Research on Nutrients Uptake and Accumulation in Grape vine

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Abstract
To find out the nutrient absorption, utilization and accumulation in grape vines, and to identify reasonable fertilizer rates and application periods, field experiments were conducted analyzing yearly biomass, nutrient contents and accumulation in different parts of grape vines (red globe) which were cultivated for about 7 years. The results show that total nitrogen absorption rate is 97.13 kg/ha in one year of the growing period. 39 % of that is absorbed during the new shoots flourishing period, and 30.5 % is uptaken during the fruit growing period. A total of 33.1 kg/ha potassium was absorbed in a year, about 3.1 kg/ha absorbed by leaves, and 11.9 kg/ha by fruits. Of 33.1 kg/ha phosphorus absorbed, 15.4 kg/ha was absorbed during the fruit growing period, being about 47 % of total uptake. A total of 140.52 kg/ha phosphorus was absorbed in a year, about 38.59 kg/ha absorbed during the new shoots flourishing period, and 64.29 kg/ha during the fruit growing period, representing 27.5% and 45.8% of the total uptake. The initial recommendation for N, P_2O_5, and K_2O applications required to offset nutrient removal within the orchard would be 129.5 kg/ha, 55.1 kg/ha and 175.6 kg/ha, respectively.

Key Words
Red globe grape vine, nitrogen, potassium, phosphorus, absorption, accumulation.

Introduction
Mineral nutrient elements such as nitrogen, phosphorus and potassium have important impact on the yield and quality of red-globe grape production in northwest China. The previous study has focused on this relationship, but little information is available on plant uptake, translocation, and distribution of N, P_2O_5, K_2O in grape vines. This article outlines a comprehensive study on the dynamics of N, P, K uptake and distribution within RED-GLOBE grape vines.

Methods
A trial was conducted in Fufeng County, on the Guanzhong of Shaanxi Province. The orchard was comprised of 7-year old red-globe grape vines with a row spacing of 1 m and 2.5 m between vines. The trial was carried out in 2006. Samples were taken from three vines at similar stages of development on six dates. Sampling took place on March 30 (sprouting and foliage growing period), May 10 (young fruit stage), June 30 (new shoots flourishing), August 20 (fruit expansion stage), September 30 (fruit maturity), and on November 30 (tree dormancy). Samples of fruit, foliage, new tops, branches, trunks, and roots were collected each time. Root samples included all those within a 100 cm depth and a radius of 50 cm around the trunk. The cortex and xylem within the trunks and roots were divided and analyzed separately. Enzymatic activity was destroyed by placing plant parts in an oven set at 100 to 105℃ for 15 minutes, and then samples were dried to a constant weight at 70 to 80℃. Samples were ground and digested with concentrated sulfuric acid (H_2SO_4) and hydrogen peroxide (H_2O_2). The N content of the resulting solution was measured by flow injection analyzer, P content was measured colorimetrically, and K content was measured by flame photometer.

Equations
Nutrient accumulation(kg/ha)=nutrient content(g/kg)×organ biomass(kg per plant) ×plant per ha；
Nutrient absorption by new organs (leaves, new shoots, fruits) =nutrient accumulation calculated by the last sampling;
Nutrient absorption by old organs (branches, stem, roots) = nutrient accumulation calculated by the last sampling－nutrient accumulation calculated by the first sampling;
Total nutrient absorption= nutrient absorption by new organs+ nutrient absorption by old organs.

Results
The results of the study showed a sharp increase in biomass from the early growth period in May to fruit

maturity and harvest in September (Figure 1). Vine growth after this period slowed significantly, and biomass decreased because of defoliation and fruit picking. The biomass change of roots was not significant. In the main growing period, the biomass of roots fluctuated between 2303-4132 kg/ha, the net increase was 1830 kg/ha, about 14.8% of the gross.

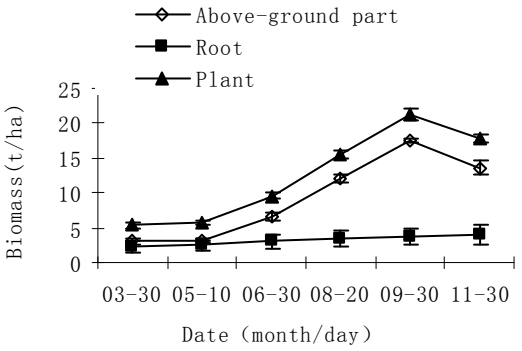

Figure 1. Annual changes of biomass

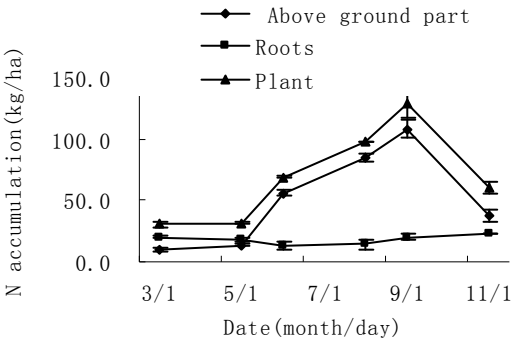

Figure 2. N accumulation in grape vine

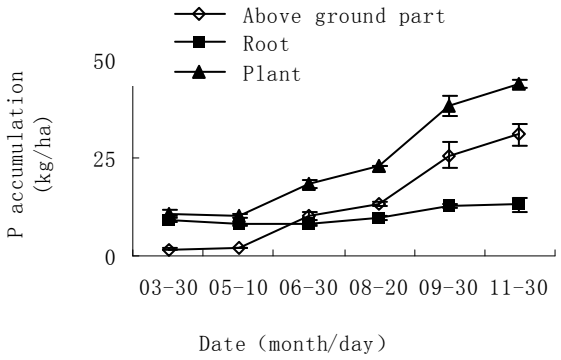

Figure 3. P accumulation in grape vine

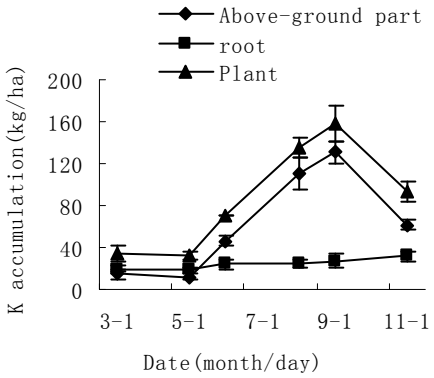

Figure 4. K accumulation in grape vine

Grape vines accumulated an average of 97.13 kg N/ha within the study period, in which N destined for fruit and foliage amounted to 32.72 kg N/ha and 35.09 kg N/ha, respectively (Figure 2). Vines absorbed the majority of N during the new shoots growth being about 39% of the gross. The days between August 20 and September 30 represented the peak period of demand for N. N accumulation after this period decreased significantly because of defoliation and fruit picking. Nitrogen loss should be replaced by fertilization.

A total of 33.1 kg/ha potassium was absorbed by grape vine in a year (Figure 3), in which 3.1 kg/ha absorbed by leaves, 11.9 kg/ha by fruits, and 3.8 kg/ha by roots. The days between August 20 and September 30 represented the peak period of demand for potassium, an average of 15.4 kg/ha potassium was accumulated during this period. Results also showed that grape vines mainly use reserved potassium to construct organs at an early stage, and potassium assignment is diverted along with the shift of growth center.

The total annual net phosphorus accumulation in this grape vine orchard amounted to 140.52 kg/ha (Figure 4), in which 17.24 kg/ha was absorbed by leaves, and 64.29 kg/ha by fruits. Among the new shoot growth period and the fruit growing period, grape vine demand more phosphorus, about 38.59 kg/ha accumulated during the new shoot growth period, and 64.29 kg/ha during the fruit growing period, 27.5% and 45.8% of the total uptake. Two distinct periods of plant K demand were identified, the first beginning in mid-May to June 30, and the second in mid-August to fruit harvest.

Table 1. Nutrient (kg) needed to attain 1000 kg economic yield for grape vine

Cultivars	Tree age	Nutrient needed to attain 1000 kg yield		
		N	P_2O_5	K_2O
RED-GLOBE	7	4.05	1.84	7.8
Ju Feng	6	3.91	2.31	5.26
Cabernet Sauvignon	5	5.95	3.95	7.68

To attain 1000 kg economic yield, the grape vine should uptake nitrogen 4.05 kg, potassium 1.84 kg, phosphorus 7.8 kg (Table 1). This agrees with previous results, but is a little different because of tree age, cultivars, etc. Ju-Feng should uptake nitrogen 3.91 kg, potassium 2.31 kg, phosphorus 5.26 kg, and Cabernet Sauvignon need 5.95 kg, 3.95 kg and 7.68 kg, respectively.

Conclusion

It is difficult to quantify the fertilizer recommendation for grape orchards by soil testing and it is recommended to construct and monitor the nutrient balance in order to properly compensate for annual grape harvest and the amount of nutrient removed by fruits and leaves. Without considering nutrient supplied by soil, the initial recommendation for N, P_2O_5, and K_2O application required to offset its removal within the orchard would be 129.5 kg/ha, 55.1 kg/ha and 175.6 kg/ha, respectively. Results from this study indicate that approximately 39.4 kg N/ha should be applied basally in the autumn after fruit harvest and the remaining 50.7 kg N/ha and 39.4 kg N/ha should be applied prior to new shoots flourishing and fruit expansion, respectively. Approximately 29.2 kg P_2O_5/ha should be applied basally in the autumn after fruit harvest and the remaining 25.9 kg P_2O_5/ha should be applied prior to fruit expansion. Approximately 46.9 kg K_2O/ha should be applied basally in the autumn after fruit harvest and the remaining 48.3 and 80.4 kg K_2O/ha should be applied prior to new shoot growth and fruit expansion, respectively.

References

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