Application and Research Progress of Trunk Whitening

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Abstract: As a traditional tree protection technique, trunk whitening is widely used in agriculture, forestry, and landscaping. This article comprehensively analyzes the research results and practical experience of trunk whitening in recent years, and explores the principles, functions, technical methods, equipment innovation, and application effects of whitening. The article elaborates on the preparation and usage precautions of whitening agents, analyzes the whitening practices and effectiveness evaluations of different regions and tree species, points out the problems and challenges of current whitening technology, and provides prospects for future research directions. Research has shown that whitening tree tr unks has significant effects in preventing freezing, sunburn, sterilization, and insect infestation. However, with the introduction of mechanized and intelligent equipment, whitening technology is developing towards high efficiency, environmental protection, and low cost.

Keywords: Painting Tree Trunks White; Whitening Agent; Anti Freezing; Insect Prevention; Mechanized Whitening; Application Practice

1. Introduction

Whitening tree trunks is a management technique that involves applying white protective material to the surface of the trunk to regulate temperature, prevent pests and diseases, and enhance tree resilience. Whitening tree trunks can be traced back to ancient agricultural practices, where early farmers discovered that treating fruit trees with lime water could reduce pest infestations. Similar practices have been documented in literature during the Ming and Qing dynasties in China. After the 20th century, with the advancement of plant pathology and horticulture, the formula and use of whitening agents gradually standardized and became a routine measure in modern garden and orchard management. With the frequent occurrence of climate change and extreme weather, the role of white coating on tree trunks in antifreeze, pest control, and other aspects has become increasingly important. In recent years, with the introduction of mechanized and intelligent devices, tree trunk whitening technology has also been constantly innovated and improved.

2. The Principle and Function of Painting Tree Trunks White

2.1 Reflecting Sunlight and Regulating Tree Temperature

The white substance (such as lime) in the whitening agent can reflect sunlight, reduce the absorption of solar radiation by the tree trunk, thereby reducing the temperature difference between day and night[1], preventing freezing damage and sunburn. Painting trees white can reflect 40% -70% of sunlight, thereby reducing the temperature of the tree body and the temperature difference between day and night, achieving the effect of anti freezingcracking; Whiteningcan reduce the surface temperature of tree trunks by up to 9℃[2]; The temperature difference between plant whitening and bare bark is reduced by about 2 ℃ between 13:00-20:00; The relative moisture content increased by 3.9%, and the relative conductivity decreased by 7.4%[3]; In addition, the trunk of magnolia trees exposed to direct sunlight can be treated with lime powder mixed with water at a ratio of 1:5 to form lime milk, which can prevent sunburn[4]. Whitening plants has a certain shading effect,

with a small diurnal range, and can be used as a shading measure during the overwintering period of plants; Preventing trees from suffering from sunburn caused by excessive temperature differences, and applying white coating in autumn as a preventive measure is very effective in combating poplar sunburn disasters[5]; Compared with other cold resistant techniques, "whitening+watering" has the best effect [6]. Research by Gao et al., and others has shown that after whitening, the daytime temperature of tree trunks can be reduced by 3-5 ℃, and the amplitude of nighttime temperature changes is reduced, effectively reducing the cracking of bark caused by excessive temperature differences [7-8]. This function is also the main purpose of whitening trees in the north, which has been verified in practice in multiple places and tree species.

2.2 Sterilization and Insect Prevention

The components such as lime and sulfur in the whitening agent have bactericidal and insecticidal effects, and can kill pathogens and overwintering pests on the surface of tree trunks. Peng Yun used a stone sulfur mixture and quicklime whitening agent, with 0.25 kg of original stone sulfur mixture, 0.25 kg of salt, 1.5 kg of quicklime, an appropriate amount of oil, and 5 kg of water. After whitening peach trees, it had a significant effect on preventing and controlling the harm of red necked longhorn beetles. Compared with the unpainted peach area, the severely damaged plant rate and total damaged plant rate in the painted peach area were significantly reduced, with the tota1 damaged plant rate decreasing by as much as 30.64%; The egg laying inhibition rate of stem boring pests (such as longhorn beetles) and the egg reduction rate of red necked longhorn beetles are 87.6%[9]; The insect strain rate of painted longhorn cattle is 6%, which is 14% lower than the insect strain rate of unpainted longhorn cattle, which is 20%.Whitening of tree trunks during the peak and oviposition periods of adult insects; Mix 10 parts of lime, 1 part of sulfur, 1 part of salt, and 30 parts of water to make a paste[10]. The control effect of rust colored grain shoulder beetle larvae was 82.35%.[11] Chen Jian believes that the incidence rate of fungal diseases (such as canker and dry rot) can be reduced by painting white on tree trunks. The rate of diseased plants after painting white is 15%, which is 57% lower than that in the uncoated white area (72%) [12]; The use of traditional whitening agents mixed with stone sulfur agents in autumn and winter can effectively prevent the occurrence of early spring apple rot disease. Compared with untreated plants, the incidence of new disease spots is reduced by 40%, and the prevention and control effect can reach43.75%.[13]. The application of white coating on tree trunks has a significant effect on the prevention and control of scale insects in poplar gardens, with a reduction rate of86.7% in the number of scale insect populations, indicating good control effectiveness[14]; After whitewashing, the number of pupae or mature larvae of apple moths on the trunk of apple trees decreased by 83.3%. The overwintering pupae of apple moths on the main trunk account for 77.73% of the overwintering population[15].Zhang Jingquan found that the population density of 100 plants with the mixture of stone and sulfur was 4, and the incidence rate was 3%; The plants treated with environmentally friendly tree trunk whitecoating and powder spraying agent had a density of one insect per hundred plants, and no diseased plants were found [16]. Before the sprouting of trees in spring and during the peak period of gum disease, the combination of other pesticides and main stem whitening can alleviate the occurrence of gum disease in apricot trees.

In addition, according to the occurrence of overwintering pests and diseases in various regions, targeted insecticides and fungicides were added to the formulation of whitening agents, which can effectively control the harm of pests and diseases.

2.3 Promote Tree Growth and Reduce Pruning

Whitening has a positive effect on bark healing, increasing photosynthetic rate and shortening bark wound healing time. Animal oil, talcum powder, viscous agent, salt, fluorescent powder and other auxiliary agents in whitening agents can emulsify and disperse, accelerate tree wound healing, and have aesthetic and warning effects. Whitening can reduce the frost damage to one year old branches of plum trees, as well as promote plant germination and fruit growth [17]. Whitening has a certain promoting effect on the formation of flower buds and short fruit

branches in young trees, which is beneficial for the transformation of young trees from vegetative growth to reproductive growth [18].

Whitening plants can promote germination. In the white coating agent with a preparation ratio of 20 parts water, 10 parts quicklime, 1 part stone sulfur mixture solution, 1 part salt, and 1 part animal oil, the strip extraction rate of 19.67% was significantly lower than the control group's strip extraction rate of 57.05%[19]; The extraction rate of white painted bark decreased by 2% compared to bare bark, and the average germination rate increased by 5.2% compared to bare bark [3].However, some whitening agents have limited effects on inhibiting the stripping rate of certain plants(mainly composed of water, quicklime, sulfur powder, salt, and vegetable oil). The quality ratio of each component is 400:400:1:2:2, which is consistent with the control and whitening stripping rate [20]; Whitening plants can reduce the frost damage to one year old branches of plum trees, promote germination and fruit growth [17].

2.4 Increase Flowering Rate and Fruit Setting Rate

In the whitening agent, adding other gums (such as children's milk gum type whitening agent, seaweed gum type whitening agent, plant-based building gum type whitening agent) can reduce the incidence of sunburn and fruit drop, improve fruit yield and quality, and the cost of single fruit whitening materials is within an acceptable range. Among them, using children's white latex to prepare a whitening agent for coating Maogu citrus fruits is the optimal choice, which is worth promoting in production; White latex for children is the best adhesive for preparing whitening agents [21]. Whitening treatment significantly increased the flowering and fruit setting rates of Lanzhou Dajie apricot, Qiuhong plum, and Goddess plum [22].

2.5 Preventing Rodents, Birds, and Rabbits from Gnawing on Tree Bark

Whitening agents contain ingredients such as lime and sulfur, which can prevent animals such as mice, rabbits, and birds from gnawing and pecking on tree bark in winter;[23] In urban gardens, it is not common for livestock to gnaw on tree bark, but it is not uncommon in nurseries. When applying whitening agent to seedlings that have not yet emerged from the nursery, adding an appropriate amount of sheep oil (concentration of 0.5% to 1.0%) can effectively prevent animals from biting the bark.

2.6 Beautification and Identification Functions

Landscape greening not only belongs to the engineering category, but also to the artistic category. So in the specific process of garden construction, "aesthetics" is a factor that must be considered. Although the purpose of painting the trunk white is not primarily for aesthetics, it is important to ensure that the painting height is consistent within the same section or area to achieve a beautiful effect. The height is generally between 1.2-1.5 meters. After the trees are painted white, the trunks reflect light, making it easy for pedestrians and vehicles to see clearly at night. At the same time, it also serves as a warning, reducing the probability of traffic accidents caused by unclear road visibility.

3. Preparation and Use of Whitening Agent

3.1 Common Whitening Agent Formulas

The basic components of traditional whitening agents are quicklime, sulfur, water, and binder. In practical applications, corresponding components are added according to local conditions. Lime sulfur whitening agent: 5kg quicklime, 0.75kg sulfur powder, 1.25kg salt, 0.1kg vegetable oil, 15-20kg water [24-25]. Lime copper sulfate whitening agent: 5kg of quicklime, 0.25kg of copper sulfate, and 15-20kg of water. Stone sulfur mixture whitening agent: 2.5kg of original stone sulfur mixture, 0.25kg of salt, 1.5kg of quicklime, a small amount of vegetable oil, and 5kg of water. Whitening agents are generally prepared as needed, but in recent years, many commercial whitening agents have emerged in the market, most of which do not indicate their ingredients.

3.2 Precautions for Use

The key technical points for whitening tree trunks include whitening time, whitening height, whitening quality, etc. There may be slight differences among different tree species in different places. Whitening time: Generally carried out from late autumn to early spring to

ensure that the whitening agent can still adhere firmly at1ow temperatures [26-27]. Whitening height: usually 1-1.5m from the base of the tree trunk, ensuring coverage of all areas susceptible to freezing and pest infestations [28-29]. Uniformity of white coating: When applying white coating, it is necessary to ensure that the white coating agent covers evenly to avoid missed coating or excessive thickness [24-25].

4. Tree Trunk Whitening Technology and Equipment

4.1 Traditional Manual Whitening

Although manual whitening is simple to operate, it is inefficient, labor-intensive, and the quality of whitening varies greatly. In recent years, with the increase of labor costs, manual whitening has gradually been replaced by mechanized equipment [30-31]

4.2 Mechanized Whitening Equipment

The common white coating equipment on the market currently includes hand push white coating machines, adaptive intelligent white coating machines, and multifunctional box white coating machines. Hand pushed whitening machine: used for whitening through a roller brush or nozzle, suitable for small and medium-sized orchards and gardens.[32-33] Adaptive intelligent whitening machine: adopting infrared ranging and ultrasonic modules, automatically adjusting the whitening mode, improving the efficiency and quality of whitening [34-35]. Multi functional box whitening machine: Combining spraying and painting methods, it can be installed on tree planting vehicles to achieve integrated tree planting and whitening [36].

4.3 Comparison of Advantages and Disadvantages between Manual Whitening and Three Types of Machinery

Traditional one coat whitening is mainly done manually. With the development of the machinery industry, various types of mechanical whitening are increasingly used in garden maintenance. However, there are advantages and disadvantages between manual and mechanical, and between mechanical and mechanical, which cannot be completely replaced. See Table 1

With the development of modern electronic and mechanical technology, the replacement technology of coating machines has also accelerated, and in recent years, there has been a significant increase in the application and approval of related invention patents.

Table 1. Comparison of Advantages and Disadvantages between Manual Whitening and Three Types of Machinery

Device Type	advantage	disadvantage
Manual whitening	Easy to operate, low cost	Low efnciency, high labor intensity, uneven white coating
Hand push whitening machine	High efficiency, even white coaling	Limited scope of application, manual operation required
Adaptive intelligent whitening machine	High degree of automation and strong adaptability	High cost, high technical requiremens
Multi functionall box whitening machine	Integrated operation, saving manpover	Large size, high cost, limited adaptability

5. Problems and Challenges

5.1 Optimization of Whitening Agent Formula

The existing formulation of whitening agents still needs improvement in terms of environmental friendliness and long-term effectiveness. For example, lime based whitening agents are easily washed away by rainwater, which affects their effectiveness[25][37]. The ratio of lime to binder affects durability [38];0.25kg of original solution of stone sulfur mixture, 0.25kg of salt, 1.5kg of quicklime, appropriate amount of oil, and 5kg of water have significant effects on preventing and controlling the harm of red necked longhorn cattle [39].

5.2 Technical Training and Promotion

The promotion of whitening technology requires strengthening technical training and improving the operational level of fruit farmers and gardeners. For example, how to choose the appropriate whitening agent formula based on tree species and environment, and how to use mechanized

equipment correctly [8][40]. Whitening machinery needs to be promoted more vigorously. Although mechanized whitening equipment has high efficiency, it is costly and difficult to promote. Especially in economically underdeveloped areas, manual whitening still dominates [30-31]

5.3 Potential Negative Effects

Price wars, bad money driving out good money: compressing costs by cutting corners. The price difference of products of the same specification is up to 10 times, making it difficult for consumers to distinguish the cost-effectiveness. Brand manufacturers and counterfeit factories share OEM factories, and OEM production leads to quality loss of control, and the cost-effectiveness of white coating cannot be guaranteed. Excessive whitening inhibits the respiration of tree bark. Traditional whitening agents contain components such as lime and salt, which can easily aggravate the degree of soil salinization and pollution in the roots after peeling off. The alkaline nature of whitening agents can change the pH value of the root soil, causing local soil compaction and inability to absorb various mineral elements, which in turn leads to poor plant growth and affects the growth of some trees. Isolation and protective measures need to be taken to prevent whitening agents from entering the soi1.

5.4 Unrealistic Form Ideas

Whitening agents have different effects on different plants such as coniferous and broad-leaved trees, seedlings and adults, native plants and invasive species. When whitening tree trunks, without considering specific situations, the effect is uniform and counterproductive. In many places, in the actual operation process, there are areas that are inspected by leaders and painted white, while areas that cannot be inspected have insufficient or no painting; There is even a phenomenon of using coatings instead of specialized whitening agents.

6. Conclusion and Suggestions

6.1 The Protective Effect of Whitening on Tree Body

Whitening plants plays an important role in preventing sunbum and freezing damage, pests and diseases, inhibiting bacteria, reducing sunburn and fruit drop rates, promoting germination and reducing pruning, preventing rodents, birds and rabbits from gnawing on tree bark, and beautifying and labeling functions.

6.2 Scientific Control of Usage Conditions

Whitening tree trunks has a certain effect on protection and growth promotion, and its effect varies for different plants. However, scientific control of usage conditions is still necessary when whitening the same species. In addition, whitening has a certain impact on the overwintering growth of newly planted seedlings, which can improve the overwintering survival rate and growth of some tree species. However, the impact on locally planted trees that have been planted for many years is not significant. Whitening the trunk is a long-standing and effective tree protection measure, but it is not necessary for all regions and tree species. Careful identification and precise application are necessary during use to ensure effectiveness without causing waste. Painting the trunk white is mainly suitable for places where the daily temperature changes dramatically, such as areas with thin bark, dark skin color, newly planted trees, young trees, exotic species, susceptible tree species or seedlings.

6.3 Standardize the Market and Application

Collaborate with departments such as agriculture, marketing, and environment to quickly establish mandatory regulations on the formulation and composition of whitening agents, or to include them in pesticide management. Avoid pharmaceutical companies adding whitening agents indiscriminately, which may increase costs, cause environmental pollution, and have toxic side effects. For situations where whitening agents are used in a formalistic manner, such as sudden inspections, unsuitable seasons, or solely for environmental aesthetics, once discovered, they should be dealt with seriously and resolutely prevented from happening.

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