Effects of soil testing and Formula Fertilizer on Fruit quality of the *Kyoho* Grape

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Abstract. The effects of soil testing formula fertilizer on fruit quality of the *Kyoho* grape was studied by using 4-year-old *Kyoho* grape as the test material. The results showed that, scientific and reasonable formula fertilizer could improve the quality of grape comparing with conventional fertilizer, evidently increase the single grain weight of fruit and single ear weight of fruit, and also increase the vitamin C content, sugar-acid ratio and solid acid ratio. On the other hand, it could decrease titratable acid content, and slightly increase vertical and horizontal diameters, but had little effect on pericarp color.

1. Materials and Methods

1.1. Experimental materials

1.1.1. Experimental materials Several 4–year-old *Kyoho* grape with similar growth and strong growth was selected as the test materials.

1.1.2. Overview of the research base The experiment conducted at the experimental base of Xinsheng Village, GanlinTown, Leshan City, Sichuan Province from 2017 to 2018. The area belongs to the mid–subtropical monsoon climate, with four distinct seasons, mild climate, abundant rainfall, simultaneous rain and heat, and long frost–free period. The annual average temperature is 16.5–18.0°C, with the annual relative humidity being 82%, the annual average being 308d, and the annual average sunshine is 1293.6h. The fertility conditions of the test sites were conditions. The rain–proof cultivation method is adopted to cover the sky and the mulch film, and the conventional management is used for soil, fertilizer, water management, and pest control.

1.1.3. The fertilizer (see Table 1)

Table 1. The proportion of each composition of fertilizers

| Fertilizers          | Nitrogen (N%) | Phosphorus (P205%) | Potassium (K2O%) | Organic matter (%) |
|----------------------|---------------|--------------------|------------------|-------------------|
| Urea                 | 46            | 0                  | 0                | 0                 |
| Monoammonium phosphate | 12          | 46                 | 0                | 0                 |
| Potassium sulfate    | 0             | 0                  | 0                | 0                 |
| Dried chicken manure | 4.4           | 1.4                | 2.0              | 42                |
| Superphosphate       | 0             | 12                 | 0                | 0                 |
1.2. Experimental methods

1.2.1. Determination of soil background value Remove the ground vegetation and the soil cover, and collect the depth of the topsoil by 0–60 cm by "five-point sampling method". The soil sample, after mixing, select 1kg of soil sample by "quadruple method", dry, pulverized and sieve, measure pH value of soil with PH acid meter (potential method), measure soil organic matter content by potassium dichromate volumetric method[1], using the BEHRINGER SK500 Soil Nutrient Analyser to analyse the content of available nitrogen, phosphorus and potassium, and obtain the basic nutrient content of the test site soil (see Table 2).

| Test site       | PH   | Organic matter /% | Available nitrogen / (mg/kg) |
|-----------------|------|-------------------|----------------------------|
| Giant peak      | 6.13 | 3.11              | 112.73.                    |

1.2.2. Experimental design Kyoho grape test program (see Table 3): By using the orthogonal design scheme, 9 formula fertilization treatments were set up (local conventional fertilization treatment as a control). Calculated in 2000kg per mu, ammonium phosphate has three grades: 30kg, 35kg and 40kg, urea 50kg, 55kg and 60kg, and potassium sulphate 55kg, 60kg and 65kg. In addition to 10kg of urea as a strong fruit fertilizer, the reset is applied for the sprouting fertilizer, strong fruit fertilizer (monoammonium phosphate, urea 10kg) is applied for one time, and the colored fertilizer (potassium sulfate) is applied at once. The base fertilizer is applied with 400kg of organic fertilizer and 120kg of superphosphate. The Kyoho grape was treated with 3 plants for 3 times, and at least 5kg per plant was applied after each fertilization.

| Test site       | PH   | Organic matter /% | Available nitrogen / (mg/kg) |
|-----------------|------|-------------------|----------------------------|
| Giant peak      | 6.13 | 3.11              | 112.73.                    |

1.3 Indicator determination

1.3.1. Measurement items and methods After fruit ripening, 3 strains were randomly selected for each treatment and control. Taking each one ear randomly from 4 directions in the north, south, east and west of each plant, and the fruit vertical and horizontal diameters were measured with vernier caliper, and the fruit quality was determined by electronic scales. The content of soluble solids in fruits was determined by WYT-4 hand-held sugar meter; the titratable acid content was determined by acid-base neutralization method with reference to Huang Xiaotong [2]; the content of vitamin C was determined by the 2,6-
dichlorophenol indophenol; the total sugar content was determined by Anthrone colorimetry in the method of the Modern Plant Physiology Experimental Guide [3].

1.3.2. Statistical analysis Using the processing software Microsoft Excel 2010 for data statistics, draws experimental data correlation charts for data processing and analysis of results.

2. Result analysis

2.1. Effects of different fertilizer treatments external quality of Kyoho grape

Table 4. Effects of different fertilizers on the appearance quality of fruits

| handle | Single grain weight(g) | Single ear weight(g) | Horizontal diameters(cm) | Vertical diameters (cm) | Color and lustre |
|--------|------------------------|----------------------|--------------------------|-------------------------|------------------|
| 1      | 11.69                  | 531.70               | 2.61                     | 3.10                    | reddish black    |
| 2      | 11.72                  | 512.30               | 2.62                     | 3.12                    | reddish black    |
| 3      | 12.03                  | 542.30               | 2.60                     | 3.16                    | reddish black    |
| 4      | 12.17                  | 609.30               | 2.63                     | 3.15                    | reddish black    |
| 5      | 11.52                  | 612.40               | 2.58                     | 3.17                    | reddish black    |
| 6      | 11.40                  | 566.50               | 2.45                     | 3.20                    | reddish black    |
| 7      | 11.53                  | 610.60               | 2.64                     | 3.04                    | reddish black    |
| 8      | 12.25                  | 537.50               | 2.66                     | 3.21                    | reddish black    |
| 9      | 11.29                  | 543.70               | 2.41                     | 3.14                    | reddish black    |
| CK     | 11.23                  | 507.70               | 2.43                     | 3.06                    | reddish black    |

It can be seen from Table 4 that the Kyoho grape under different fertilization treatments treated 8 single grain weights up to 12.25 g, and the single grain weight was the highest in all treatments, which was 9.08% higher than the control; the treated 4 was second, reaching 12.17 g by comparing with the control, the increase was 8.37%; the treatment 3 was slightly lower than the treatment 4, which was 12.03g, which was 7.12% higher than the control; the other single treatments were all lower than 12g, higher than 11g, and arranged from high to low for treatment 2>Treatment 1> Treatment 7>Treatment 5>Treatment 6>Treatment 9> CK increased by 4.36%, 4.10%, 2.67%, 2.58%, 1.51%, and 0.53%, respectively, compared with the control. It can be seen that the scientific and rational fertilization formula ratio can increase the single grain weight of Kyoho grape fruit, so as to deal with the highest single grain weight. Kyoho grape was different in different fertilization treatments, and the weight of single ear was 712.40g, which was the largest in all treatments, 20.62% higher than the control. Secondly, the weight of treatment 4 and treatment 7 reached 600g, respectively. The control increased by 20.01%, 20.27%; the remaining treatment single ear weight was less than 600g and higher than 500g, ranked from high to low for treatment 6> treatment 9> treatment 3> treatment 8> treatment 1>treatment 2> CK, respectively. The control group increased by 11.58%, 7.09%, 6.82%, 5.87%, 4.73%, and 0.91%. From the above data analysis, it can be seen that under the different soil testing formula fertilization treatment, the single spike weight of the Kyoho grape of treatment 5 reached the maximum. Formulated fertilization can slightly increase the fruit stems and longitudinal stems. Different fertilization has almost no effect on the color of the Kyoho grape, both red and black.

2.2. Effects of different treatments on the interior quality of the Kyoho grapes

Table 5. Effects of different fertilizers on the fruit contents of the Kyoho grapes

| Soluble solids (%) | Total sugar content (%) | Titratable acid (%) | Vc (mg/100ml) | Tss-acid ratio | Sugar-acid ratio |
|-------------------|------------------------|---------------------|---------------|---------------|-----------------|
| 15.87             | 13.80                  | 0.45                | 4.70          | 35.27         | 30.67           |
| 15.15             | 12.11                  | 0.41                | 4.71          | 36.95         | 29.54           |
| 15.55             | 12.36                  | 0.40                | 4.83          | 38.88         | 30.90           |
| 14.48             | 12.08                  | 0.39                | 4.78          | 37.13         | 30.97           |
| 16.12             | 12.84                  | 0.43                | 4.73          | 37.49         | 29.86           |
As shown in Table 5, compared with conventional fertilized grapes, the Kyoho grape that carried out formula fertilization has a certain increase in soluble solid content, total sugar content and Vc content, and the titratable acid content decreases to a certain extent. The comprehensive quality of treatment 8 was the best, and the ratio, both of Tss-acid and sugar-acid were the highest, which were 40.84:1, 35.95:1, and the Vc content was fourth, which was 4.75. The comprehensive quality was the worst, which treated by conventional fertilization. In treatment 8, the soluble solid content was 9.29% higher than that treatment of conventional fertilization, the total sugar content being 19.09% higher than that treatment of conventional fertilization, the titratable acid content being 19.15% lower than that treatment of conventional fertilization, and the Vc content was 1.93% higher than that treatment of conventional fertilization.

3. Discuss
In the process of grape growth and development, more kinds of nutrients are needed, the three most in demand nutrient elements are nitrogen, phosphorus and potassium. Nitrogen is the basic element of protein, it not only can increase leaf area, but also can promote fruit expansion, so as to enhance the quality of fruits. The grape has less demand of phosphorus. Phosphorus can promote the accumulation of sugar in berries and improve the ratio of solid to acid, thus improving fruit quality. The grape has the greatest demand for potassium. Studies have shown that potassium can significantly increase the content of soluble solids and total sugar in berries, and can improve cold resistance and disease resistance. Therefore, the key to improving the quality of grape is rational Formula Fertilizer.

Gang Chen[4] through research under single element fertilizer, change of yield and quality of Bixiang seedless grapes, and under the experiment of formula fertilizer, arrives at a conclusion: Formula fertilizer is more beneficial to the growth of this kind of grapes than single element fertilizer. Compared with single element fertilizer, reasonable formula fertilizer can raise the output of this kind of grape and improve the grape quality. Zhao Cuifang[5] studied the amount of nitrogen fertilizer and phosphorus fertilizer under the condition of different nitrogen fertilizer and phosphorus fertilizer application rate, effects of different formula fertilizer on the growth and fruit of Jingya grape, get the result: the fruit setting rate, grain number per plant, single grain weight and sugar content of formula fertilizer were higher than those of the contrast. It shows that the reasonable formula fertilizer can promote the growth and development of grape, making the grape grow better, and it also makes the fruit quality and quality better.

The result of this experiment is consistent with those of the predecessor, and reasonable formula fertilizer rate can improve the fruit quality significantly. As far as appearance quality is concerned, formula fertilizer can increase the single ear weight and single grain weight obviously, it can slightly increase the transverse stem and longitudinal stem of fruit but it has little effect on the color and lustre of pericarp; as far as internal quality is concerned, formula fertilizer have great influence on the ratio of sugar to acid, the ratio of solid to acid and the content of Vc. The absorption capacity of different varieties on N,P,K is slightly different, and effect of different fertilizer ratio on the inner quality of different varieties is inconsistent, but the influence on fruit quality is consistent.

References
[1] Wang Jiayuan, editor-in-chief of Wang Changquan. Soil fertilizer science [M]. Beijing: China mainland Press, 2008:42-48, 88-89.
[2] Xiaoyu, Liu Linwei. Comprehensive Experiment of Food Chemistry and Analysis[M]. Second Edition. Beijing:China Agricultural University Press, 2009 (7):165-166, 171-174.
[3] Shanghai Institute of Plant Physiology, Chinese Academy of Sciences, Shanghai Society of Plant Physiology. Guide to the experiment of Modern Plant Physiology [M]. Beijing: science Publishing House, 1999 :127 - 128.
[4] Chen Gang, Jian Defeng. Study on the effect of Fertilizer on the yield and quality of Bixiang seedless Grape [J]. Journal of Jilin Institute of Agricultural Science and Technology, 2008
(01): 1-4 Yang Chenghuan. Study on nutritional characteristics and fertilizing techniques of grape [J]. Liaoning Agricultural Science, 1993 (05): 4-8.

[5] Zhao Cuifang. A preliminary report on the comparative experiment of formula fertilizer correction for grape soil testing [J]. Anhui Agricultural Newsletter (second half monthly), 2011, 17 (06): 34-38.