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Comparison of Photosynthetic Physiological Characteristics and Yield of Watermelon Varieties with Different Resistance to Fusarium Wilt

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ABSTRACT

With the continuous development of facilities and horticulture, the area of vegetable planting in facilities increased year by year. Watermelon (Citrullus vulgaris Schrad) as the main cultivars within the facility, the continuous cropping problem is very serious, resulting in continuous cropping obstacles become increasingly obvious, the incidence of fusarium wilt increased year by year. Grafted watermelon roots developed to improve the growth of grafted roots of the conditions, resulting in robust plant growth. At the same time, the use of different purposes of the rootstock can make watermelon in different soil conditions under normal growth, such as the use of low temperature, drought, salt tolerance, barren and other characteristics of the rootstock. Secondly, the rootstock of the strong absorption of water absorption capacity, to promote the growth of grafted watermelon plants strong, large watermelon fruit, high yields. In addition, grafted watermelon seedlings grow fast early, for early maturing cultivation and overcome the seedless watermelon early growth slow defects is extremely favorable. So the use of pumpkin as a watermelon grafting rootstock, can effectively improve the effect of watermelon resistance to Fusarium wilts. And provide the theoretical basis and scientific basis for the further study of photosynthetic characteristics, disease resistance breeding and effective control of watermelon. In this experiment, the watermelon varieties with different resistance to fusarium wilt were selected, and the anti-fusarium wilt watermelon was studied systematically. There are changes in physiological characteristics during growth and development. In conclusion, grafting promotes the growth of watermelon and physiological characteristics of the index rose.

KEYWORDS: watermelon; fusarium wilt; growth period; physiological characteristics

1. Introduction

Watermelon (Citrullus vulgaris Schrad) for the Cucurbitaceae watermelon genus, native to the African savannah, is a world of horticultural crops, is the popular summer fruit, its cultivation area and total output in the world top ten, China is the world's watermelon Of the first planting power. Each year, China's watermelon cultivation area of more than 300 million hectares, watermelon is one of China's important economic vegetable crops (Wang Ming, Hou Pei, 2006).

Watermelon continuous cropping, watermelon wilt disease pathogen in the soil to survive up to 10 years, so the rotation cycle is longer. At present, with the shortening of the rotation cycle (Xu Ruyi et al., 2007), the incidence of Fusarium wilt has increased year by year, the output will be the next year. Watermelon generally requires at least 6 years of rotation, but due to China's arable land and the existing land use system restrictions, watermelon production cannot implement a strict rotation system, rotation is shorter and shorter, and the protection of watermelon production is inevitable Stubble (Wu Fengzhi et al., 2004). As watermelon for many years continuous, decline in soil productivity, productivity, increased pests and diseases, resulting in reduced production, quality decline, resulting in continuous cropping obstacles. According to the Shanghai survey, in recent years under the conditions of cultivation of watermelon fusarium wilt incidence rate is generally 10% -30%, serious sick shed rate of 50% (Guo Chao, 1995), there is no very effective way, In order to control the disease had to use a large number of chemical pesticides, not only caused the soil pollution, but also affected the product quality and agricultural safety, a serious threat to the ecological environment and people's health (Guan Junfeng, 2001). Continuous cropping obstacle has become an important factor restricting the sustainable development of agricultural production, especially vegetable production, in some areas. It is mainly related to soil infectious diseases, deterioration of soil physical and chemical properties and self-toxicity caused by rhizosphere secretions and residues Effects, etc., and these factors are different degrees of soil and microbial in the soil (Wu Fengzhi et al., 2004).

In recent years, in some watermelon producing areas occur frequently, and the spread of the trend, watermelon wilt disease on the plant seriously affected the watermelon yield and quality. At present, for the research of watermelon continuous cropping obstacle, soil-borne pests and diseases have always been the focus of domestic and international research on watermelon, and the classification and identification of pathogens, the pathogenicity mechanism and the screening of watermelon germplasm resources, the genetic law of resistance, continuous soil microbial (Fan Hongwei et al., 2004), although the selection of disease-resistant varieties is the most cost-effective measures, but the current breeding disease-resistant varieties take a long time, and the current selection of disease-resistant varieties are generally in the continuous planting 3 to 4 years later, the disease resistance decreased rapidly, while the loss of commodity value (Jiangyou article, 1998). In addition, the current quality of breeding varieties of disease is often poor commodity. Production to take grafting cultivation techniques, to overcome the harm of Fusarium has a very good effect. Soil-borne diseases are closely related to soil properties. Soil microbes play an important role in disease-related soil factors. Soil-borne pathogens are part of the soil microbial community, and the ability of microbial communities to inhibit soil-borne pathogens is related to crop. There is a close relationship between the disease index.

Through various means to cultivate high yield, good quality watermelon varieties, is to solve the standardization of commodity melon, quality and diversification of the fundamental way. In the process of introduction, breeding and grafting of watermelon, selecting some physiological indexes of growth as the reference index of these processes is the basic method used to study the growth and physiological characteristics of high yield and high quality watermelon. It can provide theoretical basis and scientific Guidance (Jiang et al., 2000). Photosynthesis is the basis of crop yield formation, the main way to improve watermelon production is to improve its photosynthetic yield. However, in the existing research, the use of fertilization and field cultivation techniques to improve the yield of watermelon reported more, and the watermelon and photosynthetic intensity of the relationship between the reported less. The photosynthetic products of the main lateral vines were mainly used for the growth of the vultures (Xu et al., 1999). During the fruit growing period, the photosynthetic products were mainly supplied fruit (Liu Wenge et al., 2003). Therefore, the research on the determination of photosynthetic intensity of watermelon can provide theoretical basis for the selection of varieties, reasonable planting and scientific field management.

In order to further study the relationship between yield and continuous cropping of watermelon, the effects of grafting on watermelon fusarium wilt were studied, and the effects of watermelon fusarium wilt Scientific theory and practice basis, as well as watermelon different resistance varieties of pathogen resistance to pathogen, for the further study of watermelon photosynthetic characteristics, disease breeding and effective control of such diseases provide a theoretical basis and scientific basis.

1.1. Study on Disease Resistance of Watermelon

China is a cultivated country with strong cultivation of watermelon, and has a long history of cultivation. The grafting technology in China originated from the enlightenment of the phenomenon of natural wood, the development of cutting propagation technology and the interspecific relationship between semi-parasitic plants in nature. Which melon grafted in China at least 3,000 years of history, according to the literature, the origin of Chinese grafting technology can be traced back at least Zhou Qin era, the descendants of the evolution. The earliest records on the grafting of Cucurbitaceae plants is the Western Han Dynasty, 'Pan Sheng's book', 'under the gourd ten, both students, two feet long, it will always gather a stems to cloth wrapped five inches Xu, reuse Muddy mud, but a few days, wrapped around it will be a stalk, keep the strong, I know pinch to go to lead the knot child, the child of the article also pinch to the do not spread.

In recent years, watermelon disease (especially fusarium wilt) has become a major threat to the production of watermelon in China. For the control of watermelon wilt disease one by rotation for the crop, but due to restrictions on land area, it is difficult to achieve; the second is the use of chemical treatment of soil, expensive, polluting the environment, little effect, so far no ideal medicine; Disease watermelon varieties, due to the limitations of breeding technology and watermelon Fusarium oxysporum bacteria race diversity caused by the diversity of breeding is very difficult. According to the practice in recent years proved that the choice of suitable rootstock varieties, the use of grafting technology is the production of watermelon wilt disease to solve the effective way. Therefore, the watermelon rootstock collection, research and utilization is particularly important.

Watermelon susceptible to fusarium wilt, so the current grafted rootstock most of the resistance to Fusarium wilt, but its resistance mechanism is unclear. The study on the resistance of grafted watermelon to Fusarium wilt showed that the disease resistance of grafted watermelon was closely related to the change of POD isoenzyme. The stronger the disease resistance, the greater the change in the isoenzyme band, the emergence of the 'disease resistance' characteristic band and the disappearance and attenuation of the 'susceptible' band (Guo Chuanyou et al., 2004). Under the condition of susceptibility, the increase of the conductivity and proline content of the grafted plants was significantly lower than that of the self-rooted seedlings, which indicated that grafting could effectively prevent the infection of pathogens and expand in vivo, so that the accumulation of proline could alleviate the pathogen the role of weakened. The activity of PAL in the plant was significantly increased after grafting and maintained a high level of activity (Zheng Qun, 2000). Some people think that in the roots of rootstock may have the synthesis of disease-resistant substances, this material can be transported to the ground, but need further study (Chen Junwei, etc.).

1.2. Study on Grafting of Watermelon

Artificial grafting is a worldwide gardening technique. Watermelon grafting research began in Japan in 1925 and North Korea, initially the main use of gourd rootstock control of watermelon protection in the production of continuous cropping obstacles, but because of grafting technology is not perfect, then failed to promote the use of production. Until the 1950s, the establishment of a cotyledon grafting system, simplified grafting technology, improve efficiency, combined with the serious occurrence of Japanese watermelon fusarium wilt, making this technology can be rapid development (Chuan Tian Wu, 1985). The grafting of watermelon is mainly focused on the collection, research and utilization of stockstock, and the discussion of grafting method, management of grafted seedlings and so on.

Two different plants grafted together to produce a successful joint, while developing into a complete plant, this graft is affinity, otherwise it is not compatible. Therefore, the study of graft affinity is valuable. At present, the process of grafting is clear. Jeffree thinks that the grafting process is the first to make the formation of spike and anvil, and then the callus is produced respectively. Callus combined, the cell division, differentiation and makes the formation layer together, the formation of healing tissue. Moore et al. Observed the cytological changes of the graft healing process in detail, and divided it into five stages: (1) the formation of necrosis layer on the cutting surface; (2) the activation of the cytoplasm and the accumulation of the Golgi (3) the callus formation and the necrotic layer disappeared; (4) the differentiation of vascular bundles between the anvils; (5) graft healing and survival. Although a lot of research works, it is still unclear on the mechanism of graft affinity. Jeffree et al. noted that there was a thinning of the cell membrane after grafting, suggesting that the healing process may involve cell recognition mechanisms. Moore argues that the healing process is related to the aggregation of callus and cell wall-forming precursor matter, but what is the precursor material is unclear. There are many hypotheses about the mechanism of grafting incompatibility. Jeffree argues that the main reason for grafting is that the scion and rootstock are different in morphology, thus hindering the movement of nutrients from the roots to the stems and leaves and assimilating the products from stem and leaf to the roots. At the same time, the rootstock supply of nutrients to the stem and leaf of the nutrient requirements, in the quality or quantity of excessive or insufficient; rootstock on the assimilation of the product requirements with the supply of scion is not balanced, also produce incompatibility. Moore and others believe that injury and lignification are one of the mechanisms of incompatibility. In addition, plant growth regulators and non-affinity poisons are important factors in controlling affinity. Grafting survived after the rootstock and scion is also mutual influence. Such as dwarf anvil can promote the early results of the plant, enhance the resistance to improve the quality of fruit; scion will also affect the growth potential and cold resistance on the rootstock. The possible mechanisms between the rootstock and the scion are: (1) the difference between the genotypes of the rootstocks and the scion; (2) the difference in the absorption and utilization of nutrients; and (3) the formation of photosynthetic products is different from that of nutrient transport. But the affinity mechanism is not clear so far.

1.3. Study on Physiological Characteristics of Watermelon

The photosynthetic rate is expressed in terms of unit time, unit of photosynthetic apparatus (dry weight, area or chlorophyll) fixed carbon dioxide or released oxygen or accumulated dry matter. On the surface, photosynthetic rate is not an efficiency indicator. However, in fact it is an important indicator of photosynthetic efficiency. It is an important indicator of photosynthetic efficiency that is not limited by light energy supply, ie, light saturation conditions. In other conditions are the same circumstances, high photosynthetic rate always leads to high yield, high light energy utilization. Therefore, people often high photosynthetic rate as high photosynthetic efficiency.

The vast majority of the literature now reports that the photosynthetic rate is expressed in terms of unit leaf area. Therefore, the photosynthetic rate and related parameters, such as leaf chlorophyll, photosynthate and the like, expressed in unit leaf area, not only facilitate the comparison between different literatures, but also facilitate the comprehensive analysis of the mutual relationship between the parameters relationships, including their causal relationships and quantitative relationships. It is advisable to indicate the various parameters in terms of fresh weight per unit of leaf, since the various parameters expressed in such units are susceptible to changes in blade water content, especially in the case of different water treatments sex and incomparability is even greater.

Plants are always living in the external environment, because the main environmental factors affecting the net photosynthetic rate - light, temperature and so on in the day showed a significant diurnal variation, therefore, plant photosynthesis also showed a diurnal variation.

Under natural conditions, there are two typical approaches to plant photosynthesis schedules. One is unimodal, the net photosynthetic rate in the morning with the increase in the intensity of sunlight increased, noon to reach the maximum, and then in the afternoon with the weakening of the sun and gradually reduced. The other is bimodal, with two peaks in the net photosynthetic rate change process, one in the morning and some later in the afternoon, it tends to be lower than the first peak of the morning , There is a noon between the two peaks, the so-called noon lower or 'nap' phenomenon. For photosynthetic 'nap' phenomenon, strong sunlight, low air humidity and low soil water potential may be the main environmental factor, the decrease in stomatal conductance may be an important physiological factor, while the increase in ABA synthesis and the photochemical system of photochemical efficiency reduce may be important biochemical factors. These factors are closely related to each other to cause physiological and biochemical changes.

The diurnal variation of photosynthesis of 'Baoguan' and 'New Jinlan' two kinds of watermelon canopy were studied under the condition of solar greenhouse. The results showed that there were significant differences in canopy light distribution and diurnal variation pattern of photosynthesis between two watermelon cultivars in solar greenhouse, and the canopy illumination conditions affected the photosynthetic intensity and diurnal variation trend of leaf layer. The daily photosynthetic rate of two varieties of canopy showed a single peak type, and the net photosynthetic rate of 'Bao Guan' watermelon was higher, and the photosynthetic time was longer, but showed lunch break characteristics. The photosynthetic rate of leaves of 'New Jinlan' was low, and the photosynthetic time was short, which did not show obvious characteristics of lunch break.

2. Materials and methods

The experiment began in November 2006 to January 2008, the experiment in the Northeast Agricultural University Vegetable Cultivation Laboratory completed

2.1. Test material

2.1.1 Test site

The experiment was carried out at the Research Institute of Vegetable Physiology and Ecology, No. 1 Greenhouses and Horticultural College, Horticultural Test Station, Northeast Agricultural University.

2.1.2 Test materials

Test watermelon varieties 2: Feng Le sweet girl (high resistance, R1), Feng Le small angel (susceptible, S2) (Hefei Fengle Seed Industry Co., Ltd.). Fruit type small and medium sized.

Test rootstock varieties: Boqiang a pumpkin (P) (Tianjin Deret Seed Industry Co., Ltd.).

2.1.3 Test time

The experiment began in March 2014 and ends in August 2014.

2.1.4 Test soil

Test soil is black soil, before the stubble cucumber.

Conductivity ($mS \cdot cm^{-1}$) EC	pH	(%) Organic matter	($mg \cdot kg^{-1}$) Alkali-hydrolyzable N	($mg \cdot kg^{-1}$) Available P	($mg \cdot kg^{-1}$) Available K
0.96	7.21	4.66	296.51	275.00	372.05

Table 1. Basic physicochemical properties of tested soil

2.1.5 Experimental Drugs

Methanol, disodium hydrogen phosphate, potassium dihydrogen phosphate, concentrated sulfuric acid; acetone, quartz sand; sodium hydroxide, boric acid, methyl red - bromocresol green indicator; sodium bicarbonate, phosphorous activated carbon powder, molybdenum antimony stock , molybdenum antimony anti-coloring agent; ammonium acetate, potassium chloride; potassium dichromate, o-phenanthroline indicator; glucose

2.1.6 Experimental apparatus

Apparatus denomination	Version	Fabricant
Electronic Balance	PL303	METTLER TOLEDO Instruments (Shanghai) Co., Ltd.
Laboratory pH meter	FE20	METTLER TOLEDO Instruments (Shanghai) Co., Ltd.
Laboratory Conductivity Meter	FE30	METTLER TOLEDO Instruments (Shanghai) Co., Ltd.
Ultra-pure water device	MILLIPORE B.P.307	France
Constant temperature shaker	ZHWY-2120C	Shanghai Zhicheng Analytical Instruments Manufacturing Co., Ltd
Light incubator	LRH-250G-I intelligent	Guangdong Province medical equipment factory
Medical clean bench	DL-CJ-2ND	Beijing Donglian Hal Equipment Manufacturing Co., Ltd
Electric blast oven	101-3A	Tianjin Tai Site Instrument Co., Ltd.
Adjustable electric sand bath	DK-2	Beijing Yongguangming Medical Instrument Factory
Rotary evaporator	N-1000	Shanghai love Long Instrument Co., Ltd
Water bath	SB-2000	Shanghai love Long Instrument Co., Ltd
Water pumping machine	A-3S	Shanghai love Long Instrument Co., Ltd
Spectrophotometer	WFJ722	Shanghai love Long Instrument Co., Ltd
Portable photosynthesis	LI-6400	United States Li-COR
Flame photometer	FP6410	Beijing
High pressure steam sterilization pot	DSX-280B	Shanghai Shen'an medical equipment factory
Electric constant temperature water bath	HW-SY21-K-4C	Beijing Changfeng instrumentation company
High speed refrigerated centrifuge	Allegra X-22R	Beckman Coulter. Inc.
PCR instrument	PTC-200	United States Bio-Rad
Electrophoresis	DYY-6C	Beijing six one instrument factory
Denaturing gradient gel electrophoresis system	Dcode™ Universal Mutation Detection System	United States Bio-Rad
UV imager	AlphaImager HP	Alpha Innotech Corp.
Electronic balance	PL303	METTLER TOLEDO Instruments (Shanghai) Co., Ltd.
Laboratory pH meter	FE20	METTLER TOLEDO Instruments (Shanghai) Co., Ltd.

Table 2. Table 2-1-6 Experimental Instruments

2.2. Test methods

2.2.1 Seed treatment

Watermelon and rootstock seeds were soaked in 0.1% potassium permanganate solution for 10 min, and then stirred at 55 ° C in warm water to constant temperature. Pumpkin soaked 6h, cast clean, 30 incubator in the germination, to be about 0.5cm when the embryo root, sowing in the nutrition bowl, scion seed sowing in sterile vermiculite plug plate.

2.2.2 Grafting

Using jacking method. Grafting, the rootstock seedlings to the emergence of true leaves is appropriate, scion watermelon seedlings to cotyledons to carry out the appropriate, for this rootstock 5d sowing, directly into the bowl, while planting germination of watermelon seeds, 7d grafting. Just grafted, during the day to maintain 26 -28, night 18 -20, placed in shade moisturizing plastic shed. After the gradual increase in ventilation with the increase, 1 week after daytime 23 -24, night 18 -20. 2 days before grafting should be fully watering, grafted after sealing, so that the air humidity to saturation, without ventilation. 5-6d after entering the fusion period, in the early morning and evening air humidity when the high ventilation, and gradually increase the ventilation time and ventilation. In the sun bed to remove the cover, accept the scattered light, and gradually see the light time, 10d after only at noon shading, 12-15d in the morning bed, remove the cover in the evening, after 5-6d in the morning, After the restoration to the general seedbed management.

2.2.3 Greenhouse colonization

Ridge, ridge distance of 60cm, spacing 40cm. Each cell area of 4.32m2 (0.6m × 1.2m × 6m), each treatment set 3 times repeated, random arrangement. 16 lines per line, 32 per plot. Apply organic fertilizer before planting, the experiment process does not impose any fertilizer. Regular management.

2.2.4 Determination of physiological indicators

Selection of fine weather LI-6400 portable photosynthesis produced by Li-COR company in the United States at 10.00-12: 00, select the varieties (lines) in the growing trend of the same consistent plants, whichever is the age, leaf position is basically the same mature the net photosynthetic rate and influencing factors of watermelon functional leaves, including light and effective radiation, stomatal conductance and transpiration rate were measured. Each treatment was randomized to take 3 strains, 3 replicates, and the average of 9 determinations.

When the watermelon fruit is ripe, the weight of each cultivar is measured in the field, and the yield is calculated.

2.3. Data processing

Data were compiled using Excel software, and the difference test was performed using SAS (V6.12) software.

3. Results and Analysis

3.1. Comparison of Photosynthetic Rate of Watermelon with Different Resistance

The net photosynthetic rate (Pn) of the four cultivars (lines) was R1> S2> PR1> PS2 when the photosynthetic efficiency was compared. The net photosynthetic rate (Pn) was R1> S2> PR1> PS2. Grafting resistant seedless watermelon seed coat thick, resulting in seedlings grow weak and slow. But PR1 is both grafted and resistant watermelon, so its growth is strong, photosynthetic rate is also higher. It can be seen on July 4, PR1 has begun to show the advantages of resistance to grafting.

In the early stage, the net photosynthetic rate was the highest in the tested cultivars, but the other varieties had no significant difference, but the late S2 varieties were infected, resulting in a significant decrease in net photosynthetic rate. The results showed that R1 was the highest net photosynthetic rate, and the PR1 and PS2 grafted PR1 had higher net photosynthetic rate than PS2.

处理	R1	S2	PR1	PS2	P
5.25	15.63 ±0.30 Bb	14.1 ±1.20 Cc	11.93 ±0.84 Dd	11.81 ±0.45 Dd	17.21 ±0.54 Aa
6.14	15.63 ±0.30 Bb	14.01 ±1.2 Cc	11.93 ±0.84 Dd	11.81 ±0.45 Dd	17.21 ±0.54 Aa
7.4	14.90 ±0.95 Aa	10.30 ±0.20 Bbc	10.10 ±0.10 Bbc	8.45 ±3.05 Bc	11.60 ±0.26 Abb
7.24	5.34 ±0.81 BCbc	3.77 ±0.85 Dd	6.89 ±0.33 Aa	6.43 ±1.04 ABab	4.51 ±0.39 DCdc

Table 3. Effects of different watermelon treatments on net photosynthetic rate of watermelon / µmol • m-2 • s-1

3.2. Comparison of Transpiration Rate of Watermelon with Different Resistance

The transpiration rate curves of four varieties of watermelon were all obvious. The transpiration rate of PR1 and PS2 decreased first and then increased, and the PR1 characteristics were the most obvious. During the period of 10: 00 - 14: 00, the transpiration rate of four varieties (lines) of watermelon was faster, and the transpiration rate of the early stage was very significant. The transpiration rate of the seedlings was significant.

处理	R1	S2	PR1	PS2	P
5.25	5.34 ±0.27 ABb	6.05 ±0.15 Aa	4.63 ±0.16 BCc	4.37 ±0.13 Cc	5.81 ±0.69 Aab
6.14	4.86 ±0.09 Aa	4.26 ±0.27 ABab	3.84 ±0.76 Bb	3.74 ±0.45 Bb	4.8 ±0.24 Aa
7.4	1.98 ±0.17 Bb	1.21 ±0.04 Cc	2.64 ±0.03 Aa	1.65 ±0.46 BCb	2.66 ±0.02 Aa
7.24	0.84 ±0.85 Bb	1.26 ±0.53 ABb	3.33 ±1.65 Aa	3.54 ±1.43 Aa	2.43 ±0.42 Abab

Table 4. effects of different treament on transpiration rate of watermelon / mol • .m-2 • s-1

3.3. Comparison of Stomatal Conductance of Watermelon with Different Resistance

Table 5 shows that the change of stomatal conductance of watermelon leaves in four watermelon varieties is a decline curve. After 10:00, the light intensity increased, the leaf temperature increased, the stomata began to close, stomatal conductance decreased to reduce transpiration loss; afternoon light intensity decreased, leaf temperature decreased, photosynthetic rate also reached the second peak, but the stomatal conductance did not increase.

The intercellular carbon dioxide concentration of the leaves of the four seasons was the highest at 08:00 AM. With the increase of photosynthetic rate, the assimilation of carbon dioxide increased continuously and the concentration of carbon dioxide was decreased. At 12:00, the transpiration rate of other cultivars (lines) was the lowest and then began to increase, and the transpiration rate of PR1 and PS2 was the lowest at 14:00 and the transpiration rate of R1 and S2 was decreased then began to rise. After 16:00, the transpiration rate of four varieties (lines) watermelon decreased, but the transpiration rate of other varieties (lines) except P decreased less.

On May 25, the stomatal conductance of susceptible seedling S2 was significant. On June 14, the stomatal conductance of the disease-resistant seedlings was significant. The results showed that the PR1 stomatal conductance was very significant at the end of the fruit stage. Sensory PS2 stomatal conductance is the same as PR1.

处理	R1	S2	PR1	PS2	P
5.25	0.15 ±0.006 ABab	0.16 ±0.009 Aab	0.14 ±0.006 ABbc	0.12 ±0.011 Bc	0.15 ±0.025 ABab
6.14	0.11 ±0.002 Aa	0.09 ±0.007 ABb	0.08 ±0.177 Bbc	0.08 ±0.006 Bc	0.11 ±0.003 Aa
7.4	0.04 ±0.0049 Bb	0.03 ±0.0003 Cd	0.06 ±0.0003 Aa	0.03 ±0.0078 BCc	0.06 ± 0.0002 Aa
7.24	0.04 ±0.016 Aab	0.03 ±0.012 Ab	0.08 ±0.042 Aa	0.08 ±0.035 Aa	0.05 ±0.009 Aab

Note: Lowercase letters indicate significant differences in levels (p \u0026 lt; 0.05). Capital letters indicate significant differences in levels (p \u0026 lt; 0.01)

Table 5. Effects of different treatments on stomatal conductance of watermelon / mmol • m-2 • s-1

3.4. The effect of watermelon wilt on yield

The difference was statistically significant ($P < 0.05$). The yield of PR1 and PS2 of the watermelon cultivars was higher than that of the susceptible cultivars, while the yield of the non-grafted watermelon resistant varieties R1 was the most stable. For the PS2, Graft resistance to the resistance of Fusarium wilt by the rise, the yield is still considerable, so its yield is more sensitive than the root of the seedlings. The difference of PR1 and PS2 between the resistant cultivars R1 and the grafted was not significant, but the difference was significant with the susceptible cultivars. In the non-diseased control area, the difference between the four treatments was not significant.

4. Discussion

4.1. Discussion on the Effect of Grafting on the Physiological Traits of Watermelon

Watermelon from sowing to fruit ripening, the entire growth cycle of plant growth were slow to slow a slow rhythm. But the effect of different resistance on the growth and development of watermelon was significant. Watermelon rootstocks are mainly different species, variants and varieties of gourd, pumpkin and melon, and the relationship between watermelon and various melon rootstocks is watermelon (anvil or cucumber) , melon, pumpkin, melon, cucumber, but the same kind of different variants and varieties vary widely. With watermelon as scion, other melons as rootstock, in addition to cucumber anvil, have shown a strong coexistence of affinity. And grafting is the integration of two systems into a system of physiological and biochemical processes. The difficulty of fusion is the healing speed of the contact surface. The temperature and humidity conditions and the requirements of the nutritional conditions are also important factors that affect the survival of the graft.

It was also found that grafting could significantly promote plant growth, but the plant height was lower than that of self-rooted seedlings, which may be caused by the existence of grafted seedlings. After planting seedlings, due to grafted seedlings have more developed roots, the rapid growth of the ground. It can be seen that the cultivation of watermelon is the first, the rootstock has a huge root system, the strong growth of the root system and the active physiological activities have promoted the growth of the aboveground parts, and the roots and the ground are mutually promoted to form a coordinated relationship between the upper part and the underground. This is consistent with previous reports.

4.2. Effects of Resistance on Photosynthetic Characteristics of Grafted Watermelon

The results showed that the photosynthetic rate of grafted plants was higher than that of grafted plants. This may be the grafted seedling has a high photosynthetic pigment content, that is, with high conversion efficiency of light energy. In order to maintain a high net photosynthetic rate (Pn), the transpiration rate was kept at a high level. On the one hand, the leaves were subjected to strong photosynthesis, and the exchange of matter and gas in the body and the outside was faster. On the other hand, the role of watermelon transpiration can be the body of the heat out of the body, reduce their own temperature, to avoid damage by high temperature, which is a reflection of its self-defense.

Plant photosynthesis depends mainly on three physiological processes, namely, photosynthetic substrate conductance, photoreaction and dark reaction. Leaves have strong ability to transport carbon dioxide, and higher photoreactivity and dark reactivity are important physiological basis for leaf photosynthesis rate. While the leaves were the main organs of photosynthesis, leaf age, leaf position, chlorophyll content, microscopic and submicron structure of leaves, chlorophyll photochemical activity and other internal characteristics of photosynthesis. The results showed that the photosynthetic rate of grafted seedlings was higher than that of self - rooted seedlings. The photosynthetic rate of grafted seedlings was higher than that of grafted seedlings. The difference was significant. The results showed that the grafted seedlings had a strong base of photosynthetic system and reproductive growth in the early stage of growth, which laid a material foundation for the grafting of watermelon. There was no significant difference in the photosynthetic intensity of watermelon during the period of extensional and ripening. In the production, the period was mainly through a series of technical measures to improve the yield and quality of the leaf area.

4.3. Discussion on the Effect of Resistance on Fruit Quality Formation of Watermelon

The accumulation of sugar is the key to the formation of fruit quality, watermelon fruit in its development process of soluble sugar content is gradually increased. The change of the main sugar in the fruit may be related to the growth rate of the fruit. At the early stage of development, the fruit grows fast and the photosynthetic product mainly provides the material basis for the fruit growth, and the increase of the sugar accumulation in the later stage may be the result of the interaction of the sucrose metabolism related enzymes The Enzymes that are closely related to sucrose metabolism and accumulation are acid invertase, neutral invertase, sucrose synthase and sucrose phosphate synthase. The sucrose is decomposed into fructose and glucose. Sucrose synthase catalyzes the synthesis of sucrose and catalyzes the decomposition of sucrose, but it is also known that it acts mainly for the decomposition of sucrose. Sucrose phosphate synthase is thought to be catalyzed by sucrose synthesis the main enzymes have been reported in large numbers to show that these enzymes play an important role in the transport, metabolism and accumulation of sugars.

4.4. Discussion on the Effect of Resistance on Watermelon Yield

Greenhouse production to see the grafted watermelon varieties PR1, PS2 resistance than susceptible S2 varieties of high yield, fruit weight should be slightly higher, the fruit full of taste appropriate. And since the root of the watermelon resistance varieties R1 production is the most stable, for the PS2, although the susceptible varieties because of grafting resistance to Fusarium wilt by the rise, so the yield is still considerable.

5. Conclusions

The transpiration rate, photosynthetic rate, stomatal conductance and other physiological indexes of high water resistance watermelon varieties were higher than those of susceptible cultivars. Watermelon grafting increased resistance, susceptible varieties can improve their resistance by grafting. Grafting can effectively improve the fruit yield of watermelon.

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