Grape or Grapevine *(Vitis vinifera L.)*

French: Vigne; Spanish: Vid, viña; Italian: Vite; German: Weinrebe

Most cultivated grapevines are of the species Vitis vinifera L.; a very small area is devoted to V.rotundifolia (Muscadines), V.labrusca (Concord) and interspecific hybrids. In most situations, V.vinifera varieties must be grafted onto Phylloxera-resistant rootstocks derived from species of American origin.

Crop data

Perennial. Harvested part: fruits.

Plant density: 1 000-10 000 vines per hectare.

Vineyards occupy 10 million hectares worldwide. They are located on various soils in zones with a Mediterranean, temperate or sub-tropical climate. The yield varies greatly (5-35 t/ha/year) depending on site, cultural conditions and end-use (fine wine, ordinary wine or table grapes). Preoccupation with quality often leads growers to limit vigour and yield.

Nutrient demand/uptake/removal

Mineral nutrient uptake depends on variety, rootstock, yield, soil, climate, etc. Total annual uptake in stems, leaves and fruit varies within the following ranges for a yield of 7-25 t/ha :

Nutrient demand/uptake/removal - Macronutrients					
Yield t/ha	kg/ha/year				
	N	P2O5	K2O	MgO	CaO
7 - 25	22-84	5-35	41-148	6-25	28-204

Nutrient demand/uptake/removal - Micronutrients					
Yield t/ha	**g/ha/year**				
	Fe	**B**	**Mn**	**Zn**	**Cu**
7 - 25	292-1 121	37-228	49-787	110-585	64-910
Source: Fregoni, 1984					

Stems and leaves, which are re-incorporated in the soil, account for about 70 % of the N uptake, and 60 % of the P2O5 and K2O, so the net removal in the harvest is clearly much smaller.

Plant analysis data

The method of foliar diagnosis for grapevines was developed at Montpellier, France, in about 1930. Since that date much information on the mineral composition of the leaf organs has been published throughout the world, but, because of the many factors involved, it is difficult to compare data from different sources.

Plant analysis data (normal growth) - Macronutrients								
Species or variety*	**Tissue samples**	**Sampling Time**	**Source**	**%o of dry matter**				
				N	**P**	**K**	**Mg**	**Ca**
L (Concord)	Petiole	July-August	Larson et al, 1956	8.2	2.0	20.1	4.4	17.5

L (Concord)	Petiole	July-August	Beattie Forhey, 1954	7.7	1.4	20.0	1.5	7.0
L (Concord)	Petiole	August-September	Shaulis & Kimball, 1956	17.0-34.0**	1.0-3.0	4.0-20.0	1.8-15.0	10.0-17.0
L-FH	Petiole	July	Bryant et al, 1956	8.9-13.8	1.2-4.1	20.5-53.1	1.7-5.6	11.8-20.6
L-FH	Petiole	August-September	Styles & Oberle, 1984	18.0-22.0**	0.8-3.0	11.0-20.0	2.5-5.0	7.5-17.0
L-FH	Petiole	Ripening	Parsons & Eaton, 1950	5.2-11.1	1.1-6.4	12.0-41.0	2.2-5.3	7.2-16.9
V	Blade	-	Shikhamany & Satyanarayana, 1971	-	1.9	6.5	3.3	8.0
L-FH	Petiole	July-August	Cahoon, 1980	9.0-13.0	1.6-3.0	15.0-25.0	2.6-4.5	10.0-18.0
V	Petiole	Bloom	Christensen et al., 1978	-	$\geq$1.2	8.0-15.0	$\geq$3.0	-
V	Leaves	-	Saini & Singh, 1975	25.0-27.0	2.0-2.3	13.0-15.0	-	23.0-25.0
V	Petiole	Ripening	Ryser, 1983	21.2-24.6	1.7-1.9	16.3-18.9	2.2-2.6	23.8-27.6
L-FH	Petiole	August-September	Cline, 1983	7.0-8.9	-	16.0-21.9	9.0-14.9	15.0-25.0
* L = V. labrusca, V = V. vinifera, FH = French hybrid. ** Bloom sample date Source: Cahoon, 1985								

Petiole analysis interpretation chart. Sampling time berry ripening (* dry matter basis)	
N > 6 %o*	normal N nutrition
P > 1.5 %o*	normal P nutrition
K/Mg < 1	K deficiency
K/Mg > 10	Mg deficiency
K/mg 2 to 8	normal K and Mg nutrition
B < 15 ppm*	boron deficiency
Source: Delas, 1990	

At present, foliar analysis is used to diagnose nutritional problems (deficiencies, imbalances and toxicities) and for adjusting fertilizer recommendations. Even if foliar analysis cannot be used directly to determine the amounts of fertilizer needed, it permits adaptation of fertilizer practices in relation to production objectives, provided results are interpreted in the light of regional norms for soil, climate, variety, rootstock and tillage practices.

The effects of plant nutrients on quality also need to be understood. Too much N, for example, can cause a reduction in the colour components of the fruit, and therefore of the wine, and can increase susceptibility to Botrytis cinerea, the causal agent of grey rot. Similarly, an excess of K can reduce the acidity of the berries and of the must, which can adversely affect the quality of the wine. Too much K can also increase susceptibility to "Stiellaehme" and induce Mg deficiency by antagonism between K and Mg.

Also, some nutrient elements may be provided in fungicides, e.g. S, used against Oidium; Cu in Bordeaux mixture : Mn and Zn as dithiocarbamates used against mildew.

Fertilizer recommendations

Before planting. The purpose of deep manuring is to provide minerals (P_2O_5, K_2O, MgO) which are not very mobile and to correct e.g. high acidity (which can induce Al or Cu toxicity) or low organic matter content. Depending on analysis of the soil and sub-soil, the amounts to be applied lie within the ranges: 0-600 kg/ha P_2O_5, 0-1 000 kg/ha K_2O, 0-300 kg/ha MgO, liming (where pH is below 6) at 2 000-10 000 kg/ha CaO, and 0-100 t/ha farmyard manure or equivalent.

Annual maintenance. For fine wine vineyards yielding less than 10 t/ha: 0-40 kg/ha N, 20-50 kg/ha P_2O_5, 60-100 kg/ha K_2O. For other vineyards : 60-120 kg/ha N (more if irrigated), 20-50 kg/ha P_2O_5, 100-150 kg/ha K_2O. In general, N is applied as an overall dressing in late winter or in spring. On clay soils with dry climates, P_2O_5 and K_2O are worked into the soil during the winter dormant period; on light soils with a wet climate, they may be topdressed together with the N.

Foliar application (usually of K, Mg, B or Fe) may be given in cases of deficiency.

Preferred nutrient forms

The grapevine is not very demanding in this respect.

As a source of K, the sulphate form is no more favourable to quality than the chloride form. However, the sulphate should preferably be used on saline soils or for heavy applications, e.g. 500-1 000 kg/ha K_2O.

In vineyards producing fine wine, organic amendments low in N (pine bark, peat, etc.) are preferred in order not to affect quality.

Fertilizer practices

There is very wide variation in current fertilizer practice. Within the same region, practice varies from vineyard to vineyard and from year to year, from no fertilizer at all to amounts well in excess of actual need. This situation is explained by the plant's low requirement, the slowness of diffusion of nutrient elements in the soil and fluctuations in economic conditions, but it represents a risk to the quality of production which may be threatened by nutrient deficiency, excess or imbalance. Rational fertilizer recommendations still need to be worked out, which must take into account basic knowledge of the soil and the needs of the plant together with the results of foliar analysis.

Further reading

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