly sweet wines forwarded will develop lactic acid, and when put on the market will be a disgrace to Australia. Mr. Young has been actually obliged to sell by auction such green, or unsuitable wines. Although sold at very low prices, they are sure not to improve the sale of our better wines; they were sold as "Australian wine" after all. We all recollect what a bad name "Colonial wine" had in former years, and how difficult it was afterwards to overcome the prejudice here when later on good wines were produced.

South Australia has not too many products upon which our province can rely that we can afford to neglect the most promising—the wine industry. If private enterprise, repeatedly applied to, is either unable or unwilling to establish *large* cellars under able manipulators, the State should guarantee for some years a low rate of interest to any Company, or else erect cellars, and let them at a low rental to any firm or company bound to purchase large quantities of the young wine. This gives a chance of realising soon after a vintage at a paying rate, and by blending the Company may send matured and uniform wines to England. It will not interfere with our winegrowers, who have already a connection for their wines in England or elsewhere. They can only gain by it if Australian wine is widely known, and distributed as a reliable, pure, and wholesome beverage. And even these vigneron, in all parts of Australia, who have made a name for their wines, have fairly large areas under vines, and purchase as many grapes as their cellarage and capital allow, may derive a direct benefit from such establishments, to which they may sell such of their young wines which may not be suitable for the particular wine they can always sell, and of which they make hardly sufficient of the same type.

GENERAL REMARKS.

I prefaced the foregoing as most necessary for the class of winegrowers who must have an immediate sale for their grapes or their young wine, they being unable to keep it for years, and are not sufficiently conversant with its manufacture to produce even then a good wine; but I dedicate the following pages to all winegrowers of Australia.

So far as I am aware the average number of gallons pressed from our better wine grapes is much below what is calculated upon in fair seasons in most other countries with a similar climate that produce medium wines. Many of our wines may be taken to be superior to the bulk of similar classes produced in Europe; but, after all, we cannot yet boast of equalling the very finest wines. Many vigneron, who have not planted their vineyards on the richest flats, are afraid of injuring the flavor of their wine if they try to increase their crops of grapes by manure, either animal or mineral, although they are well aware that they might grow on the same area a great many more grapes at a comparatively small increase in the cost by manuring it. But Professor Perkins, of Roseworthy College, says in his paper on "Manuring of Vines," read on the 24th of March before the South Australian vigneron, "I suspect that the quality of wines is to a greater extent dependent on local climate and the physical condition of the soil than on the relative richness in nitrogen, phosphoric acid, and potassium oxide. We claim little quality and moderate prices for our wines, and in which the relative fertility of the soil, natural or artificial, can have but moderate influence. The advisability of adopting the practice of manuring will be solely dependent on the likelihood of its ensuring increased yields at low rates of expenditure." The old dogma, taken for granted, that manures would give to the wine objectionable qualities of taste and aroma, is not now persisted in elsewhere so long as the farmyard dung is applied as a compost, except by M. Thézard, and although in Australia but few experiments have been made, and perhaps not enough to disprove it, those made in France and elsewhere, recorded in these pages, will doubtless induce many to go in for manuring. And if they still hold to the opinion that stable dung is not advisable to use, what possible objection can they have to the mineral fertilisers? If they use them, they will soon observe in ordinary seasons a marked improvement in the growth of the canes, and the size of the berries; of course all the more so where the vineyards are not planted on the richest soil, and have borne already many crops. Our periodical droughts force us to try to obtain most vigorous growth, not merely to prevent our vines from dying from exhaustion. Professor Perkins says in his report of 1897-8, to the Hon. the Minister of Agriculture, that "If we deduct the comparatively large sum of £10 per acre for cultivation, manures, cost of manufacture, interest on land, and buildings, &c., grape-growing leaves yet a net profit varying from £9 to £15 per acre with a yield of 2 tons of grapes per acre, or about 250 gallons sold at the cellars at from 1s. 6d. to 2s. per gallon." But I am not satisfied with 250 gallons, and personally obtained before 1864 at the rate of 400 gallons per acre in the Bugle Ranges, while my father-in-law, Mr. L. Fischer, produced still more for many years. The vines were planted in by no means strong or rich soil; for many it was not trenched. Where trenched, straw was spread at the bottom of the trenches, and the only manure used at the time was the husks and lees. Most of the red wine was made from Mataro, Carignan and Shiraz mixed, which made a palatable wine, and sold well. It was

virgin soil, however, and tenants found afterwards that they could not make the vineyard pay, through want of attention, ignorance of manufacture, and probably exhaustion of the soil. M. Thézard speaks actually of 150 hectolitres (22 gallons each) and more per hectare ($2\frac{1}{2}$ acres), but 9 hogsheads, or about 600 gallons, is by no means an unusual yield per acre in France, and in the southern departments the average according to Muntz, seems to be 1,021 gallons per acre. F. T. Bioletti, B.S., says of the San Joaquin Valley, California, that the vines at the Experimental Station have probably never really overborne, though some varieties have yielded as high as at the rate of 14 tons per acre; but the soil is very rich, and contains a large amount of saltpetre.

Before entering now upon my task to marshal numerous reports from Europe before you, where manures have led to extraordinary fruitfulness, and no apparent deterioration in the wine, I will refer first to general remarks made by experts. Professor Perkins, in his report on manuring, speaks of the absolute necessity to select a fertile soil, even a heavy soil, in South Australia, compared with the poorer hill slopes, upon which the finest wines are often grown in wet countries. It is the stronger plant that bears the better fruit, although the relatively weaker plant proves in a good soil and a favorable season the most profitable. Luxuriant growth and poverty of soil are incompatible. A rich, loose, sandy soil, sited on a good bottom, will give here the best results; poor limestone rubble of mallee country is absolutely useless for wine-making purposes." Signor Cerletti also says of some parts of Italy, where droughts are not unusual:—"Although not so fine, the wines obtained from the rich soil of the valleys of Liguria are good. In Puglia, an extensive, fertile plain, only a few metres above the Adriatic, and one of the driest districts in Italy, vines have more recently been planted, and have given ever since abundant crops of grapes without the aid of manure of any kind; but, on the other hand, the extensive culture of the vine in the Abruzzi Mountains, with a less fertile, shallower soil, manuring with green crops is general. Where manures are given in Sicily the production increases, but the greater portion, planted in the plains, never received manure since very remote times, and still produce good crops." We must assume that these plains contain unusual quantities of potash in a volcanic soil, or that the soil has a granite origin, which renders it capable of yielding for so many years good crops; for it is a well-known fact that potash, which is present in comparatively large quantities in granite rocks, is the most important fertilising element for the vine, especially in relation to the production of fruit. Signor Corletti seems also to favor the planting of vines in sandy soil, as along the coast of the province of Rom, which gives the further advantage of making it impossible for the phylloxera to do any damage.

In a lecture by Mr. J. J. Willis before the Royal Horticultural Society of London in April, 1898, I find that "one ton of grapes of 2,240 lbs. contains 363 lbs. of dry substance, 20 lbs. of mineral matter, $3\frac{1}{2}$ lbs. of nitrogen, 10 lbs. of potash, 3 lbs. of phosphoric acid, and 205 lbs. of sugar, while a ton of vine leaves had 829 lbs. of dry substance, 93 lbs. of ash, 11 lbs. of nitrogen, 6 lbs. of potash, 1 lb. of phosphoric acid, and 40 lbs. of sugar. In the stem was found 981 lbs. of dry substance, 40 lbs. of ash, $4\frac{1}{2}$ lbs. of nitrogen, 4 lbs. of potash, $1\frac{1}{2}$ lbs. of phosphoric acid, and 9 lbs. of sugar. The fruit is, therefore, essentially a sugar producer, and it, as well as the sugar in them, is greatly increased by the amount of nitrogen available. Sulphate of ammonia proved very beneficial both for the color of the skin and the sweetness of the grapes, but in any case there must not

be a lack of potash and phosphoric acid in the soil." And to return to the soil an equivalent for what has been withdrawn from it by successive crops of grapes is all the more required where—a course that has been extensively followed—fields have been planted here with vines without previous manuring and that proved themselves already to be more or less exhausted by constant cropping with cereals, especially wheat. It must be admitted that there is still in most cases a large amount of fertility even in such wheat-sick soils; but it is a slow process by which fresh plant-food is formed, and such a change—not to say rotation—as a permanent crop like vines, can only succeed for a very short time, if at all, without a supply of at once available plant-food being added by man. And vines require more than most other plants a large surplus of plant-food. It is fully understood by all vigneronns that, although the main-roots of vines penetrate the soil to a considerable depth, they have comparatively few branch-roots, which however may spread laterally up to 12, and in some soils to 21 feet in depth—but these come after all only with a small portion of the soil into contact, so that they cannot fully utilise the plant-food, which may be distributed in it. Unless you manure therefore—as you may think in excess of requirements—it may, and probably will occur—that according to Baron von Liebig's law of the minimum, notwithstanding a large dose of say 200 cwt per acre of stable manure had been given, your vineyard may hunger after phosphoric acid and potash, and the quality of the grapes will be poor. A medium crop absorbs at least 32 lbs. and a full crop 40 lbs. of phosphoric acid. Professor Wagner (see Appendix) states that 100 litres (1 litre somewhat more than $1\frac{3}{4}$ pints), or 22 gallons, require $\frac{1}{2}$ lb. of phosphoric acid, and Professor Lowrie says that one ton of stable dung contains only from 4 to 9 lbs. of phosphoric acid or about half as much as nitrogen and potash. Supposing, then, according to this calculation that ten tons of stable dung did contain 60 lbs. of phosphoric acid, this would amount to not quite one-third of the amount, which we are told is given per hectare in the Champagne—which is certainly a limestone country demanding much—and, if the dung should contain 90 lbs. of phosphoric acid in the 10 tons, it would be only one-half. The rest must therefore be given by other phosphatic fertilisers. (See later on and the Appendix I)

Science has only of late years come to the assistance of the vinegrower even on the Continent of Europe. Those practical vigneronns, who years ago came from there to Australia, had probably used distinct methods, suitable for the locality from where they emigrated. They simply followed those adopted by their forefathers, which they now transferred to Australia. Here we have a totally different climate, and grow probably to them altogether unknown varieties. The situations, aspects, and the soils are not the same wherein vines will thrive here, and produce a generous, and under fair treatment, and acting under more modern and scientific knowledge, a very good wine, or raisins and currants. These wide discrepancies of practice were years ago a great disadvantage for all intending viticulturists, who had no previous knowledge of the growing of vines and wine-making. The great advantages we had otherwise has allowed us to overcome the above difficulties. To be quite successful requires, however, some discrimination, and more than ordinary intelligence even now. We can just as little adopt a standard system for all parts of Australia, as such can be done elsewhere; but here, as there, it is of the greatest importance to follow in the wake of scientific research, if we hope to be on a level with the most intelligent vigneronns of other countries, and to find a market for our produce.

Every kind of soil requires different manuring, and yet, if we are to notably increase the average yield of vines, we must restore at least what plant-food we withdraw. The average of the figures given by Muntz are 55 lbs. of nitrogen, 15 lbs. of phosphoric acid, and 50 lbs. of potassium oxide per acre, but in what manner to apply this, is not so simple. You should not use kainit and nitrate of soda on heavy clayey soils, as they make the soil hard and impermeable even with the application of lime. It is better to use other potash manures and sulphate of ammonia, together with stable dung, chiefly for the purpose of forming humus. Sulphate of ammonia, although of slower action, is best for limy soils, but it is useless for a topdressing. For this purpose you must use nitrate of soda. The climate of those parts of Australia, where winegrowing for winemaking has been tried and found to be suitable, has two factors of very great importance—viz., sufficient heat and light; and South Australia in particular can claim during the grape harvest, almost without exception, dry air and absence of rain or heavy dews. Previous to the grape harvest dews are, however, important for thinning the skins and increasing the sap. The heat is on some few days of the year excessive, so as to roast some of the bunches not well protected by leaves. Frosts in spring are not frequent, nor general, except in low situations, which should not be planted. The rainfall is also in most years quite sufficient, and needs only to be supplemented in such localities as at the River Settlements. Irrigation elsewhere may increase the size of the bunches and berries, and be thus of advantage to table grapes; but for wine grapes it should only be resorted to, if the vines show the absolute want of moisture, or in calcareous or limestone soils, where without it a further excess of alcohol in the wine might be the result. The strength of the wine grown here on such soils is already very considerable, and greater than desirable. A little limestone or ironstone rubble in the soil may here also produce a wine of excellent quality. In Europe they obtain from such soils perhaps without exception the finest and best liked wines. They retain the heat there, which is a matter of consequence, but not required here. On the whole, however, I can but agree with Professor Perkins that I prefer a sandy, or sandy-loamy, or schistose soil as likely to produce here with manure quite abundant enough, and yet a lighter, delicate wine. Our hills up to 1,200 feet, also near Clare and many similar localities in Victoria and at Albury, can produce them.

But vines do not require so much plant-food for the formation of grapes as for the wood and leaves. On an average you may remove in pruning, after the canes are dry, from 2,400 to 3,200 lbs. per acre. Leaves, which also exhaust the soil, in their green state may weigh up to 16,000 lbs., the roots about as much as the canes, and the trunk from 16,000 to 24,000 lbs. per acre. While a hectare ($2\frac{1}{2}$ acres) of vines gave in 1892 only 143 gallons of wine, and took from the soil 74 lbs. of nitrogen, 22 lbs. of phosphoric acid, and 82 lbs. of potash; the crop of 1893, consisting of 1,224 gallons, required 82 lbs. of nitrogen, 23 lbs. of phosphoric acid, and 102 lbs. of potash. A crop, which thus was nearly ten times as large, consumed little more, except as regards potash. Therefore, the importance of feeding at once the rooted vines you plant is now generally accepted as necessary. At the Experimental Station at Southern Pines, in North Carolina, U.S., the quantities of fertilisers thus given are mentioned. During the first year each plant received on an average 146 g. of kainit, 35 g. of muriate of potash, 36 g. of sulphate of potash, 125 g. of a phosphatic manure, and 43 g. of nitrate of soda. This was spread around them so far as the roots were likely to extend the first year. In the Champagne, also, vines receive a very large quantity of manure at

the planting, and afterwards every year 250 lbs. of nitrogen, 242 lbs. of phosphoric acid, and 250 lbs. of potash per hectare, although the vigneron there calculate that on an average the crop requires only 84 lbs. of nitrogen, 48 lbs. of phosphoric acid, and 94 lbs. of potash. Nearly the same is done in Medoc, and exactly the finest wines grow on land that receive the largest quantity of fertilisers. Before planting the subsoil is in many places heavily manured, as stated elsewhere.

In "*La Fumure de la Vigne*" (the manuring of vineyards) Mons. Arthur Thézard says that he (being an agricultural chemist) found on an average in 1,000 parts of dry matter of the vine—phosphoric acid 5.00, potash 12.50, lime 19.00, magnesium 5.00, and nitrogen 18.00. Other French and American analysts found pretty nearly the same proportions, and he thinks, that if vines received in the proportion of 1 unit of phosphoric acid to 2.50 of potash, 3.80 of lime, 1 of magnesium, and 3.60 of nitrogen, we may expect to obtain the greatest yield from them. (See Professor Wagner's later experiments in Appendix I.) Mons. M. H. Joulie, an eminent analyst, says in referring to the same matter that to perfectly develop your vineyard—irrespective of nitrogen—you should in round numbers give for one per cent. of phosphoric acid three per cent. of potash (after Wagner 4 per cent.), four per cent. of lime, and one per cent. of magnesium, the same as you would use for a crop of lucerne. If a vineyard produces little fruit, but sufficient wood and leaves, it is an indication that nitrogen, lime, and magnesium are present in sufficient quantity, while more phosphoric acid and potash is required. On the other hand, if the reverse is the case and potash is abundant, the berries are numerous and well developed. Phosphoric acid being deficient, the berries are rare, small, and contain many seeds. If too much lime is present, as may be in a limestone country, heavy rains may amass it to such an extent as to become a layer impenetrable to water and air, and the vine is suffocated. The leaves get yellow, the canes poor, and the yield diminishes more and more. Magnesian limestone (dolomite) furnishes generally not a vigorous growth, but gives to white wines a great delicacy.

THE USE OF NITROGEN.

Nitrogen plays an important part, in most cases it is useful, in fact absolutely necessary, but sometimes disastrous. If in too great a proportion in the soil, the vines make too much wood and leaves, and produce a great quantity of small berries, which may not ripen. The black soils of Russia produce little, and the vines planted in Tonkin produce not a single bunch, although the wood and leaves would cover a regiment. To correct the effects of too much nitrogen there are several methods mentioned. You could trench and mix the inferior subsoil with the surface soil, or you may grow oats, which requires much nitrogen, or counter-balance the excess by adding fertilisers that are not nitrogenous. It is, however, much more likely that you may think of having given your vines quite enough of nitrogen in stable dung, and yet you are far of the mark. In Europe also, until a few years ago, it was expected that, irrespective of the admitted physical improvement of the soil, the farmyard dung used contained even more than sufficient nitrogen. But exact experiments have shown that such is not the case when manuring every third or fourth year with 450 or 500 cwt. per acre. Provided it is a really good stable dung, which in Australia is perhaps an exception, it may appear in the first year almost as if you had given an excessive quantity of nitrogen; but in the later years it is the reverse. In horse dung, more especially

if dry-rotted and fire-fangled in heaps, and through bacilli that interfere with nitrification, you may lose nitrogen to the extent of from 25 to 60 per cent., and the little there may be of active nitrogen is not at once available. Where the food of the animals was poor, or the dung badly conserved, horse dung gives to the soil little else but humus for the expense and labor. This does not apply to good farmyard dung, which many say is the foundation for manuring vineyards. Professor Barth, of the Experimental Station of Alsace-Lorraine, has come to the conclusion that at least one-third of a yearly manuring should be stable dung for the physical improvement of the soil; the rest, however, other fertilisers. Mährlen also, of Bacharach, a teacher of the cultivation of the vine, says—"The whole secret of a rational nourishment of the vine lies only in the intelligent and judicious application of commercial fertilisers with the usual farmyard manure." M. Joulie states that we should find in a well conditioned soil to a depth of eight inches 3,200 lbs. of nitrogen, the same of phosphoric acid, three times that quantity of magnesium, 8,000 lbs. of potash, 160,000 lbs. of lime, and 120,000 lbs. of oxide of iron. But a well balanced soil should also contain about 2 per cent. of organic matter, humus being the larger portion of it, and if the weight of the arable portion of an acre is about 1,600 tons, 2 per cent. of it represents 64,000 lbs. of dry organic matter. The dung in moist Europe contains on the average 80 per cent of water and 7 per cent of mineral matter. There remains in such a case 13 per cent. of organic matter. If the soil, therefore, received no other means to enrich itself than 40,000 lbs. of dung every five years, and thus obtained 1,040 lbs. of organic matter, it would take sixty years to renew the quantity of humus, which a fertile soil should possess. Besides, the organic matter is constantly destroyed in cultivated land by furnishing carbonic acid for the dissolution of mineral plant-food. But by experiments made at the school for vignerons at Waedensweil in Switzerland it was clearly shown that farmyard dung alone cannot sufficiently supply even the required nitrogen, much less the required phosphoric acid and potash. Where these latter were supplied with nitrate of soda or another nitrogenous manure the crop of grapes was far superior than on the plots that received phosphoric acid and potash with stable dung. Even with liquid manure there was a difference of 532 lbs. to 450 lbs. in favor of liquid manure. M. A. Thézard states also in his treatise positively that *fresh* dung gives an insupportable taste to wine, which is not the case with chemical manures of mineral origin.

In the wet summer and autumn of 1896 cryptogamic diseases and rotten berries were far more plentiful where farmyard dung had been used than elsewhere, where mineral manures were applied. Farmyard dung should not be used where you trench for planting new vineyards. Where it is not obtainable or where climatic conditions make their application more desirable, it may be necessary to use mineral manures both before and after the planting of a vineyard, and specially, when the soil is sand and rather devoid of organic matter. In such a case a green crop, ploughed in with a little gypsum, to saturate the acidity of the green matter, may be advisable. Commercial fertilisers have of late years only found more general favor; but winegrowers as well as farmers are frequently embarrassed on the subject of the quantities to be applied to their crops, the time for application, and the nature of the soils for which they are suitable. The analyst teaches this only in an imperfect manner, so that they have to depend alone on well conducted experiments, which embrace a period of years, and are then only useful for certain soils. They may thus exactly appreci-

ate the value and the mode of employing these fertilisers and formulate for themselves comparative conclusions. Personally I am not afraid that too much of any manure is likely to be applied in Australia, judging from the rather niggardly way in which the farmers have in general applied manures, in the vain hope of getting *full crops* from perhaps 40 to 80 lbs of a fertiliser, which may contain from 15 to 16 per cent. of phosphoric acid. But the advice given by our best known agricultural scientists is, for all that, oftentimes a puzzle. Instead of horse dung—so large a proportion of our farmyard dung—being specially subject to the destruction of a large portion of its nitrogen, up to 25 per cent. and more, through bacteria, which live upon the saltpetre, we are told by Professor Wagner to rather use 2 cwt. of nitrate of soda per acre; but Dr. Barth goes as far as 6 cwt. of nitrate of soda or 5 cwt. of sulphate of ammonia per acre for the vineyards of Alsace, while Dr. Nessler wants 3 cwt. of nitrate of soda or about the same of sulphate of ammonia. One cwt. of these to the acre will give 11 ounces to the perch. These large differences as to the quantities of nitrogen required are of course a consequence of the various soils, which these learned gentlemen had examined, the vigor of the canes and the leaves, and the greater or smaller crops removed. High and dry situations require also stronger manuring than valleys, or moist situations, especially as regards nitrogen.

According to the "Revue Agronomique" of the 16th April, 1899, a great number of methodical experiments have been made by the Departmental Professors in different parts of France, and these have confirmed the great value of nitrate of soda for vines. Professor Grandeau selects the experiments, made by M. Vassiliere last year in 25 vineyards of the Bordelais covering a total of about $9\frac{1}{2}$ hectares, to report upon. The plots were situated in the most diverse parts of the Gironde, from the sands of the Landes to the argillaceous, limestony or siliceous soils of Blayais and Berrunde. One strip in each case received no dung, another at the rate of 1,200 lbs. of a phosphatic manure and 400 lbs. of sulphate of potassium. Six other strips received the same quantities of phosphoric acid and potash, and also nitrate of soda, varying at the rate of from 400 to 1,600 lbs per hectare. The application of the nitrate of soda was made in March (August here) in a circumference of one foot around the stems, and in each case did the crop increase. The land without dung produced at the rate of 4,152 lbs. of grapes per hectare, that which received only nitrate of soda without phosphoric acid and potash produced with (at the rate of) 400 lbs. per hectare, 4,768 lbs. of grapes; with 600 lbs. 4,992 lbs.; with 800 lbs. 5,166 lbs.; with 1,000 lbs. 5,412 lbs.; and with 1,600 lbs. 5,482 lbs. Compared with the subsequently mentioned plots the foregoing showed that the soil had not sufficient phosphoric acid and potash for the larger doses of nitrogen. Land that received not only nitrate of soda but also the two other manures produced on the plots manured with at the rate of 400 lbs. of nitrate of soda per hectare, 5,930 lbs. of grapes; with 600 lbs. 7,672 lbs.; with 800 lbs. 12,576 lbs.; with 1,000 lbs. 15,376 lbs.; with 1,600 lbs. 15,662 lbs. of grapes. These experiments showed clearly that more than 1,000 lbs. of nitrate of soda per hectare was excessive in proportion to the abovementioned phosphoric acid and potash manures, and it could not increase the crop sufficiently to make it payable.

Of oilcake, bloodmanure, and other nitrogenous manures not much use is made in Australia. 150 lbs. of bloodmanure are equal to 100 lbs. of nitrate of soda or 80 lbs. of sulphate of ammonia, which latter should contain 448 lbs. of nitrogen per ton, while nitrate of soda varies between 291 and 336 lbs. of it per

ton. The contents of guano, even from Peru, are so various as to nitrogen, phosphoric acid, and potash, that nobody should purchase it without a guaranteed analysis.

THE USE OF PHOSPHORIC ACID.

So far as present observations go we are told that phosphoric acid gives to the wine the fine fragrance, the bouquet, which may require years to be fully produced, and that the want of it makes the wine only durable for very few years. The mineral acidity prevents decomposition. This is apparent, if you learn, that the common light Rhenish wines, which do not keep long, contain only up to 25 grammes of phosphoric acid in 220 gallons, while the fine Riesling wines of fully ripe grapes, the "Auslese," of the Rhenish provinces, contain frequently more than 450g of phosphoric acid in 220 gallons, which gives them their bouquet and keeping quality for more than 100 years. If we hope, therefore, to make really fine wines, it is necessary to give our vineyards an abundant supply of phosphoric acid, although too much may ripen the berries too early. Continental results point to Thomas phosphate as preferable to other phosphatic fertilisers. Messieurs Viala and Rivaz give this as their opinion in the *Revue de Viticulture* of March 1897, for the following reasons, viz.:—"It does not only give to the vines phosphoric acid, but also magnesium, lime, iron, &c., which are very useful; it is at once soluble, and gives good results as regards the yield, and the ripening in good time." The extraordinary good results which had been obtained in limeless, in peaty, and in argillaceous soils, led to the belief that Thomas phosphate was only suitable for these soils, but experiments made in limestone country surpassed all hopes. Thomas phosphate does not, contrary to all expectations, undergo any transformation in the soil except that the lime which it contains is carbonised. The phosphate of lime is at once available for the plants; besides its phosphoric acid not being soluble in water, will not be lost into such depths which cannot be reached by the roots of the vines. M. Thézard mentions also what can be hardly true—that, probably on account of the keeping quality, &c., before mentioned, the use of this manure gives to an hectolitre of wine a 50 to 60 per cent. better price in the market. In Europe you may spread Thomas phosphate before, or at the time of budding, as may suit the convenience of the vigneron. M. Thézard recommends what seems excessive for a vineyard that is not vigorous, makes short canes, and shows yellow leaves—the first year from a ton to 23 cwt. of Thomas phosphate per acre, 160 to 320 lbs. of kainit, from 120 to 200 lbs. of nitrate of soda, and in limestone country 320 lbs. of sulphate of iron. In the following years 320 to 400 lbs. of Thomas phosphate, 160 to 180 lbs. of kainit, and 120 lbs. of nitrate of soda would be sufficient per acre. Of the last-mentioned you may apply too much, and in that case the vine may become unproductive. If the other quantities seem too large compared with the crop, it should be considered that more must be at first given on account of the long time before these substances come into contact with the mass of the roots. Although M. Thézard admits the great usefulness of mineral and bone super-phosphates, he seems generally to prefer Thomas phosphate for a light, dry, gritty, or gravelly, limestony, or volcanic soil, such as is suitable for vines in France. And he is in that respect at one with the great majority of vignerons. Up to a few years ago super-phosphates were generally used; now Thomas phosphate is preferred on account of its

lasting and always even action, which is of great importance for a perennial plant like the vine, and further as containing much lime and magnesium, both of which are valuable for vineyards, if you consider, that no less than 50 to 70 lb. of lime, and 8 to 10 lbs. of magnesium are annually withdrawn per acre. Professor Grandeau, one of the greatest authorities on viticulture in France, publishes in the *Revue Agronomique* of the 16th of April, 1899, new researches, which have shown that mineral manures, and especially phosphoric acid, exert on the quality of wines a clear and the most favorable influence. He then compares the crops of grapes cut in the years 1891 to 1894 from an hectare at Avenay, manured with 30,000 lbs. of farmyard dung mixed with the mud from ditches, with those obtained when manured with 1,000 lbs. of Thomas phosphate, 400 lbs. of chloride of potassium, and 600 lbs. of sulphate of iron. The soil seemed sufficiently supplied with nitrogen, contained 20 per cent. of carbonate of lime, and could only be worked to a depth of ten inches to a foot. The former hectare gave on an average in three years 6,680 lbs. of good grapes after rejecting those that were unripe or rotten; and the latter gave in 1895 and 1896 an average of 7,898 lbs. In 1897 manuring with compost was altogether abandoned, and the vineyard received per hectare the abovementioned 2,000 lbs. of mineral manures. Thereupon the average crop increased in 1897 and 1898 to 7,990 lbs. The cost of the 30,000 lbs. of dung was at 15 francs per ton (225 francs); the working of it, transport, and spreading, 200 francs; while the mineral manures cost 105 francs (£5) per hectare; and a few francs for the spreading. Next year some nitrate of soda is to be applied to supplement the nitrogen, and a still better crop is expected. As regards Thomas phosphate, he says that he now applies certain rules on about 750 acres of his properties in Lorraine, in concert with M. Thiry, at the Agricultural School of Tomblaine; also, on nearly all the land of the School of Matthisieu, at Dombasle. He uses quantities of 1,000 to 2,000 lbs. per hectare, together with nitrate of soda, and the results of ten years' trials have been a large increase of his crops. His land, and that at Tomblaine, is siliceous and poor in lime, and the use of Thomas phosphate is an economic way of obtaining better crops, its action on vegetation being immediate. The vigneron in Bourgogne and Champagne being by him advised to enrich their vineyards with phosphoric acid, and lately, through using Thomas phosphate, must be well satisfied, his expectations having been justified, as shown by reports in the *Revue Agronomique*. He had used in a vineyard containing 18,000 vines, from 25 to 35 years old, in Avenay, in the Champagne, planted on a thin, clayey, limy soil, which contained 20 per cent. of carbonate of lime, in the years 1891 to 1894, 10 in. to 1 ft. deep, 12,000 lbs. of farmyard dung and mud from ditches per acre. In the following year the vineyard was divided into two equal parts of $1\frac{1}{4}$ acre each. One half received farmyard dung again, the other 400 lbs. of Thomas phosphate, 160 lbs. of muriate of potash, and 240 lbs. of sulphate of iron—this latter being considered necessary in France for the formation of chlorophyll, and to counteract the chlorosis (paleness and yellowness of the leaves) so frequent in soils rich in lime. As Thomas phosphate contains also some iron in a soluble form, it may, in most instances, supply here sufficient iron. The manures were broadcasted in autumn, and worked in. The result was 30 per cent. more grapes on the land manured with the fertilisers, and the net gain was actually 50 per cent. on account of the saving of labor. In Burgundy no sulphate of iron was used, although the soil contained there even more lime, up to 20 per cent. and 42 per cent., and yet the results were quite as favorable:

These experiments were made in six vineyards, of which some contained very old vines, some only four years old, and all showed the superiority of Thomas phosphate over super-phosphate. The vineyards were equally divided, and in the month of April part A received 400 lbs. of Thomas phosphate. The other, B, received 240 lbs. of super-phosphate, and at the same time both received equal quantities of 320 lbs. of kainit, and 160 lb. of nitrate of soda per acre. Results were very good; but the vines in part A showed more vigor, broader, and dark greener leaves, and had with one word the advantage over those in part B. The owners of these vineyards found the advantages of Thomas phosphate so superior that they decided, although the results with less super-phosphate had been good, to manure in future only, as they had done in part A. P. Grandeau ascribes the greater success with Thomas phosphate in part to the gradually settling down of the fine, but heavy meal to the deeper roots of the vines without the danger, however, from being leached out of the soil. Similar results are reported from other parts of France and other countries, and it is now an established fact, that you can spread Thomas phosphate before vegetation commences, up to the moment when it stops. Mr. Bettinger, of Temmels, on the Moselle, planted in 1892 a vineyard on calcareous soil. Before planting he brought Thomas phosphate and potash salts into the subsoil. The vines made strong canes, and in the second year he gave a top-dressing of nitrate of soda. The vines grew so well, that in four years he had a crop of grapes, while on an adjoining vineyard, planted at the same time without fertilisers, you could find only here and there a bunch of grapes. Mr. B. had spent £3 8s. for the fertilisers and their spreading, and he realised a net profit of £21 12s. Mr. Scheffgen, of Nittel, on the Moselle, manured in spring, 1893, a quarter of an acre of his vineyard with $1\frac{1}{2}$ cwt. of Thomas phosphate by digging it deep round the vines. He had 20 gallons more wine from it than from a like piece immediately adjoining, but unmanured; this being a net gain of £2 3s. 6d. against a cost of 4s. 6d. In the Moselle it is now the rule to add 1 lb. of Thomas phosphate to every newly-planted vine.

THE USE OF POTASH SALTS.

Both nitrogen and phosphoric acid can only in conjunction with potash salts ensure success. As Mr. W. F. Snow remarked at the Congress of the Agricultural Bureau in October, 1897—"Although vines are consuming a great deal of nitrogen and phosphoric acid (of the latter in fact more than fruit trees generally), the great standby of the vine is potash. Judging by the experience of the most scientific vinegrowers in France, if more potassic manures were applied to the vine we should get much better results; but kainit I would not advise to use." The ash of the canes of the vine shows already how necessary potash is to the vine, for it contains 30 per cent. of potash, or more than double the percentage of most other plants, so that not unfrequently 140 lbs. per acre may be required. In analysing the seeds of grapes considerable quantities of phosphoric acid, lime, and nitrogen (see Appendix I) are found, and we must come to the conclusion that the potash co-operates chiefly in producing the flesh, or pulp, of the berries. According to Baron von Liebig, however, potash is instrumental in the distribution of carbo-hydrates throughout the plant, it being found in the buds, shoots, and also relatively largely in the seeds. But the chief use of potash salts is that they favor the decomposition of mineral

particles in the soil, and, in connection with phosphoric acid, they enable pea-flowering plants to draw upon the air for a stock of nitrogen, which, when ploughed in—as may be done for vines also—or in lesser degree by the root residue, supply in a very cheap way the most expensive nitrogenous plant-food.

For a long time our vigneronns seem to have been of opinion that to return the husks, and to bury them with the leaves and the ashes of the burnt canes, were sufficient to restore to the soil the plant-food removed by the crop. The bunches of grapes contain, however, in a fair crop, 20 lbs. of phosphoric acid, and 48 lbs. of potash, of which the wine retains at least 4 lbs. of phosphoric acid, and 12 lbs. of potash. The husks and stalks can, therefore, return only 16 lbs. of the former and 36 lbs. of the latter. It is also fully understood that any part of a potash manure that is not taken up the first year remains fit to be used for subsequent crops. The best kind of a potash fertiliser for vines is one that does not contain a considerable quantity of chlorine. In fact, I am surprised to find so much kainit used in France. The grapes of the better kinds contain a much larger quantity of potash, and the quality of the wine is thereby improved. It is at least probable that the grapes contain more sugar where the soil is rich in potash. Professor Wagner recommends 50 lbs. of muriate of potash to be applied yearly, with 100 tons of farmyard dung, and, of course, phosphoric acid. For all vineyards that are to be planted or replanted large quantities of both Thomas phosphate (1 ton to 1 ton 4 cwt.), and sulphate or muriate of potash (from 10 to 12 cwt. per hectare), are worked into the subsoil in Europe, at least 18 in. deep. In Australia, where trenching for a vineyard is now an exception, not as forty years ago, a rule, it will be difficult to persuade the owner to go even to the expense of trench-ploughing, and thus to supply the subsoil for the deeper roots with a store of phosphoric acid and potash. The absence of these in the subsoil may be the chief reason for the comparatively poor crops of grapes generally obtained in Australia. To remedy this at old vineyards, it may be of use to make holes between the vines and deposit into them (plant-salts) *naehrsalze*, of which Ohlendorf's of different compositions have been applied. My friend, Mr. Thomas Hardy, one of South Australia's successful pioneer vigneronns, informed us also in a letter written last year from Africa, that "Where they have there planted vines, two hundred years ago, in a rich alluvium, only 3 x 4 ft. apart, they fertilise them by opening out a hole for manure between every four vines. Various substances are used. Fertilising is also done by opening deep furrows with a plough and deepening them with a shovel, the idea being to bring the roots downwards." But this plan is likely to destroy more of the small roots near the surface than is desirable (see Seppelt's report).

A few examples of what phosphoric acid and potash salts, in connection with green manuring, or liquid manure, or the best of farmyard dung, can do, even in districts where it is already somewhat difficult to obtain good and well-ripened grapes, may here find a place. Mr. J. J. Hoffmann acquired at Liebfrauenthal, in Rhenish Hesse, poor, drift-sandy land, used only for sheep up to 1887. He has now made a vineyard of 85 acres, and, after applying first liquid manure and ploughing in a crop of green manure, he used mineral manures as mentioned at the bottom of the plates at the back of this pamphlet. The vines were Early Burgundy, some growing on poles, mostly on wires. Before using these latter fertilisers he obtained on an average 34 bunches from a vine of a weight of 810 gr.; but afterwards he cut as many as 83 bunches, weighing 4,780 gr.

I may remark here that vines may be manured *once* with kainit, but generally another potash manure should be used. Kainit contains, besides 25 parts of sulphate of potash, no less than 75 parts of other salts, mostly common salts. It also hardens the surface to a crust, and thus acts badly as regards the physical nature of argillaceous soil, while this may be actually useful if applied to a light soil. But that it is desirable to use mineral manures to a large extent is clear enough. If you have to cart and spread 100 cwt. of good farmyard dung to enrich your soil as much, as 2 cwt. of Thomas phosphate, 1 cwt. of sulphate of potash, or muriate of potash, and 2 cwt. of nitrate of soda would do. Mr. von Lassaulx, a vigneron on the most northerly limit for growing vines on the Ahr, found his vineyard soon become profitable after he had commenced to use 6 cwt. of Thomas phosphate and 6 cwt. of potash salts per acre, with dung. Mr. G. Froelich, of Bavaria, had twice as many grapes after using potash, phosphoric acid, and nitrogen, in form of fertilisers, compared with other parts of his vineyard. The quality of the wine was very good, as he realised at auction for this two-year-old wine £60 for 215 gallons. Mr. L. Isler, of the Palatinate, says that he can better regulate manuring with fertilisers. With very much farmyard dung he had frequently too much wood, and one of his vineyards, which did not receive any since 1883, but every year mineral fertilisers, is at least as fruitful as the adjoining, that received the farmyard dung. The grapes are finer, the must heavier, and the wood earlier ripe. Mr. Dühr, of Luxembourg, manured well with stable dung in 1889 and 1890, but not in 1892 and 1893. He then broadcasted in spring, 1894, 2 cwt. of Thomas phosphate on 1,000 square metres, and pressed from that piece 2,000 litres more wine than from other pieces of the same size, and otherwise equal. He had a net gain of £26 15s. from it. In autumn he used again 2 cwt. of Thomas phosphate, and as much of potash salts; also, in spring, 1895, after the buds were well forward, 1 cwt. of nitrate of soda, and had a net profit of £41 11s. Being compelled, in consequence of the vigor of the vines, to leave more wood, he pressed in 1896, after manuring as before, 6,000 litres, with a net profit of £65. And now the vignerons of the neighborhood, who at first ridiculed Mr. Dühr's experiments, try to emulate him. Professor Coloman, at Kerpely, director of the Agricultural College of Debreczin, in Hungary, reports on the sandy vineyard, planted with Italian Riesling, and, although manured with farmyard dung, were very poor in plant-food. The leaves were yellowish chequered, the berries in the bunches quite loose. In autumn, 1894, he used 280 lbs of Thomas phosphate and 280 lbs. of potash per acre, and on a few plots some nitrate of soda and sulphate of ammonia was given. The results of the vintage for 1895 were not striking, the fertilisers having been used in autumn, after the fruit-buds had been already formed. The leaves, however, were dark green, the bunches were close-berried, the wood much stronger, able to produce finer fruit-buds, and the manured plots gave 49 gallons more per acre than the unmanured. He applied now in autumn, 1895, 140 lbs. of kainit and the same of Thomas phosphate per acre, and had a surprising crop from the plots so manured, viz., 7,720 lbs. of grapes per acre against 5,040 lbs. from that not so manured, and the former gave 505 gallons per acre of 18.2 per cent. of sugar, the latter 341 gallons of 17 per cent. sugar.

NOURISHING SALTS (NAEHRGALZE).

In Germany so-called naehrsalze (nourishing salts) are frequently spread on heavy soils six weeks to two months before budding; in lighter soils somewhat later. But the time is not of great consequence. They consist of a mixture of the three plant-nourishing elements. Frequently, also, each young vine receives 25 gr. of such naehrsalze, or you open holes of 8 to 12 in. depth and length between two vines and put into such hole from 30 to 40 gr. Leave such holes open until a rain dissolves the salts. Young vines will make strong and many roots, and will gain a year or two, the bunches and berries will be superior, and the wine far finer.

If you wish to use Albert's concentrated horticultural manure, which contains the three principal elements in its brand A.G., it is advisable to use it in early spring, when the vines begin to show leaf-buds, by making some holes around the stems, and, after putting in each from 1 to 2 oz., fill them with water. You are thus carrying the manure to the deeper roots. A second application after the berries have just set should make your crop pretty certain. The objection to this is the almost impossibility of doing this in larger areas, and that you may supply one or more of the principal elements in this manure which your soil may not require, or not in the proportion. I can but recommend to experiment on plots with and without fertilisers, but I am against the use of any mixed manures, although some of these complete manures may have given satisfactory results, especially when planting a vineyard. Composed as these are of the three plant-foods, and perhaps some lime, you may be purchasing one or other of these, which your soil does not actually require. In America enormous sums are thus wasted. To obtain the largest net profit, you should by your experiments ascertain the effect of giving nitrogenous, potassic, or phosphatic manures together or separately and two and two together. Vignerons using complete manures forget what the soil itself contains, and thus pay for one or two ingredients which there may be no need to supply, and yet to provide a most profitable crop.

TREATMENT OF DISEASES AND OF PHYLLOXERA.

If you treat your vines well from the beginning you may safely calculate upon them remaining fruitful for sixty and more years, even in Germany. Their vigorous growths will prevent many diseases. It is worthy of record what Mr. F. H. Molesworth, F.C.S.I., said in the *Australian Vigneron*:—"While persons are fighting their foes above the ground with washes and emulsions, &c, let them feed the soil properly, and it will carry on the battle more powerfully than they can below the surface. Unless the vigneron keeps the soil sufficiently supplied with the three chief plant-foods to satisfy his plants' requirements, he will grow nothing, or at most unhealthy, weak plants, open to the successful attacks of every disease of the world. In Australia phosphatic manures are very necessary in most localities. They assist the production of the fruit more than leaf and stem." In Bulletin No. 76 of the Cornell Station, N.Y., it is, for instance, stated, that the shelling of grapes, which I presume means the dropping of the young berries (in French *coulure*) is prevented by the use of muriate of potash. There are actually instances given where 1 lb. of kainit, or of sylvinite, or of 1 to 1½ lbs. of muriate of potash, applied early in spring to each vine, stopped this trouble where it was formerly very serious. Where 200 lbs. of muriate per

acre was used in spring scarcely a berry was lost, nor were the leaves blighted to any greater extent than might be expected so late in the season. With bone manure on the next plot the berries shelled, that the ground was fairly blue in some places. Other plots showed improvement in proportion to the amount of potash used. Monsieur Thézard combats "coulture" by using phosphoric acid, as quite necessary to perfectly develop the ovaries and the seeds; without it the berries set badly and remain small. Professor Trouessard says:—"When we consider that for long years the same hoary old stocks have been required to produce grapes without truce or mercy, and often without taking pains to supply to them by a fitting manner the nourishment which is withdrawn from them by the fructification of the grape, we shall be less astonished at the decadence of our (French) vineyards. And, indeed, enlightened minds ascribe the attacks of the numerous parasites to the weakness and exhaustion of our vines rather than to any accidental cause, such as importation from abroad." Mr. D. McAlpine also, the Government Vegetable Pathologist of Victoria, states in his "Fungi of the Vine in Australia":—"Treatment for disease and manuring should go hand in hand, and this plan has been followed in the experiments conducted under my supervision by Mr. R. F. Gow at Abbotshall Vineyard, Rutherglen, Victoria. A three-acre patch of Shiraz, 37 years old, and said to be worn out and almost past bearing, was treated in 1895 with artificial manures. One acre was treated with Albert's P.K.N.D. at the rate of 8 ozs. per vine, the cost and labor being 87s. 8d. per 1,000 vines, and the yield of grapes last vintage was 41 cwt. Another acre received potash chloride at the rate of 10 ozs. per vine, at a cost of 85s. 6d., and the yield was 35 cwt. The third acre had Thomas phosphate at the rate of 10 ozs. per vine, at a cost of 33s. 11d. per 1,000 vines, for a yield of 40 cwt. The total return for the three acres was 116 cwt. of grapes, which gave 435 gallons of wine per acre, whereas at the 1896 vintage the same land yielded only 79 cwt. of grapes, for 263 gallons of wine per acre (the three acres gave 516 gallons more). Other parts of the vineyard bearing Shiraz, and where no manure was applied, produced a much smaller yield, even although the vines were younger, and pruned and treated in exactly the same way. The vines during that season were practically free from disease, vigorous in growth, so that the effect of manuring upon disease was not observable." According to the Swiss press, in "phylloxerol" a composition has been invented and successfully tried, which not only destroys phylloxera on the roots, but acts besides as a fertiliser, if a hole 8 in. deep is made around the vine before winter, filled with from 8 to 12½ oz. of phylloxerol, and covered up.

Professor Grandeau stated in the *Revue Agronomique* of the "Temps" of the 20th day of July, 1897, that he visited vineyards in the Champagne with Professor Tisserand, and found that very rich manuring with Thomas phosphate, kainit, and nitrate of soda counteracted the destructive ravages of the phylloxera; stable dung and bisulphide of carbon alone cannot do it. In fact, an excess of nitrogen stimulates an herbaceous vegetation, resulting in a nitrogenous sap, which favors the several fungi and insects, such as the phylloxera. Monsieur Thézard also says that phosphatic manures, and especially Thomas phosphate, do augment the resistance of the vines, as they make the wood drier, the roots firmer, and less succulent for the phylloxera, and therefore less favorable for its development. To use these fertilisers is therefore an indispensable complement of treating vineyards with bisulphide of carbon. Of a vineyard at Vougeot Professor G. tells us that phylloxera had in 1889, destroyed it to such

an extent that the unanimous opinion of the Burgundian vignerons condemned it to eradication with a view of replanting it with American vines. The canes were so poor that layers were found only with difficulty, and had to be marked by sticks to find their place. The vineyard had been planted, perhaps, three hundred years ago, by the monks of Citeaux, and the present owner undertook to restore one portion (35 acres) of it, while another part was to be replanted with American vines. In the first year, 1890, he spread about 70,000 lbs. of horsedung per hectare, and hoed it into the soil. The layers being so weak showed no greater vigor. In 1891 he used 90,000 lbs. of rich poudrette, but the effect of these organic manures was nearly nothing. After an analysis of the soil, which was about the same as one made twenty years before, Professor G. induced Monsieur M. Bocquet to use, in April, 1892, 25 cwt. of Thomas phosphate, 16 cwt. of kainit, and 400 lbs. of gypsum, and in the middle of May 600 lbs. of nitrate of soda per hectare. The health of the vineyard was now assured, if only followed up by similar treatment. After the vintage in the middle of October, 100 tons of farmyard dung, equal to 400 lbs. of nitrogen, were spread per hectare. In 1893 another ton of Thomas phosphate and 600 lbs. of kainit were applied, and no nitrate of soda. The farmyard dung did not act in consequence of the dry season, so that the vineyard did not improve. It remained only stationary. In 1894 800 lbs., and in 1895 240 lbs. of nitrate of soda were used per hectare, except on a piece named Montiotès, where the dose of nitrate of soda for both years was 13 cwt. per hectare. At the commencement of April, 1895, the vines at Montiotès did show yet an inferior growth to other parts of the vineyard; but, as the soil was enriched previously with potash and phosphoric acid, the addition of the large dose of nitrate of soda was such a success that since that time the vines at Montiotès were as vigorous and productive as those of the other part. In 1896 no manure was given; but in March, 1897, 1,000 lbs. of Thomas phosphate and 800 lbs. of kainit, and in May 400 lbs. of nitrate of soda were applied. It showed plainly that the resistance of the plants against the attacks of the phylloxera stands in direct proportion to their vigor. Since that time has Monsieur M. Bocquet resolved to manure all his vineyards equally with 1,000 lbs. of Thomas phosphate, 800 lbs. of kainit, and 400 lbs. of nitrate of soda per hectare, and Monsieur L. Bocquet has renounced the use of farmyard dung in all his vineyards except for layering. Although many of the vines at Vougeot, and also at Grands Peuillats, were hardly alive, they grew even the first year after manuring with mineral salts fairly well, and, as the bisulphite of carbon and manuring was continued annually as before mentioned, the old Burgundy vines are now as strong again as the best grafted on American vines. Professor G. is now perfectly satisfied that almost destroyed vineyards, treated as before mentioned, will not only keep alive, but show an extraordinary growth and fruitfulness. According to a pamphlet, "How to Use Salts Containing Potash and Magnesium," published and controlled by the Professors Drs. Fleischer, Maereker, and Wagner, the magnesium seems specially important in the war with the phylloxera. Although kainit, which has been used in such great doses at the vineyards of the Messrs. Bocquet, contains large quantities of magnesium sulphate, viz., 16.5 per cent., and of magnesium chloride 13.0 per cent., it might perhaps be preferable, after the first two or three years, to use purified double sulphate of potassium and magnesium, which contains 34.0 per cent. of magnesium sulphate, and 2.5 of magnesium chloride, with only 1.6 per cent of common salt, against 31.0 per

cent. to 34.6 per cent. in kainit. I imagine that the great quantities of common salt added with the kainit year after year must eventually have an injurious effect on most soils. Sulphate of potassium and magnesium contains also twice as much sulphate of potash, and thus a part of the higher price will be recovered.

MANURING IN AUSTRALIA.

Having applied to a large number of vignerons here and in the other colonies to inform me whether they have made use of dung or mineral fertilisers, many have had the courtesy to reply, to whom I tender my thanks. Unfortunately a great proportion of them merely state that they have not yet used any manure, even in aged vineyards; but I am not so sure that the reply of others—that they found it unnecessary—will be reiterated after they have perused these pages. At all events, it is time to consider the advantages of manuring, in which so many fully believe, and this is my excuse for publishing extracts from the letters received.

SOUTH AUSTRALIA.

Mr. J. BASEDOW, of Tanunda, used artificial manures in 1897 on his very light soil; but the season being very dry, the grass and weeds appearing after the vintage and rain received the benefit of it. Neither foliage nor the young fruit showed any difference in 1898, and after a heavy hailstorm most of the grapes were lost, so that he had only 5 cwt. of grapes per acre. Against this may be set *my own* experience. I used in 1897 in Norwood to thirty vines (table grapes), which did not show any necessity for manure, on medium, rather dry soil, 8 lbs. of Thomas phosphate and 2 lbs. of muriate of potash, and on stronger soil 8 lbs. and 2½ lbs. I never had as fine grapes before notwithstanding the dry season; but I had no weeds feasting on the fertilising elements.

Mr. C. F. CHAFFEY, of Renmark, has used about three tons to the acre of sheep manure on vines with very satisfactory results.

Mr. R. V. CHOLMONDELEY, of Vale Royal Vineyard, O'Halloran Hill, reports that he does not yet manure his young vineyard, except that he burns all the cuttings after pruning in a burner, going between the vines and all the potash falling through a grating on to the land. He carts out also all the husks that have been put through the cellars. He hears that some use the Adelaide Sugar Refining Company's manure by placing a small insectibane tinful around each vine, which makes them wonderfully productive.

Mr. JOSEPH CORRELL replies that Correll Bros., of near Minlaton, Y.P., manured some old vines two years ago with bone superphosphate and this year they had a much better crop from these than from some younger and more vigorous vines which had not been manured. They intend this winter to manure with Thomas phosphate and perhaps some sulphate of potash. But phosphates are most needed on the Peninsula.

Sir SAMUEL DAVENPORT, of Burnside, replies that he has used very little manure and that with mineral ones, as potash and phosphoric acid, the last two dry years had affected the results.

Mr. C. B. DOMEYER of Moppa, had to deal with a light, white, sandy soil,

which required mechanical improvement as regards retentive properties before planting. This was done eight years ago by digging holes 4 feet square and 2 feet deep in which he made in two of the corners holes 3 feet deep by 6 inches with a patent posthole digger, and the clay dug out was spread on the surface. He has since sown every year in March a portion with either barley, rape, mustard, crimson clover, or any other quick-growing fodder plant, with superphosphate of the Chemical Works as a light dressing, turned pigs with a ring in their noses or sheep into the vineyard in May until July, and ploughed the crop down at the end of August. Afterwards the cultivation was kept going until Christmas. The soil is getting darker every year, and is now a chocolate to dark grey loam. This year he has sown in the middle of February Baart wheat, dwarf Essex rape, Chinese cabbage, and white mustard, with 8 cwt of Chemical Works superphosphate on 12 acres. In May he will turn in thirty pigs and plough in August the rest of the crop down. Pigs or sheep have hitherto paid the cost of seed and manure. The before-mentioned deep holes were used for the planting of Zante currants, into each of which he placed $\frac{1}{2}$ cwt. of boiled bones, which he rammed well down and on these planted five years old Zante currants, one in each hole, 12 feet apart in the row, and the rows 20 feet apart. They commenced to bear two years after planting, and have given on an average fair crops for the last four years, notwithstanding the droughts and the hail of this season. These yielded very much better than those of his neighbor planted in the ordinary way. Unless the price for wine grapes improves he and many others will uproot them.

Mr. J. GILLARD, the Manager for Penfold & Co.'s vineyard at Magill, states that he only manured hitherto with the husks of the grapes, which he puts on any hard clayey ground. Generally speaking, he finds deep cultivation to act well.

Mr. G. GRAMP, of Rowland's Flat, whose carte blanche is so well and widely known, has hitherto used no fertiliser of any kind. What I have personally seen of his vineyard is on rich land, which may not yet require much manuring.

THOMAS HARDY & SONS, of Bankside and McLaren Vale vineyards, have taken an interest during the last two years in manuring of vineyards. Unfortunately their experiments made are, as they say, not reliable as a test, as many of the vines have in places failed very much, probably from salt. In looking over the figures sent to me, I cannot but come to the same conclusion, although Thomas phosphate, except in one instance, seems to have slightly improved the return, where 160 lbs. of it with 60 lbs. of nitrate of soda had been used on plots of 60 x 60 feet. Where 40 lbs. of sulphate of potash was added to the above 2 cwt. and 14 lbs. more grapes were cut. The unmanured plot proved, however, this year to be as good as the former, and better than where 196 lbs. of Ohlen-dorff's manure was used, and on another plot manured with 224 lbs of superphosphate.

Mr. E. MAZURE, the Manager of J. H. Symon's (Q.C.) Auldana vineyard, near Magill, states that Thomas phosphate and kainit have given him good results, the latter especially in soil rather rich in organic matter. He has found that it was sufficient by itself. In poorer soil he has used both. Organic manures he has found useful on hillsides. It is more costly, but lasts longer than artificial. He has also tried on a small scale one of Mr. G. Ville's compound manures with excellent results, composed of 4-10ths superphosphate of lime, 3-10ths nitrate of potash, and 3-10ths sulphate of lime. Fertilisers containing a high percentage of potash salts generally give the best results on vinegrowing.

Professor A. J. PERKINS, viticulturist for South Australia, values grape skins as about equal to farmyard manure, perhaps a little better. Average composition, about 1 per cent. nitrogen, 3 per cent. of phosphoric acid, and 5 per cent. of potassium oxide. He prefers to keep the grape skins in heaps, and then spread them before ploughing. Better still, put them in a pit, and mix lime with them to hasten decomposition, which is rather slow, and cart them when required. In his report to the Minister of Agriculture of 1897-8, he says—"Owing to the total absence of rain after June the fertilising elements remained completely inoperative. These manures, however, were not lost; they remained in the superficial layers of the soil to be washed down by the (next) winter's rain, and it is only during the present season (1898-9) that the vines are feeling the beneficial effects." From this it is clear that Professor Perkins had already as long ago as 1896 used fertilisers for the very young vineyard at Roseworthy College. The above negative result, for the season when applied, makes him propose for the future to apply readily soluble manures in the drier districts of South Australia in the early winter, before the first ploughing. And the four tests which were made in 1897-8 with manures granted by the Syndicates of the Stassfurt Potash and the Thomas Phosphate Manufactories led me and the gentlemen applying the fertilisers to the same conclusions. The fertilisers had been applied too late—in August and September—and the beneficial effects could only be felt in 1898-9 or still later.

Mr. FRANK POTTS, of Langhorne, on his very fine black alluvial flat has not as yet found it necessary to manure, although the vines are old.

Mr. WALTER REYNELL, of Reynella vineyard, applied in August to his old vineyard stable manures at the rate of ten tons per acre. This gave good lasting results both on a black flat and a limestony hill. It had the most marked effect at the second vintage, when a vineyard of ten acres of Carbinet, Shiraz, and Malbec gave 5,000 gallons of wine. Superphosphate used in August 1897 at the rate of $2\frac{1}{2}$ cwt. per acre on old vineyards gave almost no appreciable result in last year's crop, but may do so this year. Mr. Ross Reid, the Manager, considers sulphate of potash the most perfect artificial manures for vines.

Mr. J. A. RIDDOCH, of Katnook, near Penola, replies on behalf of J. Riddoch, Esq., that the vineyards of Coonawarra, which have a loamy chocolate soil on a limestone formation and a rainfall of $24\frac{1}{2}$ inches, have as yet required no manuring. They have borne but very few crops.

W. SALTER & SON, of the Saltram vineyard, Angaston, used on forty years old vines $1\frac{1}{2}$ cwt. of nitrate of soda to the acre, and once, some years ago, some bone-dust. The result in both cases was no appreciable benefit. In 1898 they tried grape skins, but owing to the destructive hailstorm they could not gauge the effect on the crop. They noticed, however, that the growth was better and the foliage retained its green color rather better than where none had been applied. They suggest that the manurial value of grape skins should be ascertained, and whether it is better to scatter the heaps at once, or to leave them as tipped from the dray until ploughing season. (Mr. Th. Hardy scatters the heaps at once. See under A. J. Perkins.)

Mr. WM. SALTER, Manager for D. & J. Fowler at Nuriootpa, has used only grape skins and stalks, but thinks that the judicious use of fertilisers in the vineyards will pay handsomely.

Mr. B. SEPPELT, of Seppeltsfield, never used any manure except in 1898 one ton of Ohlendorff's vine manure on one acre. Result, a less quantity of grapes

(Doradilla) than from an equal patch next to it. He attributes this to the cutting of roots, as he trench-ploughed between the vines, which are ten feet apart (one way only) and applied the manure in the trench. No doubt the effect of the manure will be seen next season.

S. SMITH & SONS, of Yalumba vineyards, Angaston, never use stable manure, but spread grape skins more thickly than they would the former, and value these highly. Two and a half tons of bonedust, used two years ago, gave very visible results in the wood when pruning, but the crop had not benefited to a great extent.

VICTORIA.

Mr. FRANCOIS DE CASTELLO, Manager of the Chateau Dookie vineyard, replies that the 500 acres of vines planted on very rich soil require as yet no manure.

Mr. ALEX. CAUGHEY, of Mount Prior vineyard, uses what little stable manure he has got. Required as yet no commercial manures.

Mr. THOMAS McCaw, of St. Hubert's vineyard, used farmyard manures (except pig manure) and bonedust with good results.

Gow & Co., of Abbotshall vineyard, Rutherglen (where the fine results were obtained mentioned on page 22) write to me "that they have treated in July 1898 a four-acre block of vines with Thomas phosphate and will note results next vintage. The yield having been so very good on the acre treated with Thomas phosphate at the low cost of 33s. 6d. per 1,000 vines seems to have decided them in using this fertiliser, and it is quite correct that they do not expect any material increase in the crop lately cut, as the buds now formed will give the crop.

Messrs. G. F. MORRIS & SONS, of Fairfield vineyard, use bonedust with good results.

Proprietors of Chateau Tahbilk vineyards have never used any manure, although they seem from analysis of soil to require especially potash and phosphoric acid.

JULES RENARD & Co., of Melbourne, write—"A number of vigneron in Victoria are using manures with good results; but the experiments are carried on in a haphazard manner. The results so far obtained bear out those obtained in the late Mr. Gow's vineyard, and go to prove that the vines pretty well show no result the first season, a better result the second season, and a very good and striking result the third season."

G. SUTHERLAND SMITH & SONS, of All Saints vineyard, Wahgunyah. Thomas phosphate has been used broadcasted in the district on various soils, which has given good results. They themselves used nothing, but allowed the sheep to run into the vineyards after the vintage.

NEW SOUTH WALES.

ED. CAPPER & SONS, of Pokalbin, near Maitland, have a strong chocolate colored, ferruginous, and magnesian limy soil, with a subsoil containing fossils of marine shells, and although the rainfall is only 12 inches manure has not been used, as the average is 500 gallons to the acre.

J. T. FALLON, of Murray Valley vineyards, Albury. The soil is a red chocolate color with a mixture of granite and ironstone. Rainfall from 30 to 34 inches. Has used on a portion of the vineyard a limited quantity of well rotten stable dung with good results; also one ton of bonedust to ten acres applied about the 1st of August, and the result was satisfactory. But a much larger quantity could be used to advantage. The above would apply to the other vineyards in the Albury district.

GEO. J. FRANKLAND, of Mowbray, Paterson, has very rich alluvial land, at times further enriched by occasional floods, which has been cropped for forty years. The grossness has been sufficiently worked out to produce now enormous crops of very fine wine from Verdelho, Black Hermitage, and a Riesling (not the German). They are trellised on two wires north and south, and from both the latter varieties—in a good season, uninjured by frost or excessive rain—he has made from 600 gallons per acre, and twice 1,000 gallons, when the vineyard was younger, of which the first portion was planted in 1870. He gets 25s. a dozen for his wines.

J. D. LANKESTER, of Ettamogah, near Albury, has given me with unusual courtesy in every respect the fullest information. Part of his vineyard, consisting of upwards of fifty acres, was planted as early as 1863, and during the last nine years he has conducted experiments with manures. Farmyard dung has been used with considerable success by some of his neighbors. He finds that the Sugar Company's phosphates are the most suitable and give him the best results; but further experiments alone will give reliable data. Using Colonial Sugar Co.'s No. 3 and 5 increased his crop, in some instances doubling it. But he keeps the surface always loose and allows no weeds to grow. All manures containing ammonia he covers as quickly as possible. Instead of growing and ploughing in leguminous plants, which in dry seasons would not succeed well, he thinks it is of advantage to run a few sheep into the vineyard after the vintage. Any manure, and especially if very fine, should be sown in calm weather and at once worked in, and he manures and works it in autumn, soon after the vintage, except with nitrate of soda, which he uses about the time the buds break.

T. MATHER, of Roslyn vineyard, Inverell, has a red volcanic sandy loam containing 55.3 per cent. of lime, 34.7 of phosphoric acid, 1.28 of nitrogen, 2.73 of magnesia, 1.05 of potash, and .013 sulphuric acid. He had taken twenty crops off the vineyard and with the exception of one year has always had a good vintage. Three acres of Verdelho and Pineaus, however, began to fall off about three years ago. This winter (1898) he has manured them with half a pound of Sugar Company's manure D to each vine. He keeps his vines, however in a high state of cultivation, by which he assists them to resist a dry time like 1898, where only 17 inches fell to the middle of November against the usual rainfall of 28 to 30 inches.

MITCHELL & SONS, of the Olives, Howlong. The vineyard has a red clay with a stiff dry subsoil and a 24-inch rainfall. Sheep manure has been used and six experiments made with 32 lbs. of superphosphate of lime, 8 lbs. of sulphate of potash, and 40 lbs. of plaster of paris, upon which blocks were different legumens sown—viz., crimson clover, yellow lupin, white lupin, field peas, vetches, and sulla. Six other experiments were made with these leguminous plants without the above manures. Other blocks received different manures only, but the results, although promised by Professor Blunno, have not yet been received. No. 13 had the above manures with 24 lbs. of nitrate of soda; No. 14 the same, with-

out superphosphate ; No. 15 omits potash ; No. 16 omits nitrate of soda ; No. 17 omits plaster of paris ; No. 18 substitutes 18 lbs. sulphate of ammonia for the nitrate of soda ; and No. 19 got only plaster of paris.

CONCLUSIONS TO WHICH I HAVE MYSELF COME.

You may have used the best and most suitable fertilisers for any soil or climatic conditions and find no improvement in the crops of grapes in the first season ; only canes and leaves look healthier. Even if you manured in our spring, the crop cannot then benefit much, only the buds forming for the following season will harbor larger bunches, which a good season will perfect for the next year's vintage. If the season should be too dry, or the soil too compact for want of proper tillage, even then you must have patience to await the action of the manures.

In deciding upon the kind of manure, soils poor in humus require stable dung, and to be assisted with nitrate of soda as top dressings, or with other nitrogenous manures. Most soils demand as well phosphatic and potassic manures. In limestone formation the latter are almost always necessary every year, with nitrogenous manures, as may seem advisable. Light sandy soils require nitrogenous manuring, and benefit physically and chemically by light annual dressings of farmyard dung or others rich in organic matter. Cow and pig manure is here preferable to the hot sheep and horse dung. Sandy soils are also generally deficient in potash, but may not require large quantities of phosphates. Heavy argillaceous soils demand lime and humose dungs, which we may give, as in Europe, once in three years ; but yearly doses of nitrate of soda and phosphates might be useful in addition. Professor Perkins recommends for these soils a good dressing of gypsum to transform the large store of carbonate in the soil into sulphate of potash, and thus making potassic manures unnecessary. In our climate, except in some parts of New South Wales, where leaching may be possible, any plant food given, but not used on account of absence of rain or bad cultivation, will still remain in the soil for future crops. The above general remarks explain fully that one vigneron may double his crop when another fails, but results are as often due to thoughtful or careless application, and the selection of the particular fertilisers used.

One more matter I beg yet to impress upon those who have hitherto been afraid of using commercial manures—that they are *plant food*, not merely *stimulants*, which leave the soil after some years in an altogether exhausted state.

APPENDICES.

APPENDIX I.

Professor Dr. Wagner, of Darmstadt, addressed a number of experts on the third day of December, 1898, at Hattenheim, on the manuring of vineyards, of which I received a pretty full abridgment in manuscript. Before reading his paper he said that he would like to ask every vigneron present, "In what way do you manure your vineyard? It would be foolish to let your vines hunger." The conclusions to which the professor has come agree almost with those of Mr. Chr. Oberlin, but on first appearance M. Grandeau seems to disagree as regards the use of phosphoric acid. It being admitted on all hands that at least large tracts in South Australia require it for other crops, and frequently more than other plant food, Professor Wagner might here, perhaps, advise the use of large doses of phosphoric acid, like M. Grandeau in some parts of France. It will therefore be necessary to make experiments, as also recommended by Professor Perkins, to decide this question for our vineyards. The first experiments made by Professor W. were made 13 years ago in six different vineyards of Rhenish Hesse, with 20 plots of 42 vines in each of them. These showed him only that nitrogen was always wanting, and that too much phosphoric acid in one vineyard at Nierstein was undoubtedly harmful. Lately he made new experiments in vessels containing about 7 cwt. of soil, and others with twice such quantity. He selected as his vines "Riesling," and made 120 experiments, chiefly to ascertain the percentage of grapes, wood, and leaves obtained with the several manures, the hunger after potash, phosphoric acid, or nitrogen, or the largest quantity necessary for the vines until oversatiated. For such experiments he manured one with the normal quantity given to each vine, viz., 8 gram. phosphoric acid, 8 g. potash, and 16 g. nitrogen; secondly, with the last two without phosphoric acid; thirdly, with the last two and 12 g. phosphoric acid; fourthly, with 8 g. phosphoric acid and 16 g. nitrogen, without potash; fifthly, with 8 g. phosphoric acid, 16 g. nitrogen, and 12 g. potash; sixthly, with the first two, normal quantity, without nitrogen; seventhly, with the first two and 24 g. nitrogen; eighthly, with half as much more than the normal quantity, and ninthly, with no manure at all (see plates numbered 11 and 12).

Six and 9 showed soon the want of nitrogen; the leaves got yellow, the wood and young bunches remained weak, and after setting of the berries coulure was general. Seven showed only a darker green of the leaves than 1. Experiment 2 had also healthy leaves, but those of 3 were not so good as of 1, so that the soil seemingly did not require manuring with phosphoric acid. Four showed lighter green leaves compared with 1 and 5. At experiment 8 the vines were healthy, but did not otherwise seem better developed. As regards the ripening and the dropping of the leaves he observed that those vines which

received no nitrogen (6) or no manure at all (9) lost them by the 3rd of October, while all the others had lost only on the average 20 per cent. of their leaves.

The weight of grapes on five vines taken from 6 (without nitrogen) and 9 (without manure) was only 1.54 and 1.96 kilog., while all others except 4 (without potash, and which gave 10.71 k.) had more than 12 k. Five vines of 2 (without phosphoric acid) had actually 14.03 k., and of 5 (more potash) 14.01 k.

The extractive matter of the must was, in 9 (without dung) 15.88 per cent., while the average of all others, with unimportant fluctuations, was 17.50 per cent. The average of acidity was 11.050 per cent.

The canes of the five vines, counted as dry substance, gave the largest number, viz., 100 with 1 (normal manuring), while the leaves were heaviest, viz., 100 with 8 (the larger doses); 6 and 9 (without nitrogen and without manure) were in either case very low, for wood 54 and 49, for leaves 41 and 42 respectively. These experiments showed clearly that the want of nitrogen gave, firstly, fewer grapes, and consequently must, and also produced less wood and leaves.

The contents of phosphoric acid in must and in the dry husks, wood, and leaves, were on the average in the must, 0.0494 per cent.; in the husks, 0.499 per cent.; in the wood, 0.261 per cent.; and in the leaves, 0.529 per cent.; but while the average in the must of the seven others was 0.0418 per cent. the percentage in 6 was 0.0661 per cent., and in 9 0.0865 per cent. The average in the leaves of the seven others was 0.481 per cent., against 0.748 per cent. in the leaves of 6, and 0.642 per cent. in those of 9. Wagner explains that a soil sufficiently rich in phosphoric acid, but either unmanured or without getting a nitrogenous manure, will produce in the crop generally a larger percentage of phosphoric acid as where manured with nitrogen. Whenever, however, heavy nitrogenous manuring has taken place, and the crop contains much phosphoric acid, it will be found that there was a large surplus of phosphoric acid ready for absorption.

The contents of potash were, on an average in the nine experiments, in the must, 2.0128 per cent.; in the dry husks, 2.654 per cent.; in the dry wood, 0.707 per cent.; in the dry leaves, 1.414 per cent.; but 4 (without potash) and 5 (with more potash) differed much from the other seven. The must in 4 contained 0.1869 per cent., against 0.2184 per cent., and in 5 0.1995 per cent. against 2.184 per cent.; the husks in 4 contained 2.390 per cent., against 2.672 per cent., and in 5 2.792 per cent., against 2.672 per cent.; the wood in the seven others contained 0.717 per cent., against 0.617 per cent. in 4, and 0.729 per cent. in 5; and the leaves in the seven contained 1.464 per cent., against 0.998 per cent. in 4, and 1.484 per cent. in 5. The soil required, therefore, potash, as shown, as well in the crop of grapes as in the percentage of it in the must, the husks, the wood, and the leaves, and their color.

The percentage of nitrogen in the must shows not much difference in the nine experiments. In the husks only 9 (without manure) contained much less nitrogen, viz., 1.348 per cent., and 6 (without nitrogen) 1.540 per cent., against an average in the others of 1.588 per cent. The percentage in the wood was, in 9, 0.532 per cent., and in 6, 0.567 per cent., against the average of 0.744 per cent.; and, while the leaves in 9 contained 0.994 per cent., and in 6 1.033 per cent., the average was 1.708 per cent.

The chief results, therefore, were:—1. That as the soil was relatively rich in phosphoric acid, and the vine seems sensitive against too much of it, those, where only nitrogen and potash was used, proved to be the healthiest. Manuring with phosphoric acid was not only unnecessary, but to a small degree hurtful; 0.05 per cent. of it in the must, 0.5 per cent. in the husks, 0.5 per cent. in the leaves, and 0.25 per cent. in the wood is normal. 2. The soil was not rich enough in potash for the requirement of vines; 2 per cent. of potash in the must, 2.5 per cent. in the husks, 1.5 per cent. in the leaves, and 0.7 per cent. in the wood is normal. 3. That nitrogen was insufficient in the potting soil was shown where nitrogenous manure was given; this showed least, however, in the husks, and not at all in the must. Ripe leaves of the Riesling should contain as a minimum 1 per cent., while 2 per cent. is the maximum, and you may consequently ascertain within these boundaries whether your vines require nitrogen. Normal is 1.005 per cent. of nitrogen in the must, 1.5 per cent. in the husks, 0.7 per cent. in the wood, and 1.7 per cent. in the leaves.

Finally, Professor Wagner gives what quantity of the three plant foods Riesling vines require. Omitting 6 and 9, which gave an extremely low composition of substances harvested, each Riesling vine consumes, for the production of 2.424 g. of grapes, 1.854 g. of phosphoric acid, 9.703 g. of potash, and 5.636 g. of nitrogen; for the 470 g. of wood 1.253 g. of phosphoric acid, 3.437 g. of potash, and 3.561 g. of nitrogen; for the 291 g. of leaves 1.434 g. of phosphoric acid, 4.069 g. of potash, and 5.006 g. of nitrogen; or together, 4.541 g. of phosphoric acid, 17.209 g. of potash, and 14.203 of nitrogen. For every 100 parts of phosphoric acid are therefore required for the grapes 523 parts of potash, and 304 parts of nitrogen; for the wood, 274 parts of potash, and 284 parts of nitrogen; for the leaves, 284 parts of potash, and 349 parts of nitrogen. Adding these together you may say that in round numbers for every 100 parts of phosphoric acid, 400 parts of potash, and 300 parts of nitrogen are required. To manure one Morgen (containing 2,500 vines) very fully would require 11 kilog. of phosphoric acid, 43 kilog. of potash, and 36 kilog. of nitrogen but in giving annually 100 cwt. of stable dung per Morgen you might probably have given 13 kilog. of phosphoric acid, 32 kilog. of potash, and 25 kilog. of nitrogen; or, according to the above calculations, quite enough of phosphoric acid, 11 kilog. short of potash, and also 11 kilog. of nitrogen. As, however, only about 30 per cent. of the stable dung is available, there is, in fact, a much greater shortage of nitrogen in the stable dung. Instead of the 36 kilog., which is taken as a very full manuring of nitrogen, only perhaps 8 kilog. would be actually at once fit as plant food. Exact figures cannot be given, as the quality of the dung is so very uncertain.

As regards a mixture sold as P.K.N., he remarks that this manure is not suitable for vines. For every 100 parts of phosphoric acid it contains only 175 parts of potash, and only 35 parts of nitrogen, instead of 400 and 300 respectively. In the *Weinbau und Weinhandel* paper of the 10th December, 1898, the address was criticised, some of the remarks made during the discussion were given, and also the points generally admitted by the experts. The leader stated that in practice an addition of Thomas phosphate or superphosphate to the stable dung has frequently a favorable effect, and this can be explained that phosphoric acid does not move much in the soil, and may not reach the roots unless these search for it. As regards potash a good addition is necessary

unless the soil is very rich of it, when a smaller quantity may be sufficient; but nitrogen is never sufficient in stable dung. If only 100 cwt. were given, nitrate of soda is a useful addition in two or three doses; or, for heavy soils, sulphate of ammonia. "The whole secret lies in the right quantity of nitrogen," and the necessary lime must never be absent. Heavy nitrogenous manuring demands also potash and phosphoric acid, as these will influence the quality of the crops of grapes. These latter are, however, more favorable if taken from a surplus of previous manurings than if given in strong direct doses. The good results of manuring with nitrogen alone are only possible if a surplus of potash and phosphoric acid is present from former manurings, or was already contained in the soil itself. In the latter case it will soon result in exhaustion, and the future production of grapes must suffer. Counsellor of Economies Mr. Czék stated that he could not much improve a neglected vineyard by means of several double quantities of stable dung until he brought it deeper into the subsoil. Mr. von Mumm, of Johannesburg, said, and was supported by several vigneron from the Moselle, that 40 g. of P.K.N. applied to each vine in the two years between two manurings with 200 cwt. of stable dung had not only increased the crops, but improved also the quality. Mr. Schlegel, of Oestrich, recommends to patiently wait for results from commercial manures for three, four, and more years, as the deeper roots will only then reap the advantage, and quantity and quality will improve. Dr. Kulisch, of Geisenheim, advocates the use of lime in vineyards poor in lime. He also found excessive manuring with phosphoric acid harmful. He pointed out, that the assertion commercial manures imparted to wines a bad taste is a prejudice and superstition. It was also stated that the finer varieties of vines contained much more phosphoric acid and potash in the wood, and especially in the tops of the canes, while nitrogen predominates in the more common varieties.

The points admitted after discussion were:—1. That stable dung is insufficient in its composition, uncertain in its contents, and frequently defective; also, comparatively expensive. Commercial manures are therefore necessary as a supplement, and especially for planting new vineyards, when phosphoric acid and potash should be given to the subsoil. Nitrogen can then be given annually. 2. If the soil received and retains the commercial manures near the surface, means should be found to bring them into contact with the roots. 3. The quality, instead of being injured by commercial manures, is frequently improved.

APPENDIX II.

Monsignor Gino Ovoisto, of Florence, Italy, has published in November, 1898, nine experiments with fertilisers made during 1897-8; the results seem to show unequal soil, which had probably been well manured not long ago. The average weight of grapes gathered from two not then manured plots was per hectare in 1897, 8,400 lbs.; in 1898, 11,600 lbs. From the plot between these two plots, manured with 2,400 lbs. of Thomas phosphate, 400 lbs. of nitrate of soda, and 600 lbs. of muriate of potash, he took in 1897, 8,120 lbs., and in 1898, 15,200 lbs. of grapes. From the plot manured with the same quantity of Thomas phosphate and nitrate of soda and 600 lbs. of sulphate of potash he gathered in 1897, 11,020 lbs., in 1898, 30,360

lbs. of grapes, while the average of the two unmanured plots on either side was 10,840 lbs. in 1897, and 17,120 lbs. in 1898. The results from plots which received only two of the above fertilisers were better than from unmanured plots in two instances and not as good in two others; but in all cases was the quality of the grapes better from the manured plots.

APPENDIX III.

Under the supervision of Professor Dr. Czerhoti, of the Experimental Station at Altenburg, in Hungary, six experiments in manuring of vineyards on sandy soils have been made in 1895 and 1896 at five different localities. Each plot contained 1,425 are (about 35 acres). Following the advice of Professor P. Wagner excessive quantities of phosphoric acid, viz 1,120 lbs. of phosphatic manure and 560 lbs. of sulphate of potash, were given with a view of regulating the growth of the vines through a suitable addition of nitrogen, and thus to prevent any damage to the vines and also to the quality of the must through an excess in nitrogen. Professor C. prefers this plan much to the usual way, in which well decomposed farmyard dung is generally applied in Hungary, by which so much nitrogen is lost. As has been experienced also elsewhere, the results of the first year are frequently not reliable for any conclusions, as the buds then formed will of course only give the crop in the second year. In the first year all phosphatic and potassic manures were given with nitrogen in the form of 420 lbs. of sulphate of ammonia. In the second year nitrogen alone was given in the form of nitrate of soda.

The vines in the several plots in the five vineyards were all planted three feet apart either way, trenched and manured with the above quantities per hectare as follows:—One, unmanured; 2, with phosphoric acid; 3, phosphoric acid and sulphate of potash; 4, phosphoric acid, sulphate of potash, and sulphate of ammonia; 5, sulphate of ammonia (not manured in 1896); and 6, unmanured.

I. Moor Comitát Ludwig Tehér, Pencz. The soil is level, a loose sand, and not previously manured, the vines three years old of the variety Ezergo. Plot 4 was the only one which showed finer leaves and stronger canes and gave a considerably larger crop. This left no doubt that the soil demanded the three plant-foods. In 1895 198 lbs., and in 1896 848 lbs. more grapes per hectare were cut and the must contained $16\frac{1}{2}$ per cent. and 18 per cent. respectively of sugar, in 1895 from $\frac{1}{2}$ per cent. to $1\frac{1}{2}$ per cent. more than the grapes of other plots.

II. Szent Ivan Comitát, Ladislaus Györ, Blacke. Soil gravelly sand and wavy surface, planted five years ago with mixed vines and received pig manure in 1894, but otherwise the plots were manured in 1895 and 1896 as at Pencz. Here also plot 4 had the largest crop, viz. per hectare in the two years 1,878 lbs. more grapes; but the percentage of sugar was 14 in 1895—one per cent. higher than on the other plots. For 1896 the must did contain only 12 per cent., or one per cent. less than in four others.

III. Dunakesz in Pester Comitát R. Kleisner. Soil loose sand with wavy surface. Planted in 1890 with White and Red Chasselas. Plot 4 had in 1895, per hectare, 480 lbs. more grapes, and 3,378 lbs. more in 1896. Plot 3, manured with phosphates and sulphate of potash, showed also a better crop than the rest, although much less than plot 4.

IV. Dunakesz Pester Comitát, Widow F. Künköl. Soil, a brown sand with wavy surface, trenched and planted in 1890. Plot 4 had 904 lbs., and 1,148 lbs. more grapes per hectare in 1895 and 1896, and plot 3 was again better than the other four plots.

V. Nyersapati, Pester Comitát, M. Szerka. Soil light, level sand, planted in 1888 with Pearl grapes. Otherwise manured as the former, only in 1896 the plots received compost. Plot 4 had 446 and 1,544 lbs. more grapes per hectare in 1895 and 1896 respectively.

For 1896-7 the second and fifth plots were left out in four other vineyards as neither phosphoric acid nor nitrogen *alone* had given good results. For plots 3 and 4 smaller quantities of the fertilisers per hectare were tried, viz. 700 lbs. of a phosphatic manure, 350 lbs. of sulphate of potash, or sometimes proportionately more of kainit, and 250 lbs. of nitrate of soda. The first three vineyards were planted on sandy land with Wälsch Riesling, on two of which they were four years old; on the third seven years old; the fourth vineyard was planted on sandy but wavy land five years before with Aramont and Bouchet. The results from the plots that received the full three fertilisers were as follows for the two years together against the unmanured plots—viz., No. 1 yielded per hectare 3,382 lbs. more grapes; No. 2, only 1,444 lbs. more; No. 3, actually 4,946 lbs. more; and No. 4, where planted with Aramont, 2,928 lbs. more, and where planted with Bouchet, 4,256 lbs. more grapes.

Mr. R. Nadeczky added for 1896 an experiment on humose sand planted with mixed vines by using pig manure, obtained from the firm excrements of pigs fattened with maize, which acts very quickly, but, as we shall see, is not lasting. While he obtained from the unmanured plot per hectare 1,237 litres of must, phosphate and sulphate of potash gave 1,296 litres, the plot manured with the three plant-foods 1,482 litres and the pig manure 1,945 litres. For the year 1897 the plot not manured in 1896 was manured with horse dung, the next two with nitrate of soda, and the fourth plot in 1896 manured with pig manure, received nothing. Result per hectare from the horse dung 1,405 litres of must, from the second plot (in 1896 phosphate and potash) 1,738 litres, from the third plot (in 1896 all three plant-foods) 2,085 litres, and from the fourth plot (not manured in 1897, but in 1896 with pig manure) 1,390 litres of must. Nadeczky adds that to manure with all three plant-foods, with a repeated doses of nitrate of soda the second year is much better than manuring with horse dung, so much liked by his vinegrowing friends. With the addition of phosphoric acid to the plot manured with horse dung, and also to that with pig manure, he would expect better results; but he thinks it his duty to recommend on sandy soil the three plant-foods in the proportion before mentioned.

Other persons continued now the experiments in 1897 and 1898 by leaving one plot unmanured and using on the next in 1897 per hectare 700 lbs. of phosphates, 350 lbs. of sulphate of potash, or 1,400 lbs. of kainit, and 350 lbs. of nitrate of soda; and again in 1898, only 350 lbs. of nitrate of soda. In one case of loose sand 3,352 lbs. more grapes were gathered per hectare, in another case on light sand 1,938 more litres of must were pressed, and in a third case on humose sand 11,800 more litres of must.

In 52 other cases experiments were only carried on for one year, and in only four of these did the manured land give a smaller crop than on the unmanured.

while in the other cases the following results of the increased crops per hectare are given, viz. :—

In 8 cases, between			200 and	400 lbs.
„ 5	„	„	400	600 „
„ 2	„	„	600	800 „
„ 2	„	„	800	1,000 „
„ 5	„	„	1,000	1,200 „
„ 4	„	„	1,200	1,400 „
„ 2	„	„	1,400	1,600 „
„ 5	„	„	1,600	1,800 „
„	„	„	1,800	2,000 „
„ 5	„	„	2,000	4,000 „
„ 3	„	over 4,000 lbs.		

From the foregoing the following conclusions were drawn as regards sandy vineyards, viz. :—

1. The crop can be much increased with commercial fertilisers ; but
2. A paying crop can only be calculated upon if all three plant foods—phosphoric acid, potash, and nitrogen—are used.
3. It is probable that if manured with farmyard dung an addition of phosphoric acid, and especially potash, will greatly increase the crop.
4. Even without stable dung the very best crop can be got by manuring with commercial fertilisers.
5. If you give the first year a complete manuring, with sufficient potash and phosphoric acid, you may in the second year repeat only manuring with nitrogen, and it is very likely that this will be also sufficient, if you repeat it, for the third year.
6. As nitrogen prevents the early ripening of the canes (here of less importance) it is necessary to give a surplus of phosphoric acid and potash in proportion to the nitrogen applied.

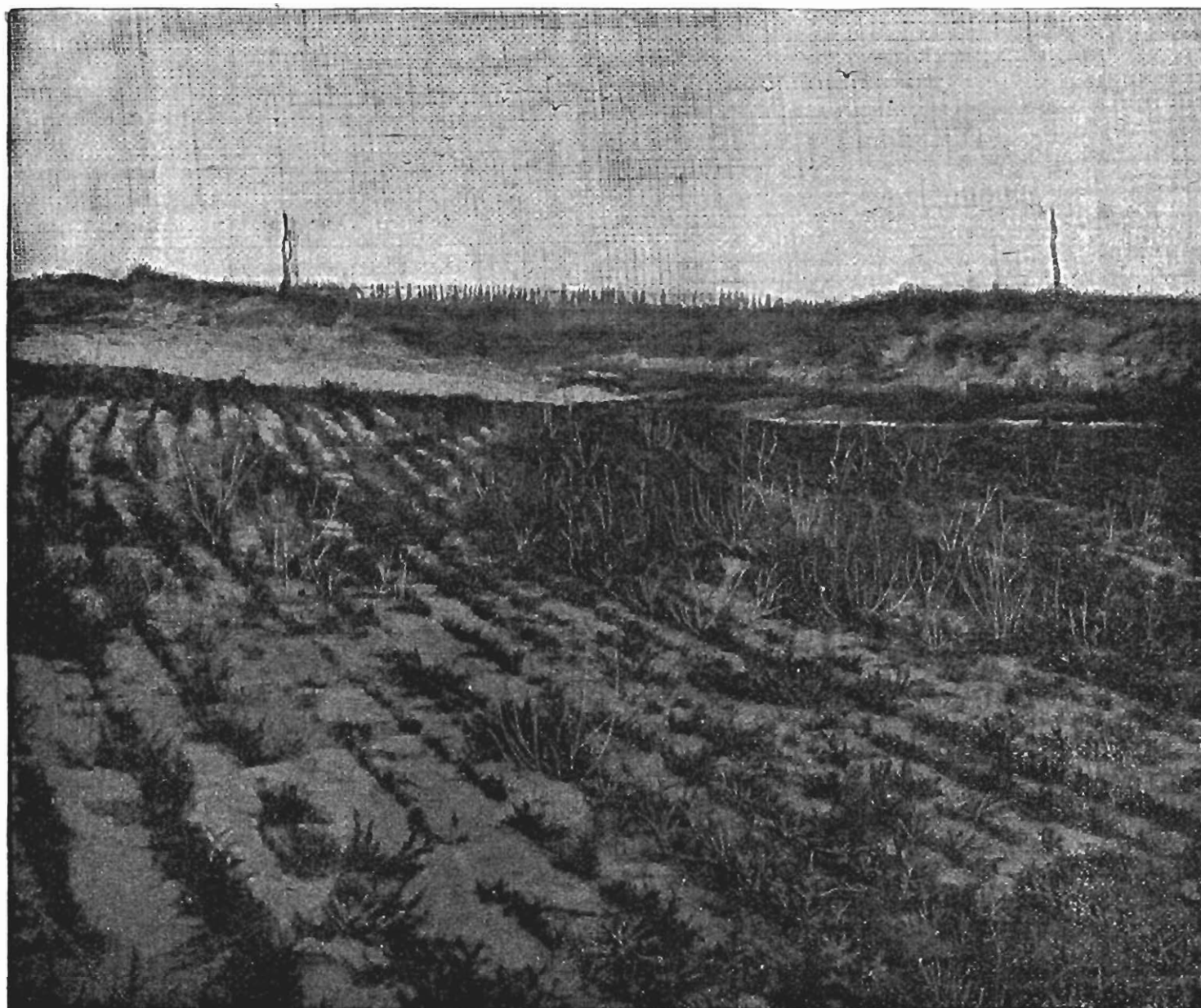
The cost of the manures for the two years would be, in Hungary, about £5 per hectare, or £2 per acre, and the larger crop gathered had cost to the several vignerons, per litre of must, 1·69 pfennige, 4·04, and 10·31 pfennige respectively, and to others, for each 2 lbs. more of grapes, 4·69, 5·92, 5·96, or 6·83 pfennige (of which eight are like one penny).



VINEYARD OF LIEBFRAUENTHAL.

[No. 1

Driftsand with *Lathyrus silvestris* before planting.



VINEYARD OF LIEBFRAUENTHAL.

[No. 2

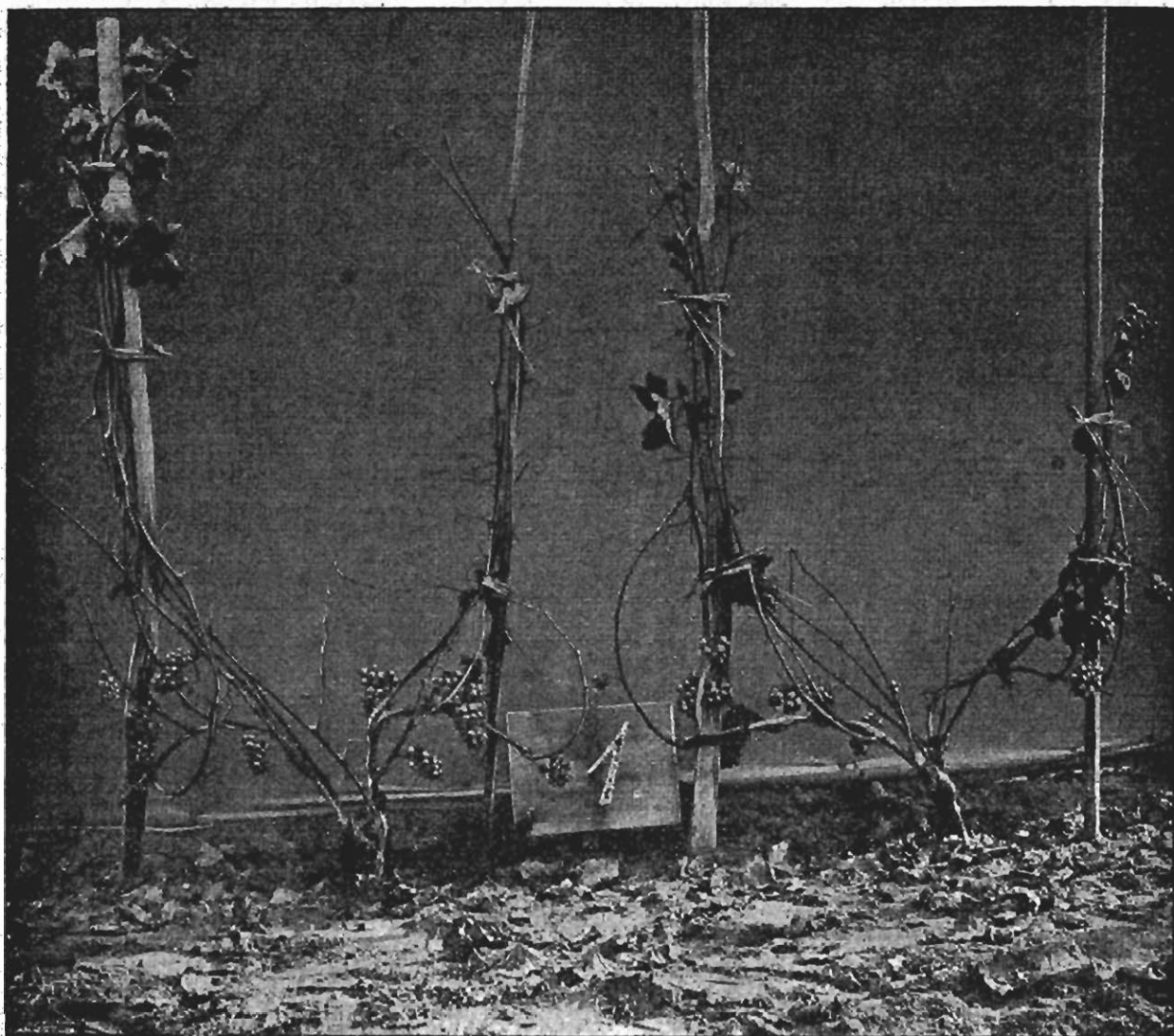
Driftsand visible beyond.



LIEBFRAUENTHAL, 1896.

[No. 3

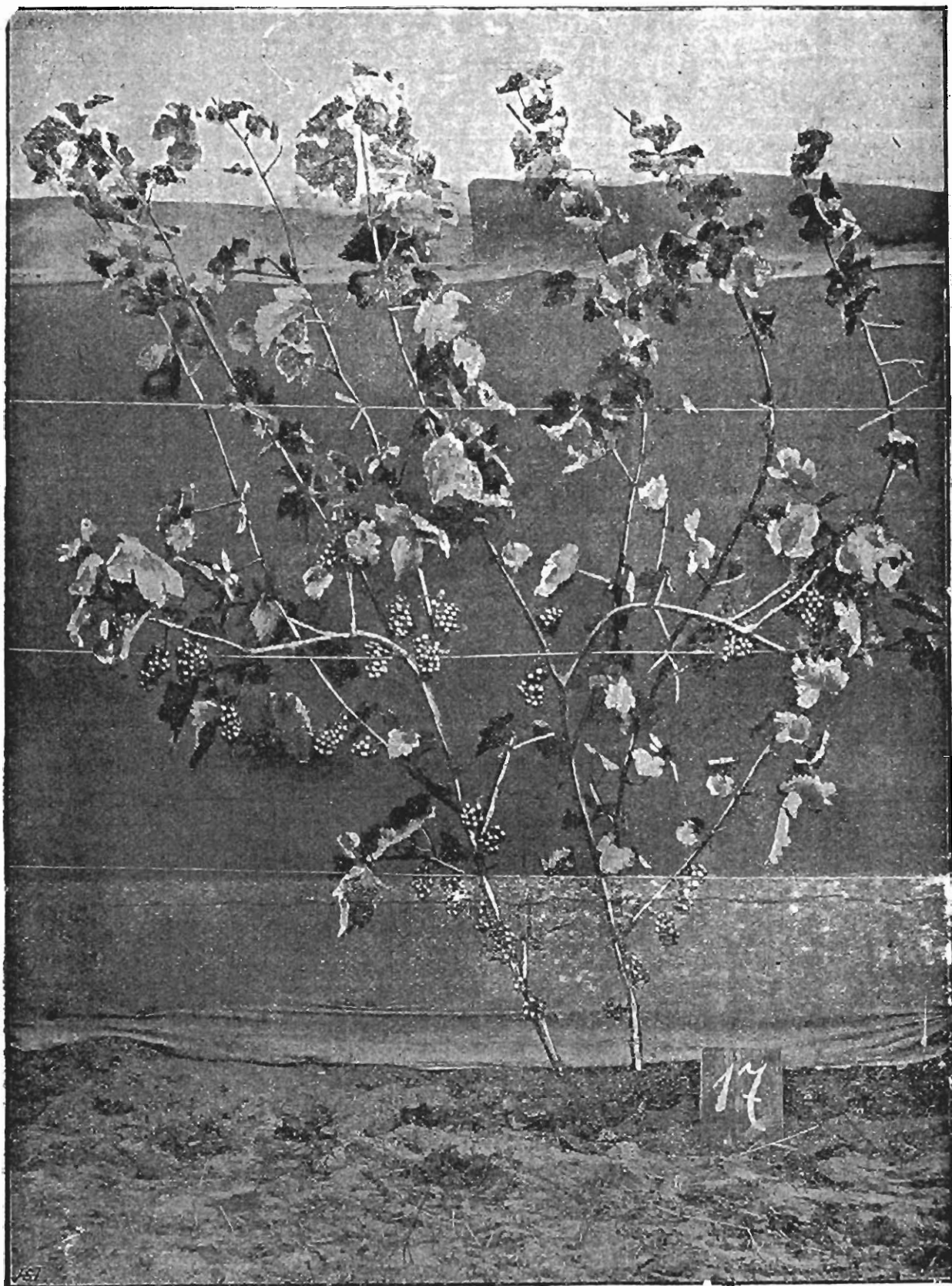
Very light sandy soil.



Unmanured.

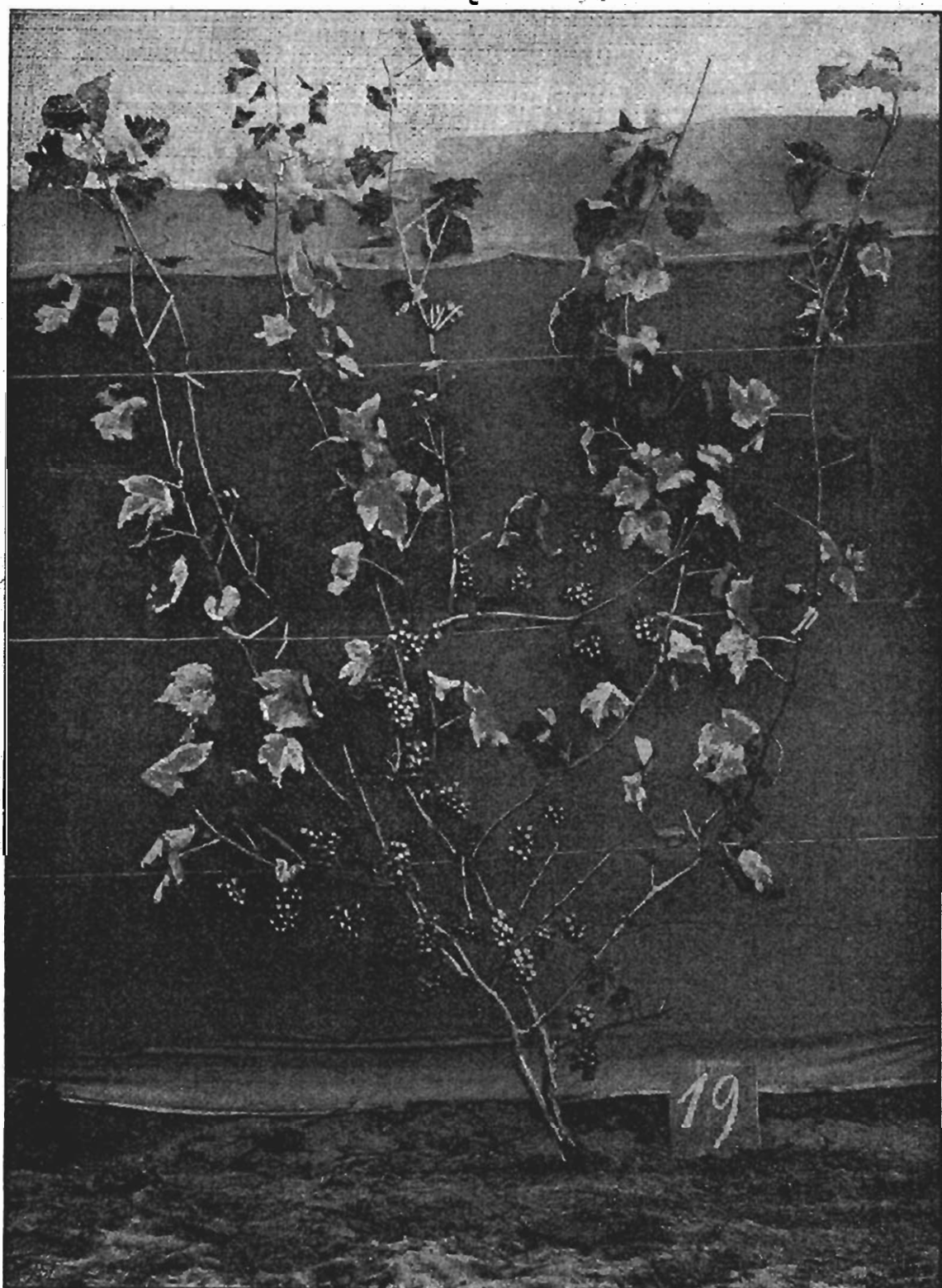
13 bunches = 450 gr.
1 bunch = 34, 6 gr.

14 bunches = 410 gr.
1 bunch = 29, 3 gr.



Unmanured.

34 bunches = 818 gr.
1 bunch = 23, 8 gr.



Manured, beside green manuring, per acre			
1893	—	1894	— 1895
with —		320	240 lbs. Thomas phosphate.
768 lbs.		—	— oil cake.
—		192	192 lbs. sulphate of ammonia.
33 bunches	=	830 gr.	} Poor result for want of potash.
1 bunch	=	23, 2 gr.	

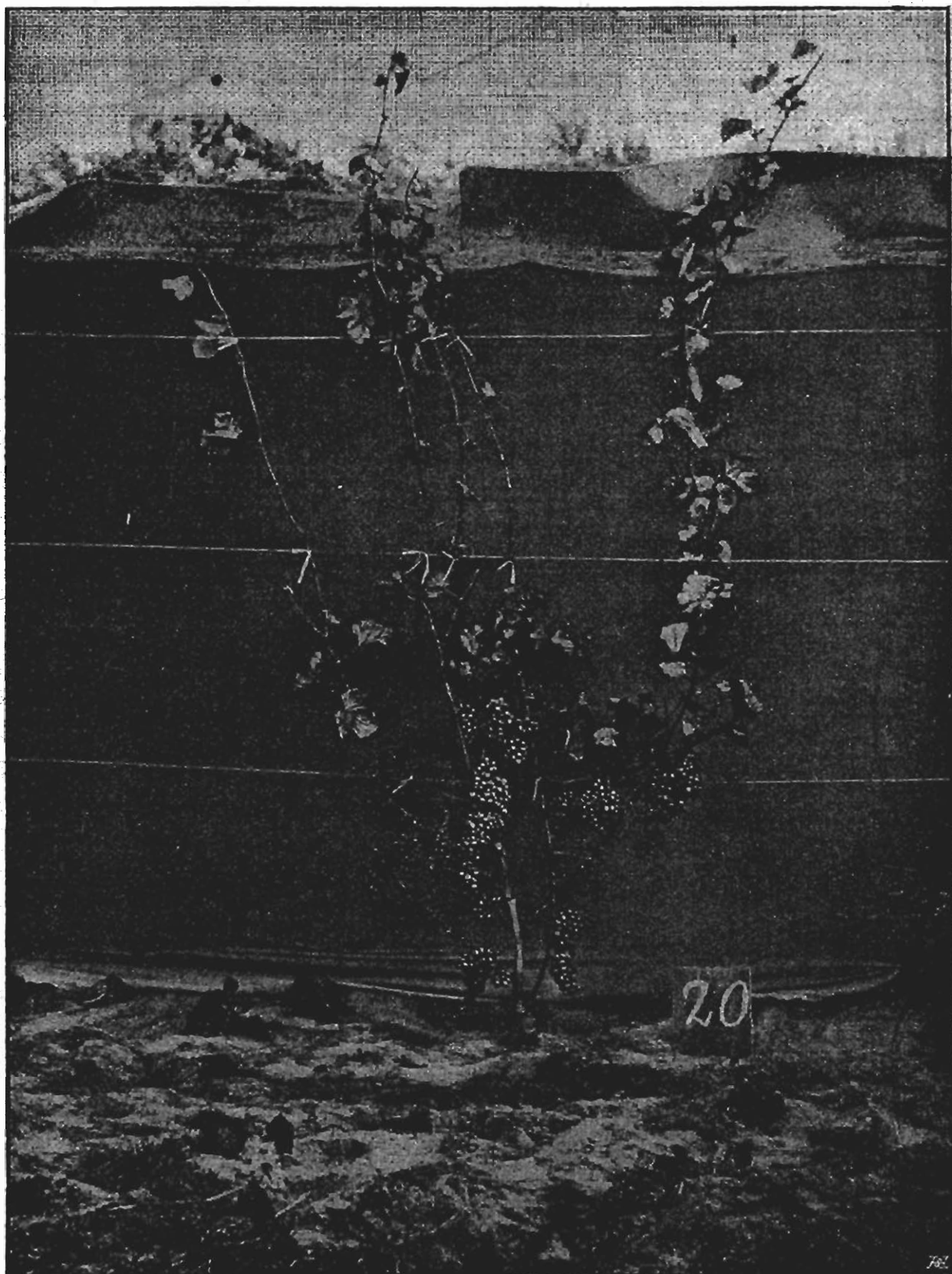
LIEBFRAUENTHAL, 1896.

[No. 6

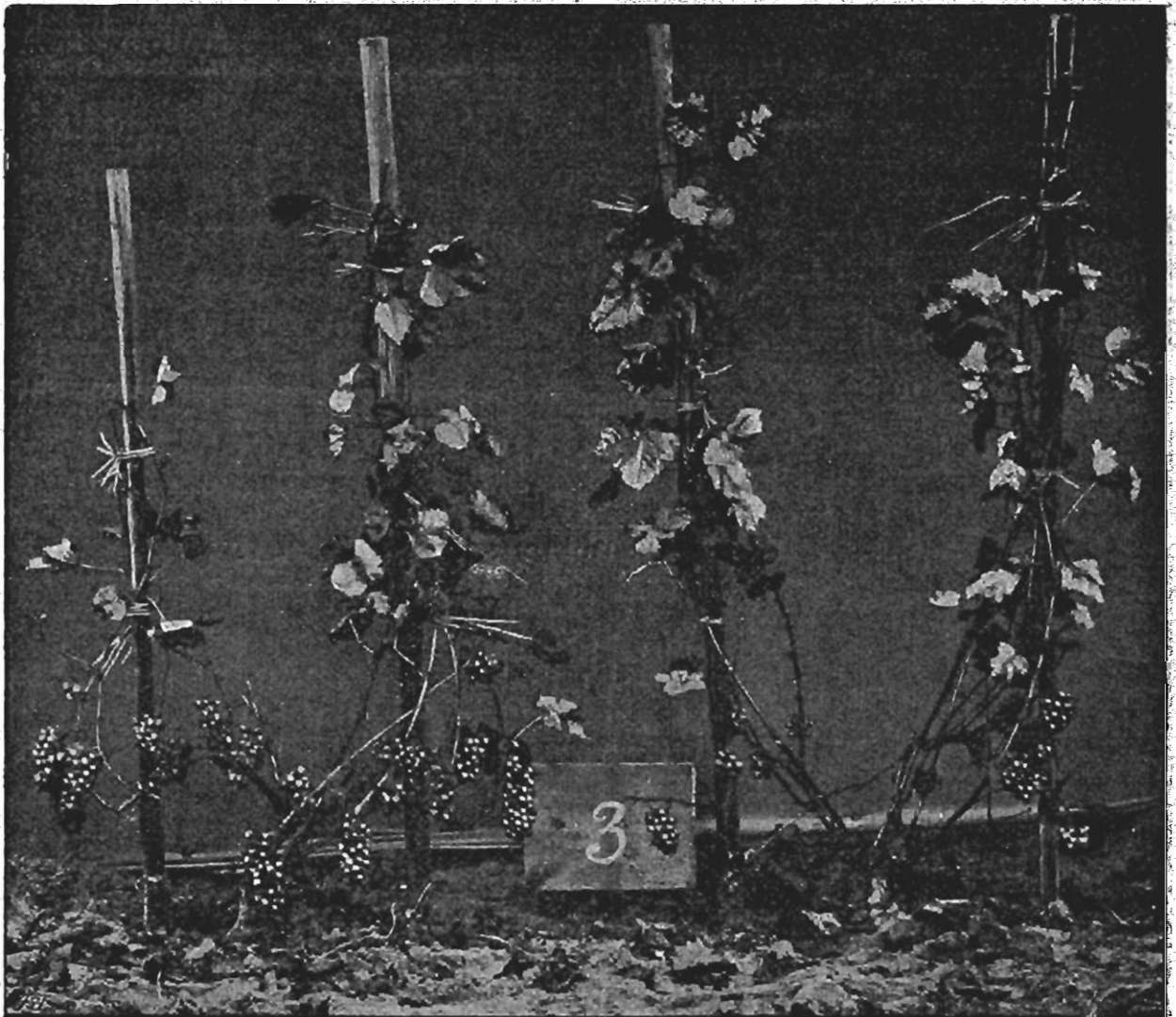
Very light sandy soil.



Manured in 1893 — 1894 —	295	per acre with
768 lbs.	—	of oilcake.
—	240	lbs. of nitrate of soda.
—	320	lbs. of Thomas phosphate.
19 bunches	= 820 gr.	18 bunches = 630 gr.
1 bunch	= 43, 2 gr.	1 bunch = 35, 0 gr.
Poor result for want of potash.		



Manured in	1893	—	1894	—	1895 and green manuring
per acre with	400		200		200 lbs. of muriate of potash.
	—		192		192 lbs. of sulphate of ammonia.
Result	22 bunches = 760 gr. (on wires)				} Poor result without phosphoric acid.
in 1896	1 bunch = 34, 5 gr.				



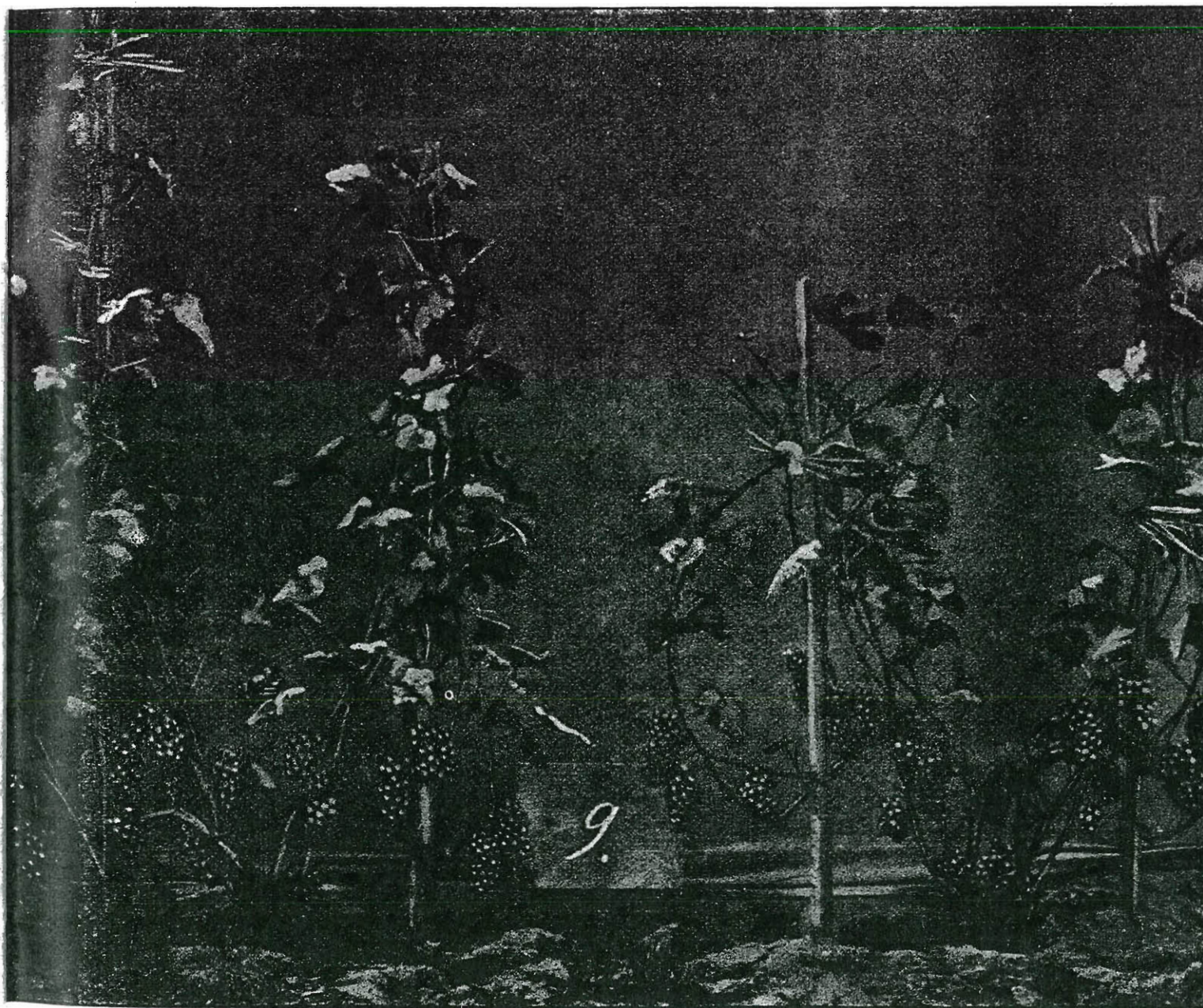
Manured in 1893	— 1894	— 1895
per acre with 1,600	800	800 lbs. of kainit.
—	320	240 lbs of Thomas phosphate.

15 bunches = 580 gr.
 bunch = 38, 7 gr.

22 bunches = 1,030 gr.
 1 bunch = 46, 8 gr.

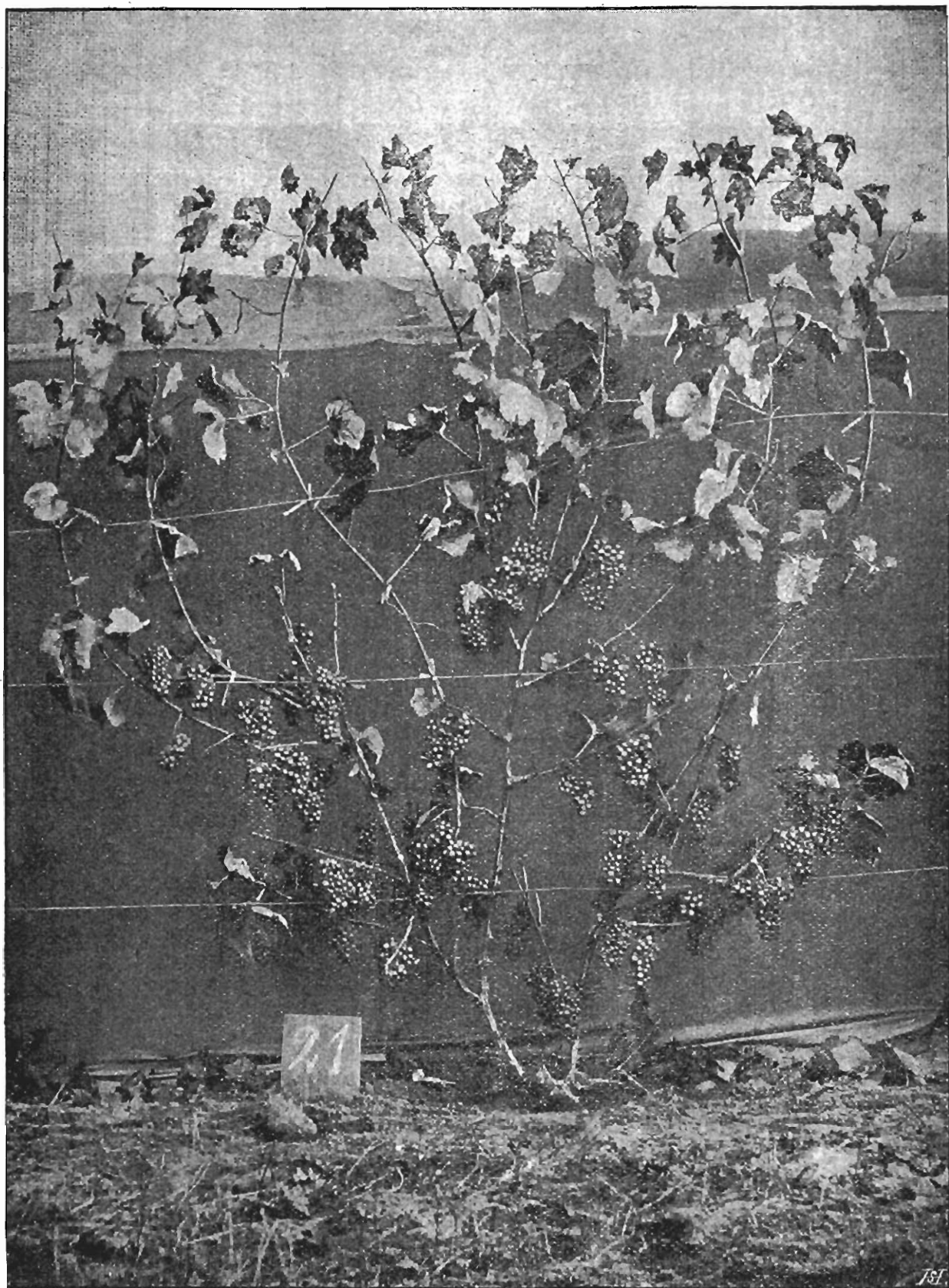
Poor result without nitrogen.

Very light sandy soil



1895

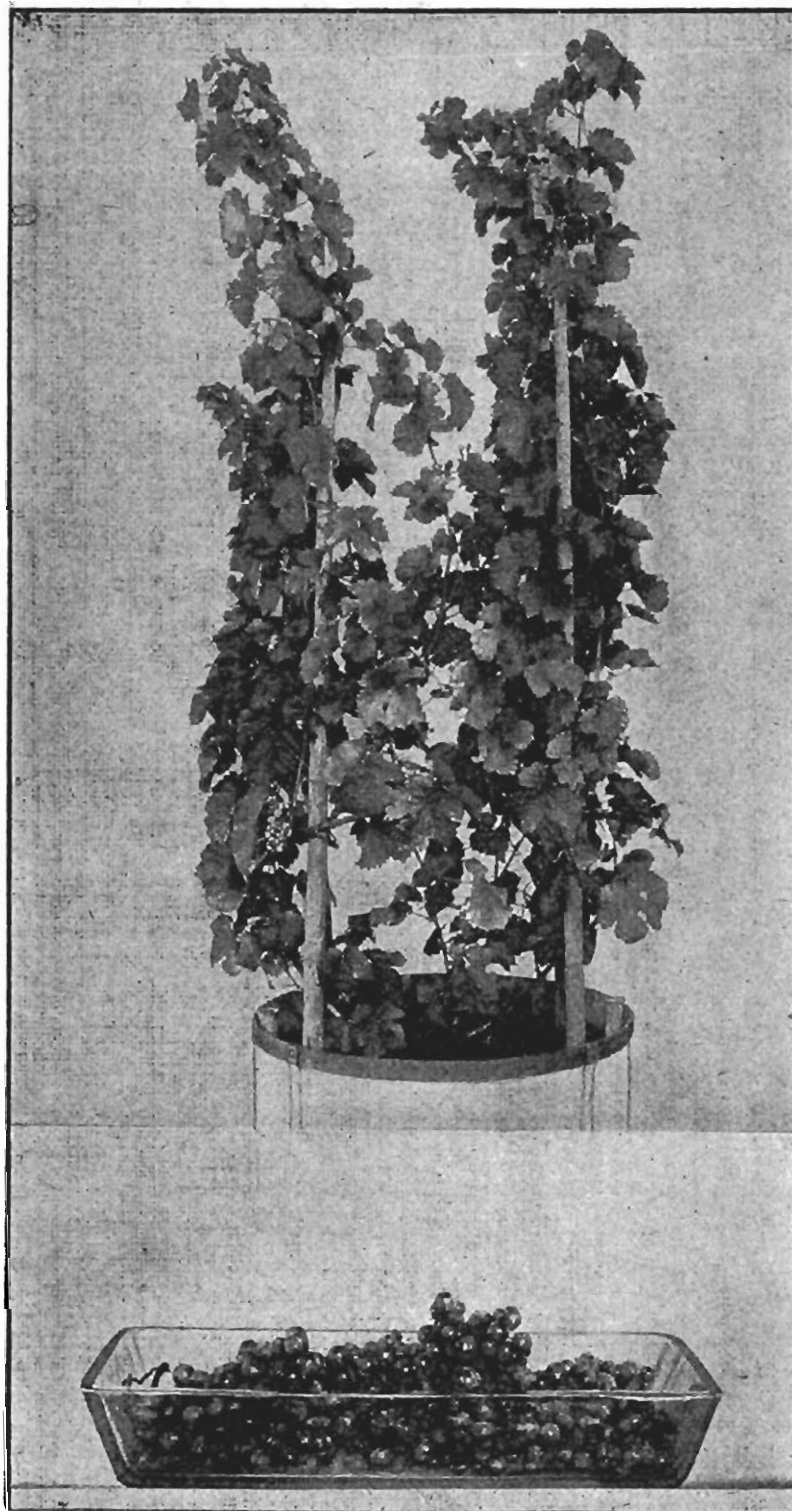
Manured in 1893	—	1894	—	1895	per acre with
—		320		243 lbs. of Thomas phosphate.	
768 lbs.		—		— of oil cake.	
—		240		240 lbs. of nitrate of soda.	
800 lbs.		400		400 lbs. of kainit.	
Result—26 bunches	=	1,840 gr.		24 bunches	= 1,920 gr.
1 bunch	=	70, 8 gr.		1 bunch	= 80 gr.



Manured	1893	—	1894	—	1895	after green manuring with
per	400		200		200 lbs. muriate of potash.	
acre	240		—		240 lbs. nitrate of soda,	
	—		320		240 lbs. Thomas phosphate.	
			58 bunches	=	3,850 gr.	
			1 bunch	=	66, 4 gr.	

[No. 11]

PROF. DR. WAGNER'S EXPERIMENTS WITH RIESLING IN POTS.

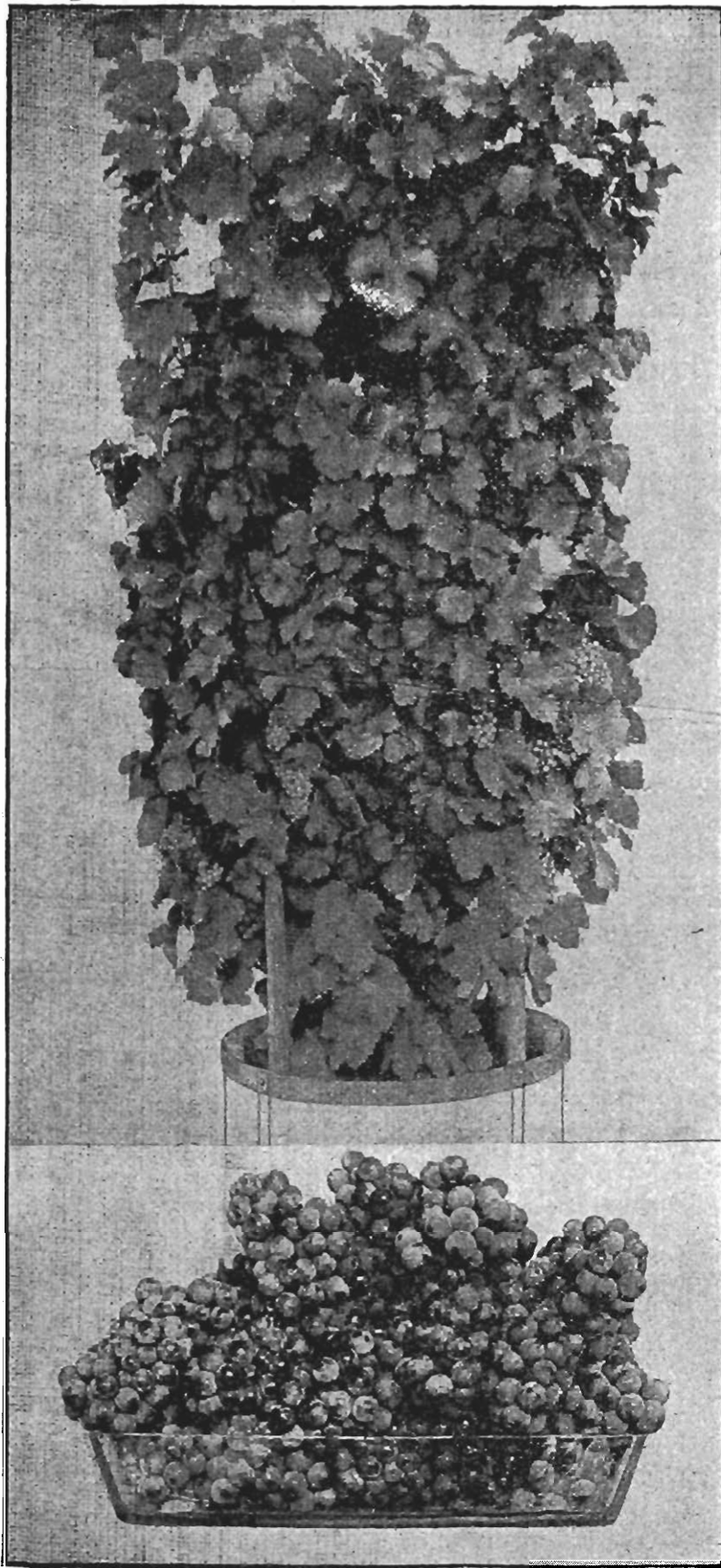


Unmanured.

Result in 1897—0,513 kilog. of grapes.

[No. 12]

PROF. DR. WAGNER'S EXPERIMENTS WITH RIESLING IN POTS.



Manured with phosphoric acid, potash, and nitrogen.
Result in 1897—2,470 kilog. of grapes.