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Study on the effect of microbial agents on grape yield

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Abstract

By applying compound microbial fungicides on conventional fertilizer and reduced fertilizer base clumsily, the effects on yield, soluble sugar, organic acid, vitamin C content and soil nutrient status of grapes were studied. The results showed that the average yield of grapes was 2942.92 kg/667m2, which was 33.29% and 83.87% higher than the control treatment of T3 and T4 (CK), respectively.

Keywords

Grapes; Microbial agents; Yield; Organic acids; Soluble sugars; Vitamin C.

1. Introduction

Microbial fungicides are a kind of preparation containing live functional microorganisms or metabolites(Jin 2010,Ge 1995),mainly bacteria and fungi,in addition to beneficial microorganisms, some of the fungicides also have a certain proportion of organic ingredients(Huang 2013,Guo 2015), therefore, microbial fungicides belong to a kind of biological fertilizer(Wang 2011,Du 2010), microbial fungicides applied in orchard production(Soil and Nutrition 1998), can increase the nutrients of fruit trees and soil functional bacteria, in addition to improving fruit yield and quality(Wang 2003,Wang 2003), but also can regulate Microbial flora can be used to improve soil ecological environment and reduce soil-borne diseases(Ge 2000,Meng 2008 and Wang 2000). The trial has been conducted for three years with a view to providing a scientific basis for the large scale demonstration and extension application of the fungicide.

2. Materials and methods

2.1. Overview of the test site

The experiment was conducted in April 2020 at the grape growing base in Linli County, Changde City, with red loam soil type, medium loam soil texture, medium uniform fertility, 45.8 g/kg of organic matter, 82 mg/kg of alkaline nitrogen, 39 mg/kg of fast-acting phosphorus, 207 mg/kg of fast-acting potassium, and pH 6.25 in the cultivated layer.

2.2. Test material

The grapes were grown in small trellises with a row spacing of 2.5 m × 0.8 m and two drip irrigation pipes in one row.

Ltd. containing Bacillus subtilis and Bacillus licheniformis with an effective number of live bacteria ≥ 500 million/mL and organic matter ≥ 20%, as granules.

Conventional fertilizers: urea, monoammonium phosphate, potassium sulfate, standard fertilizers available in the market.

2.3. Experimental design

The experiment adopts a randomized group design with 4 treatments, which are

T1: conventional fertilization + microbial fungicide 25kg/667m^2.

T2: conventional fertilizer + equal amount of inactivated substrate 25kg/667m^2.

T3: conventional fertilization alone: urea 30kg/667m^2, potassium sulfate 20kg/667m^2, monoammonium phosphate 20kg/667m^2.

T4 (CK): clear water control.

Each treatment was replicated three times, randomly arranged in groups, a total of 12 treatment plots, plot area of 1 mu. The soil and terrain conditions were relatively the same in the plots. Protective rows were set up around the plots, and fertilizer was applied by drip with water, and each plot was irrigated separately. The plots were managed in accordance with local viticultural management practices and harvested on October 5.

2.4. Measurement indicators

The growth of the grapevines was recorded from the beginning of the new growth period. Ten healthy vines with uniform growth were selected during the fruit set period to investigate the fruit set rate of each treatment. Ten healthy leaves were selected at the first two nodes of the first bunches, and the leaf color was recorded.

During the pre-harvest period (September 24), 10 grape clusters were randomly selected from the middle of the vine for each treatment, and the number of grains per cluster, the weight of each cluster and the weight of each cluster were measured by counting and weighing methods.

3. Results and analysis

3.1. Effects of different treatments on growth and yield components of grapes

As shown in Table 1, the application of a certain amount of microbial fungicides in the late stage of grapevine fertility had a significant effect on the growth and economic traits of grapes. Among them, T1 treatment was significantly better than the other treatments in terms of tree growth, and the basal diameter of the main trunk was 0.4 cm, 0.5 cm and 0.9 cm higher than that of T2, T3 and T4 (CK) treatments, respectively, with significant differences among treatments; T1 had the best leaf development, rich green leaf color and increased leaf area by 44.26 cm^2, 49.02 cm^2 and 174.22 cm^2 compared with T2, T3 and T4 (CK) treatments, respectively. The leaf weight of T1 treatment also increased significantly compared with other treatments, and the fresh weight of a single leaf increased by 10.25%, 10.63% and 21.30% compared with T2, T3 and T4 (CK) treatments, respectively; the dry weight of a single leaf increased by 20.19%, 21.75% and 46.48% compared with T2, T3 and T4 (CK) treatments, respectively. The increase in leaf area and leaf dry matter could improve the photosynthetic efficiency of fruiting branches, which could accumulate nutrients for mid- and late-stage growth and development, and also facilitate the differentiation of basal flower buds, therefore, it had a significant effect on improving grape yield and fruit quality.

Table 1 Comparative analysis of grape growth traits and yield composition factors among different treatments

Treatment	Diameter of main stem base (cm)	Leaf color	Leaf area (cm2)	Single leaf weight		Fruit set rate (%)	Number of grains per spike	Single fruit weight (g)	Single spike weight (g)
				Fresh weight (g)	Dry weight (g)				
T1	2.6	thick green	563.58	9.68	3.75	90	93	13.45	1250.85
T2	2.3	green	519.32	8.78	3.12	85	89	12.36	1100.04
T3	2.2	green	514.56	8.75	3.08	85	87	12.32	1071.84
T4（CK）	1.9	thick green	389.36	7.98	2.56	80	82	9.88	810.16

The investigation of yield factors such as fruit set rate, number of fruit and weight per cluster in each treatment showed that microbial fungicides applied in the middle and late stages of grapevine fertility had a significant effect on the yield composition of grapes. The fruiting rate of grapes in T1 treatment was significantly higher than that of other treatments, with 5.9% higher than that of conventional fertilizer treatment and 12.5% higher than that of T4 (CK) treatment; the number of fruits per spike was 4-11 higher than that of other treatments; the weight per fruit and weight per spike increased by 8.82% and 13.71%, respectively, compared with T2, and by 9.17% and 16.70%, respectively, compared with T3. The ANOVA results showed that the differences in yield components between T2 and T3 treatments were not significant, but both were significantly higher than T4 (CK) treatment.

3.2. Effect of different treatments on grape yield

The average yield of T1 treatment was 2945.43 kg/667m^2, which was 26.78%, 33.08% and 83.87% higher than that of T2, T3 and T4 (CK) treatments, respectively. The highest yield was obtained in T1 treatment, followed by T2 and T3 treatments, which were not significantly different from each other, and the lowest yield was obtained in T4 (CK) treatment.

Table 2 Effect of different treatments on grape yield

Treatment	Plot yield (kg/667m2)				Yield increase rate%
	I	II	III	Average	
T1	2942.35	2940.98	2945.43	2942.92 a	83.87
T2	2320.69	2318.65	2324.58	2321.31 b	45.04
T3	2314.36	2311.59	2320.75	2207.99 b	37.96
T4（CK）	1593.39	1592.68	1615.33	1600.47 c	/

3.3. Effect of different treatments on grape quality

The results of the analysis of the appearance and intrinsic quality of the grapes in each treatment (Table 3) showed that there were obvious differences in the color of the grapes in each treatment, with the T1 treatment showing purple-black color and uniform and bright fruit color. The increase in soluble solids was highly significant, with an increase of 27.93% compared to the conventional fertilizer treatment and 50.11% compared to the control; the sugar-acid ratio was significantly higher than the other treatments.

Table 3 Analytical results of grapes' external and internal quality by treatment

Treatment	Fruit color	Earlier ripening than T4 (d)	Soluble sugar (%)	Organic acid (%)	Vitamin C (mg/g)	Soluble solids (%)	Sugar-acid ratio
T1	Purple-black	9	21.32	1.9	22.58	19.65	11.22
T2	Deep Black	5	17.85	2.4	20.08	16.54	7.44
T3	Deep Purple	4	17.79	2.5	20.53	15.36	7.12
T4（CK）	Purple	/	15.32	3.4	16.52	13.09	4.51

Through the investigation of grape ripening period in each treatment, it was found that the follow-up application of microbial fungicides could advance the ripening period by 9 d compared with the T4 (CK) treatment, which was beneficial to the early ripening and marketing of grapes, which is important to improve the economic return of grapes.

4. Conclusion

The overall growth of the vine was significantly better than the other treatments, and the diameter of the main stem base was 0.5 cm higher than that of the conventional fertilizer treatment during the new growth period. The dry matter weight per leaf increased by 20.19%, 21.75% and 46.48%, respectively. The yield components such as fruit set rate, number of fruit grains, weight per fruit and weight per spike were significantly increased compared with the conventional fertilizer and control treatments. The average yield of grapes was 2942.92 kg/667m^2 which was 33.29% and 83.87% higher than the control treatment with conventional fertilizer T3 and T4 (CK), respectively, when 25 kg/667m^2 of microbial fungicide was applied during the fruit set and fruit expansion periods in addition to the conventional fertilizer drip application.

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