The role of variety as genetic potential in nutrient utilization

J. ANDRÉ and E. HAJDU

Research Institute for Viticulture and Oenology, H-6000 Kecskemét, Hungary

Summary: A container model trial was set up on sandy soil with 5 replications to study the nutrient regime of 16 wine grape varieties in a 10 year program starting in 1982 at Kecskemét-Miklóstelep in the Institute for Viticulture and Oenology.

Leaf, fruit and wood analysis data and production parameters (fruit and wood weight, frost tolerance) were evaluated every year under identical cultural conditions. Interactions between years, varieties and nutrient elements (N, P, K, Ca, Mg, Zn, B, Fe, Mn) were discussed.

Trials so far have proved the decisive role of variety characters fixed genetically on nutrient uptake and nutrient utilization at given nutrient supply.

Key words: variety of vine, nutrition, mineral, leaf, fruit, wood, yield, must quality, shoot yield, cold resistance.

Introduction

A very important step in breeding is the study of values and production characteristics in a given variety or clone. This study also includes the establishment of the nutrient regime in varieties and clones recommended for production under different conditions (soil, climate, cultivation methods, etc.). For this purpose model container trials were installed in our Institute to test the nutrient regime of 16 wine grape varieties. The trial was planned for 10 years. Observation data of 6 years are presented.

In the test program, the nutrient requirement and utilization ability of different wine grape varieties were determined in sandy soil at different levels of stock nutrient supply.

In the test we wanted to determine:

(i) the effect of different nutrient doses on the nutrient regime of the varieties, on growth, on quality and quantity of cluster yield, on wood ripening and on winter tolerance of buds,

(ii) the role of variety as genetical potential in the rate and quantity of nutrient uptake,

(iii) the effect of fertilizer doses as recommended for a variety in a given production area considering aspects of environmental protection.

Material and methods

The trial started in Kecskemét-Miklóstelep in 1982 on a level site. Methods developed by several Hungarian and foreign authors were followed (POLYAK 1968, 1973; PAPP 1971; FÜRI *et al.* 1974; FÜRI and KOZMA 1975; EDELBAUER 1976; MÉREAUX *et al.* 1979; SZŐKE and FÜRI 1980; ARUTJUNJAN 1981).

The closed containers were placed, one close to the other, in a 80 cm deep trench, in an unheated plastic tent. The containers were plastic barrels, 80 cm high with 50 cm diameter. The bottom of the barrel was filled with sifted river ballast 15 cm thick (40 kg/barrel) to receive possible stagnate water. The gravel was covered by a plastic net in two layers. The barrel was filled with soil enriched with nutrients (144 kg sand/barrel) and slightly pressed. The nutrients used as stock supply were homogenized with the soil prior to filling in. No maintenance fertilization was given. In the trials the nutrient uptake of 16 varieties was studied at two soil nutrient levels. The water supply was regulated to complete the winter precipitation and remove the surplus water accumulated at the bottom. The superfluous water was pumped out through a plastic tube placed into the barrel.

The own-rooted vines planted in the barrels were rooted in hoses filled with perlite. High cordon training was used with 3 short spurs of 2 buds. Stocks were covered with straw to protect them from winter frosts and the plastic tent was also covered by a plastic film at the end of the growing period (ANDRÉ 1986).

The order of the 16 varieties in trial and sand analysis data are presented in Table 1.

Since the beginning of the trial the following values have been measured continuously:

- Foliage mass
- Topped green weight
- Cluster yield, cluster number, mean cluster yield
- Sugar content and acidity of berries
- Water quantity accumulated at the bottom of the barrel
- Weight of pruned woods
- Frost tolerance of wood in heat chambers.

Every quantitative measurement was completed with an analysis of the sample. Changes in the nutrient uptake were followed by leaf analysis 4 times in the growing period. Yield and wood analysis were performed from the 3rd year.

Table 1: Trial characteristics

STUDIED VARIETIES:

K - 9	F. Kadarka
Medina	Rheinriesling
Chardonnay	RF-48
Ezerfürtü	Jubileum 75
Zweigelt	Blaufränkisch Tf.
Steinschiller	Zengő
Zalagyöngye	M 7
Sztyepnyak	Kunleány

SOIL TYPE: calcareous sandy soil of slight humus content of 0 - 1,0 m depth.

SOIL ANALYSIS RESULTS		TRIAL SOIL NUTRIENT LEVELS	
		LOW	HIGH
pH	8,1 (KCL)		
KA	25		
$CaCO_3$ %	4-5		
H %	0,44-0,50		
Total salt	0		
AL P_2O_5 ppm	86	100	200
AL K_2O ppm	70	150	300
Mg KCl ppm	25	80	150

Results

The role of variety as genetical potential in the nutrient uptake

The measurement and analysis data accumulated in the 6 years (1982-1987) can be evaluated from several points of view. In this case the role of variety was studied as genetical potential in nutrient uptake.

An increase of the nutrient supply caused considerable differences in the uptake, in the mean of the 16 varieties (Table 2). Differences varied in varieties, plant parts and nutrient elements as well. Within one variety, however, even extreme differences did not surpass 76 % between the two treatments (low and high). The low nutrient level served as reference. If, however, the analysis data of the plant parts (leaf, fruit, wood), of the 16 varieties were compared within identical treatments of the varieties, almost 300 % difference was found.

Table 2 shows that the variety plays a decisive role in the nutrient uptake of the plant. Considering any of the 3 plant parts (leaf, fruit, wood), it is clear that doubling the nutrient supply resulted in a 20-50 % mean surplus uptake (maximum 76 %), compared to the low nutrient level. At identical nutrient supply, uptake differences varied between 50-70 % in the average, with 300 % maximum among varieties. The difference can be caused by the different nutrient requirement and different nutrient utilization ability of the varieties fixed in the genotype.

Fig. 1 shows in detail the analysis values of magnesium. Considering the nutrient elements, it can be said that uptake differences among varieties (fixed genetically) were twice as high (in certain elements even more) as obtained by doubling the nutrient supply.

Table 2: Treatments and highest nutrient differences among varieties

NUTRIENTS	HIGHEST NUTRIENT CONTENT DIFFERENCES								
	AMONG TREATMENTS WITHIN THE SAME VARIETY			AMONG VARIETIES					
				LOW			HIGH		
	EXTREME VALUES ± %								
	NUTRIENT EFFECT			VARIETY EFFECT					
	1.	2.	3.	1.	2.	3.	1.	2.	3.
N	11	40	13	20	97	25	20	63	20
P	76	50	50	62	91	30	117	54	50
K	37	25	36	53	43	49	51	30	60
Ca	-32	-24	-25	93	68	57	79	122	69
Mg	50	35	36	123	54	64	104	38	29
Zn	25	-36	36	48	80	63	41	67	110
B	38	210	17	69	57	33	71	288	45
Fe	49	50	46	50	109	110	53	103	138
Mn	14	-20	-29	72	56	73	84	44	61

Legend: 1. Leaf analysis 2. Fruit analysis 3. Wood analysis

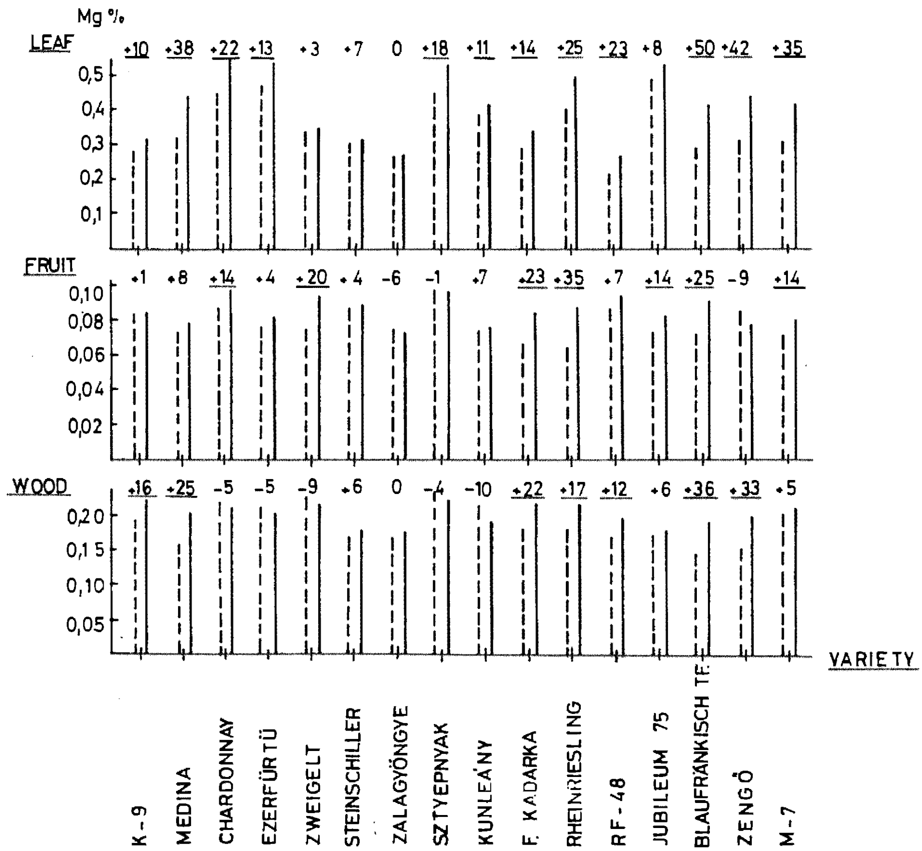

Fig. 1: Average results of magnesium analysis over 6 years (1982-1987).

The role of variety in the nutrient uptake during the growing period

At identical nutrient supply and bud loading, there were significant differences among varieties in the rate of nutrient uptake during the growing period (Fig. 2). The difference among varieties was also expressed in the nutrient elements. In the figure, P, K, Mg uptake rates of varieties with extreme values are shown. When changing the nutrient supply, the difference in uptake among varieties was modified but not eliminated. There was a change in the uptake curve of varieties in the different years as well, probably explained by different climatic factors (precipitation, temperature, light).

These yearly differences are important in a variety at identical nutrient supply with given nutrient elements. In the mean of several years the same variety indicates an uptake trend characteristic of the variety at identical nutrient supply.

It can be concluded that at identical nutrient supply and bud loading the nutrient uptake rate of a variety is regulated by its genetical properties. The rate can be modified by year effects but genotype effects can not be eliminated.

Differences in the nutrient uptake and supply of varieties during the growing period and in certain elements affect the whole life of the plant and its production value. Data obtained so far do not yet allow the determination of these effects precisely.

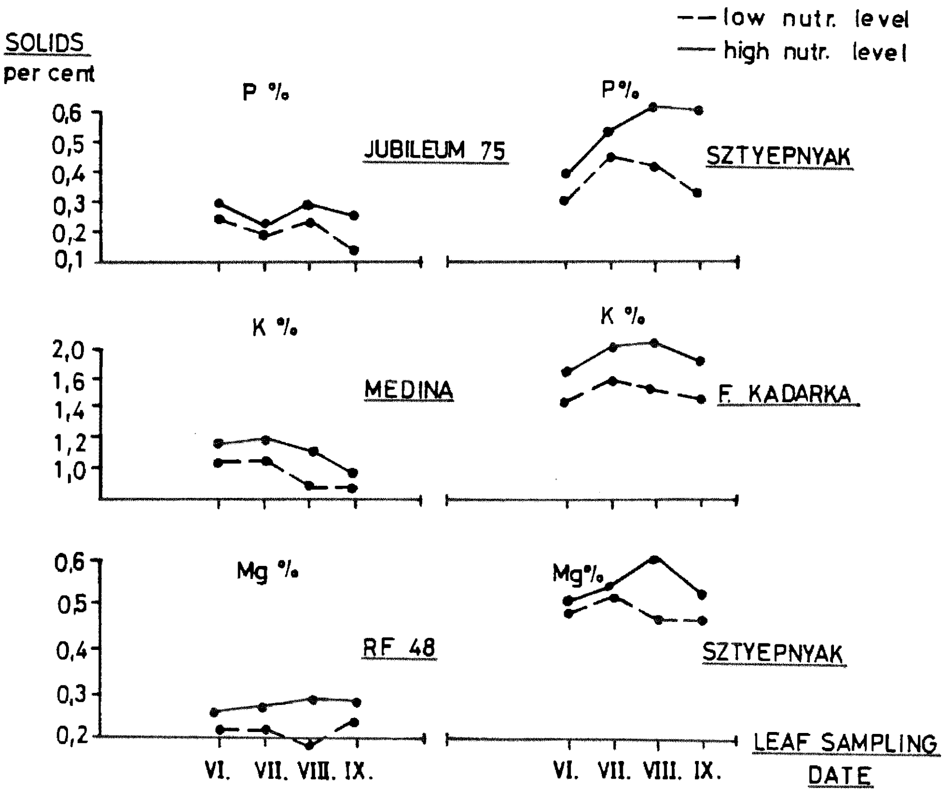

Fig. 2: The effect of variety on nutrient uptake during the growing period based on leaf analysis.

The considerable differences among varieties in the tested parameters despite identical nutrient supply and production conditions can be explained by the different nutrient content - which is specific for the variety - within the growing period.

The role of variety in green, fruit and wood weight, in sugar content and acidity and in frost tolerance of buds

Results show clearly the importance of varieties in the nutrient uptake at identical nutrient supply. This observation is only affirmed by the remarkable variety effect on the studied plant parts (Table 3). While at the double nutrient supply the highest difference produced 3.5 fold surplus (which is very high), the difference due to different genetical properties was much more high, 11 fold.

There is no variety with the same difference at every elements in identical treatments. That is, in the 9 elements tested the nutrient supply can be superior or inferior to the average. So, if we take Liebig's rule strict, the notion of general nutrient supply and the variety classing following the rule may seem rather artificial.

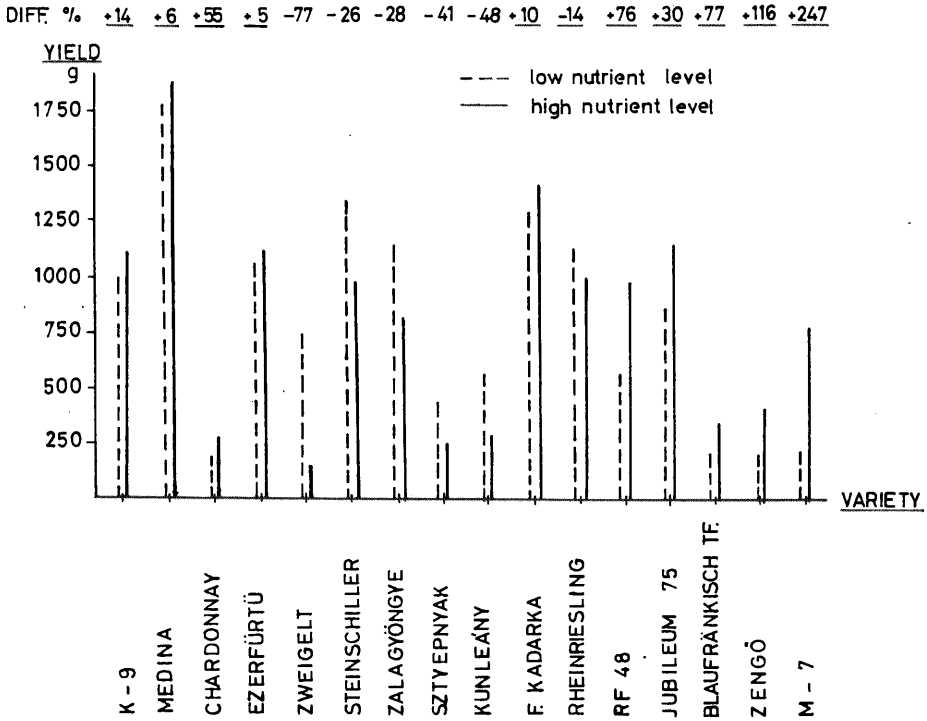

Fig. 3: Mean yield over years 1984-1987 as g/variety (5 vines).

Fig. 3 represents the cluster yield in the 16 varieties at two nutrient levels. If variety reactions to nutrient supply changes are evaluated according to the results obtained in production parameters (see Table 3) and we try to draw conclusions as to the different nutrient requirements and utilization of varieties, we receive quite different results from those of analysis evaluations.

The mean nutrient uptake surplus in a variety proved by analysis does not necessarily coincide with a general increase in the majority of production parameters. It can be stated that in the case of vine the nutrient requirement, nutrient uptake and utilization can only be spoken of as related to a concrete variety or element. Thus, it is very important to know exactly the production value and within it, the nutrient regime of a variety.

Literature

ANDRÉ, J.; 1986: A szölö tápanyagháztartásának vizsgálata homok és lösztalajon, modellkisérletben I. Szölötermesztés és Borászat 8 (3), 22-26.

ARUTJUNJAN, SZ. SZ.; 1981: Szoderzsanie azota, foszfora i kalija v. organah vinograda v. szvjazi sz mineralnüm pitaniem lozü. Biol. Zh. Arm. Erevan 34 (8), 861-866.

EDELBAUER, A.; 1976: 4e Colloque International sur le Contrôle de l'Alimentation des Plantes Cultivées, Gent, 293-301.

FÜRI, J.; KATONA, J.; KOZMA, F.; 1974: A szölö öntözésének és vízháztartásának vizsgálata. Jubileumi Tudományos Napok. Budapest. SZBKI Közleményei, 201-220.

Table 3: The highest differences measured (%) for the studied characters among treatments and varieties

MEASURED PARAMETERS	AMONG TREATMENTS WITHIN THE SAME VARIETY	AMONG VARIETIES AT LOW NUTRIENT LEVEL	AMONG VARIETIES AT HIGH NUTRIENT LEVEL
	NUTRIENT EFFECT	VARIETY EFFECT	
GREEN WEIGHT g	230	913	518
WOOD WEIGHT g	127	182	187
FRUIT WEIGHT g	[347]	1000	[1097]
CLUSTER NUMBER	262	660	425
MEAN CLUSTER WEIGHT g	186	664	429
MUST SUGAR Mm°	-10	128	118
MUST ACIDITY ‰	-16	187	187
FROST TOLERANCE %	240	650	420

-- ; KOZMA, F.; 1975: A szölö evapotranszspirációja. Idöjárás. OMSZ. Kiadványa **79** (2), 112-120.

KOZMA, P.; POLYAK, D.; 1968: Tenyészedények a szölészeti kutatásban. Kert. és Szöl. Föiskola Közleményei **32** (1), 123-135.

-- --; -- --; 1973: A szölö ásványi anyagellátottsága, produktivitása és a levélanalízis adatai köz ötti összefüggés. A Kert. Egy. Közleménye **37** (5), 89-103.

MÉREAUX, S.; ROLLIN, H.; RUTTEN, P.; 1979: Effets de la sécheresse sur la vigne. 1. Etudes sur Cabernet Sauvignon. Ann. Agron. **30**, 553-575.

PAPP, J.; 1971: A málna tápanyagigényének vizsgálata. A Kert. Egy. Közleményei **35** (3), 177-187.

SZÖKE, L.; FÜRI, J.; 1980: Tenyészedényes módszer a szölö ásványi táplálkozásának tanulmányozására. Szölötermesztés **3** (2), 1-4.