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Mini Review
Factors Impacting Sheepnose Incidences and Potential Practices in Citrus: A Mini Review

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Abstract

Grapefruits, or citrus in general, contribute importantly not only to human health but also to the economy because they can be exported worldwide. Thus, quality of them, especially the shape, is required more strictly. One of the most common incidences influencing the exporting standard is sheepnosing. Therefore, this review was made to investigate factors that contribute to sheepnosing and also potent cultivation techniques to control. It was affected by many factors, including geographical location, rootstock, irrigation and fertilization. Sheepnosing can become severe in not only quality but also quantity, when fruits face one of these conditions, including low humidity, high temperature, large day/night temperature gap, budded to sour orange, microjet irrigation, high N fertilization and low K fertilization. Up to now, there is a lack of methods that can predict the sheepnosing incidence in grapefruit and among the factors, the proper use of fertilizers is the controllable one. Thereby, good and balanced fertilizations are needed. For that demand, an application of both the Diagnosis and Recommendation Integrated System (DRIS) and the Site-Specific Nutrient Management (SSNM) is potent. The DRIS can show which fertilizers should be used to achieve the optimum yield of a crop, while SSMN can balance and determine which nutrients that crop needs and the nutrients providing the capacity of the local soil.

Key words: Citrus, fertilization, grapefruit, nutrition status, sheepnosing, diagnosis and recommendation integrated system, site-specific nutrient management

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INTRODUCTION

Citrus is one of the most important fruits in the world, which plays extremely important roles not only in the economy but also in the health of human-beings[1]. Moreover, fruits are no longer used locally, they are required in other parts of the world[2], so fruit shape is more considered than it used to be in the past. One of the incidences in grapefruit shape is sheepnosing. With diversity in geographical locations and times, some grapefruit crops have become ovoid with high-collared and depressed bases like a snout, popularly known as "sheepnosing"[3]. It can be known as pear-shaped fruits[4,5]. Sheepnosing in fruits is accompanied by thick rinds and puffy fruits[4] and is a major factor of elimination from the packhouse due to failure to fulfill export and market requirements[6,7]. While rind diameter represents a good percentage, sheepnosed fruit would negatively influence the commercials[8]. Sheepnosing is usually found in young and vigorous nuclear trees[9], more in the inland than in coastal areas and more in large fruit than in small ones. The quantity of sheepnosed fruits in South Africa changes from year to year and place to place. However, the understanding of sheepnosing is insufficient. Moreover, no effective approach to predict the occurrence of sheepnosing at the beginning of a crop has been found. Therefore, to meet the requirement of modern markets, the factors influencing the sheepnosing need to be summarized in this study and investigated in the near future. It has been told that humidity, temperature and some possible other factors that take part in affecting fruit shape[3]. Many factors, e.g., fruit varieties, rootstocks and crop removal, limit the yields or increase the average fruit size, i.e., increase the percentage of sheepnosing. Sheepnosing symptoms in citrus were investigated in Vietnam (Fig. 1-9).

Key factors impacting sheepnose incidences in citrus

Location and temperature: Locations, as well as the climates, are known to affect the fruit shape tremendously because they facilitate tree water status and fruit development[6]. For instance, when humidity is high and daily mean temperature is low, the sheepnosing is fewer[6]. On the contrary, sheepnosed fruits are more likely to be found in inland and arid areas with high temperatures and low relative humidity[10], along with warm at day and cold at night, which results in a huge difference in the maximum and minimum temperatures[3]. In Israel, from 8 locations, fruit sheepnosing has been measured to be correlated to climate, which was strongly negatively correlated to evaporation rate[10]. On the other hand, sheepnosing is found rarer in coastal growing areas[3], humid

Fig. 1(a-c): (a) Top, (b) Front and (c) Cut views of sheepnosing signs captured on limes in Vietnam and indicated by red arrows

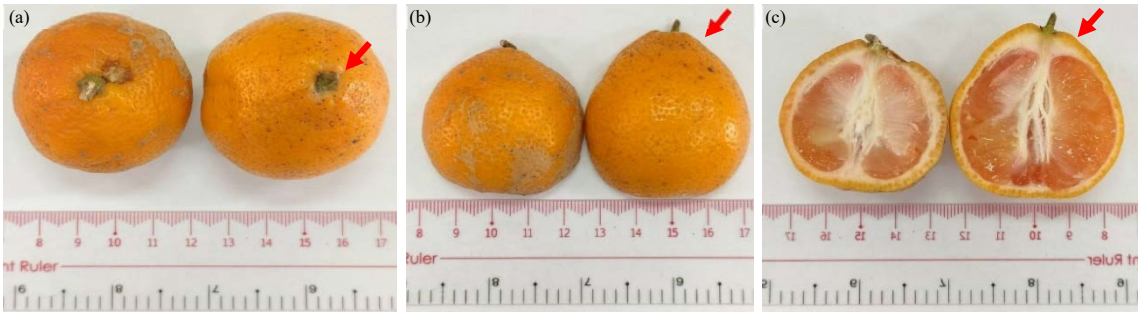

Fig. 2(a-c): (a) Top, (b) Front and (c) Cut views of sheepnosing signs captured on lemons with rosy pulp in Vietnam and indicated by red arrows

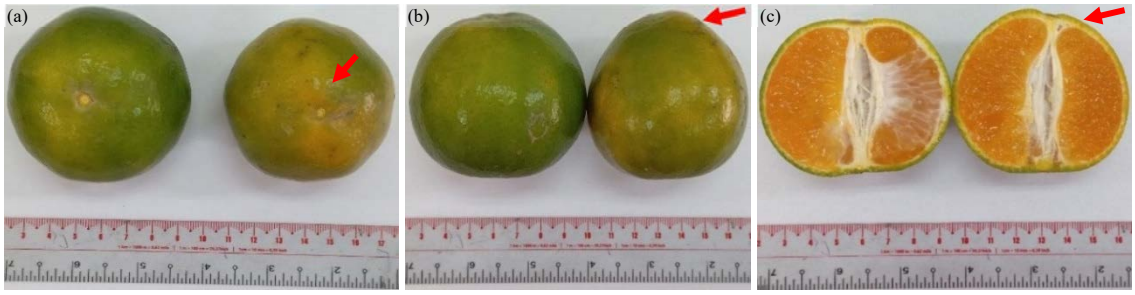

Fig. 3(a-c): (a) Top, (b) Front and (c) Cut views of sheepnosing signs captured on sweet mandarins in Vietnam and indicated by red arrows

Fig. 4(a-c): (a) Top, (b) Front and (c) Cut views of sheepnosing signs captured on grapefruits in Vietnam and indicated by red arrows

Fig. 5(a-c): (a) Top, (b) Front and (c) Cut views of sheepnosing signs captured on king oranges (Xoan) in Vietnam and indicated by red arrows

Fig. 6(a-c): (a) Top, (b) Front and (c) Cut views of sheepnosing signs captured on king mandarins (Sanh) in Vietnam and indicated by red arrows

Fig. 7(a-c): (a) Top, (b) Front and (c) Cut views of sheepnosing signs captured on Egyptian mandarins in Vietnam and indicated by red arrows

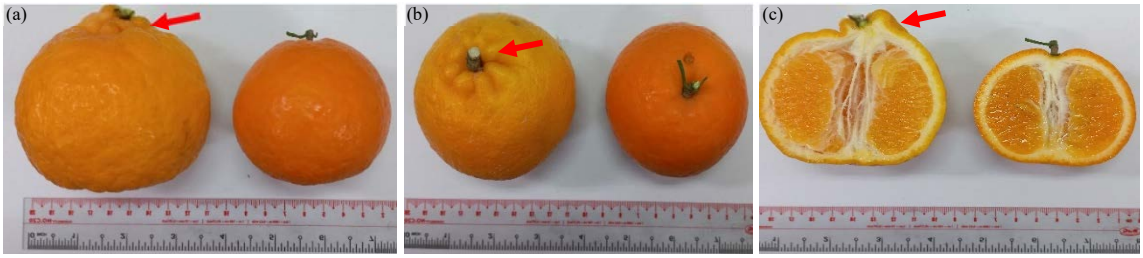

Fig. 8(a-c): (a) Top, (b) Front and (c) Cut views of sheepnosing signs captured on Australian mandarins in Vietnam and indicated by red arrows

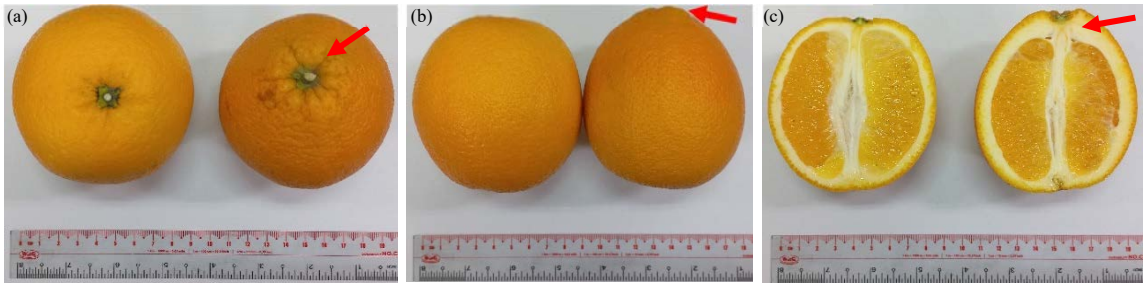

Fig. 9(a-c): (a) Top, (b) Front and (c) Cut views of sheepnosing signs captured on Egyptian oranges in Vietnam and indicated by red arrows

subtropical or tropical conditions[11]. In particular, regarding locations, grapefruits in Weslaco were found to have a higher sheepnosing rate than that in Mission, with 62.66% compared to 57.32%, while in Bayview, the rate was little and valued approximately at 4.07[12]. In addition, during late blooms or off-blooms, i.e. during warm late spring, sheepnosing becomes more abundant[3]. During bloom or early fruit formation, dry weather and higher than normal temperature are the most likely to cause sheepnosing[7]. Simultaneously, the increasing temperature during flower bud formation results in elongated fruits, in another word, increase percentage of sheepnosing[13]. For temperature gap, in the study of Wutscher[3], influences of environments on fruit shape of 'Redblush' grapefruit have been analyzed and resulted in that day and night temperatures participate significantly. Fruits treated with a 32°/30°C day/night temperature result in increased stem-ends, while with a 32°/24°C results in a normal fruit shape and with a 32°/7°C, severe sheepnosing happens, in another word, when the temperature difference is 25°C, fruits get sheepnosed. Moreover, reducing the day length from 14 to 11 hrs does not influence on fruit shape.

Rootstock: For rootstock, available information about the effects of rootstock on sheepnosing is insufficient[6]. McCollum and Bowman[14] found that the fruit peel of citrus is thicker and rougher when the rootstock is sour orange, instead of sweet lime, leading to an increase in the sheepnosing rate. Likewise, as found in the study by Patil[12], 'Rio Red' grapefruits on Carrizo [*C. sinensis* (L.) Osbeck × *Poncirus trifoliata* (L.) Raf.] possessed a significantly higher percentage of sheepnosing (59.46) than those on Swingle (*C. paradisi* × *P. trifoliata*) (47.83). Rootstock may have a secondary effect on sheepnosing by affecting fruit yield or fruit size.

Irrigation: Sheepnosing signs, including rind thickness and fruit size, may be influenced by water stress[6]. Grapefruits have a significantly higher percentage of sheepnosing (53.40) with microjet irrigation than with flood irrigation (42.68)[6]. In another word, declining water application leads to reductions in fruit size and the percentage of sheepnosing. Controlled decreasing irrigation appears to be a way to reduce fruit size and sheepnosing. Thus, optimization of irrigation is required to prevent a poor set of large fruits. Trees applied with microjet irrigation possess a higher quantity of sheepnosing than those with flood irrigation[6]. Moreover, in sandy soil, sheepnosing appears to be more severe than in silt loam[11]. Ultimately, sheepnosing can be affected by water status. Therefore, fruit growth can be slowed down by reducing irrigation, thereby, sheepnosed fruits can be decreased. In another word, drought stress can be applicable to reduce the sheepnosing incidence, if it is moderate and temporary.

However, on 'Rio Red' grapefruit (*Citrus paradisi* Macf.) and on sour orange (*Citrus aurantium* L.) rootstock, at three sites in the Lower Rio Grande Valley of Texas, a two-year field study was carried out to determine factors that influence sheepnosing, including location, rootstock and irrigation[12]. Altogether, the irrigation and rootstock are considered to participate in sheepnosing less than the location[12].

Fertilization: Although irrigation quantity and timing can be said to be vital factors in citrus crop yield and quality[15], different types and quantities of fertilizers can change fruit yields and shapes. Different levels of nitrogen, potassium, calcium and boron in leaves have been found correlated to the sheepnosing[6]. Particularly, N fertilizer applied with timing and different quantity can reduce the amount of sheepnosed fruits, whose shape is more ovoid, limiting packing into fruit boxes[7]. Split N fertilization at high levels from ammonium sulfate to citrus leads to more sheepnosed fruits[16]. While N fertilizer rate is risen, the sheepnosing is more likely to happen[7]. Annual high N applications can lead to sheepnosing, which can result in decreased fruit sales to the fresh market[17]. Moreover, gibberellin, a phytohormone, should be limited, because it can elongate the crop duration, leading exhaustion of carbohydrates, which increases the rate of sheepnosing.

Potential practices to reduce sheepnose incidences in citrus: Among the above factors, fertilizer is a factor that can be manipulated the most easily and effectively, it can not only supply nutrients to crops but also ameliorate the nutrient contents within the soil. However, how much fertilizers plants require to reach the maximum yield, what the amount of fertilizers is and which fertilizers should be chosen are questions to be solved. Fortunately, with the advent of the Diagnosis and Recommendation Integrated System (DRIS) and Site-Specific Nutrient Management (SSNM), a promising approach to those questions appears. In particular, DRIS can categorize which nutrients are needed more than the other and vice versa, which nutrients are too excessive based on the maximum yield of a crop[18]. Thereby, fertilizers are chosen or got rid of based on DRIS indices, i.e. negative, positive and zero index of a nutrient means deficiency, excess and balance[19]. Many crops have been applied with DRIS, e.g., citrus[20], mandarin[21], orange[22], etc. On the other hand, SSNM can provide optimum fertilization between the nutrients from fertilizers and those from natural sources such as soil, crop residues and water[23]. Notably, this has been applied to citrus and mandarin as well[24].

CONCLUSION

This review has gone through the principal signs of sheepnosing incidence. It is affected by several factors. Firstly, the growing locational factor, fruits suffering from low humidity and high temperature or remarkable temperature gap between day and night (approximately 25°C) can get sheepnosed more possibly. Secondly, rootstocks can play a role, but the effect is considered to be secondary. Thirdly, in irrigation, the more water is applied, the higher chance of sheepnosing is, though the effect of both rootstock and irrigation is not as significant as the geographical location. Last but not least, fertilization, while the high level of N fertilizer can cause sheepnosing, doubled level of K can suppress it. Among them, fertilization is more like to be controllable as many approaches have been made to balance and optimize nutrients applied to crops.

SIGNIFICANCE STATEMENT

The current review was made to raise a new concept of a disorder in grapefruits, which are one of the most important crops in Vietnam. The incidence here is the sheepnosing, which can decrease the economic quality of grapefruits and it has not been known well due to the lack of studies. The review found that nutrients in fertilization contribute to the occurrence of the sheepnosing. Fortunately, there are two novel methods known as diagnosis and recommendation integrated system and site-specific nutrient management, which have been widely applied to crops, especially citrus plants, in the last decade. Altogether, they can determine the ideal amount and type of fertilizers based on the maximum crop yield and the indigenous soil factors to prevent the prevalence of sheeposed fruits.

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