The effect of *Botrytis Cinerea* and *Rhizopus Stolonifer* on pre-harvest energy losses of strawberry production in Iran

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Abstract: It is well accepted that agricultural production must be increased considerably in the foreseeable future to meet the food and feed demands of a rising human population and increasing livestock production. Crop protection plays a key role in safeguarding crop productivity against competition from weeds, animal pests, pathogens and viruses. The aim of this study was to evaluate the amount of energy losses caused by pre-harvest strawberry losses in the Kurdistan province of Iran. These losses were caused by *Botrytis cinerea* (Gray Mold) and *Rhizopus stolonifer*. The average pre-harvest losses of strawberry production were found to be 6% in this study, thus the average losses were found to be about 544.3 kg ha^{-1}. The total energy losses of strawberry production in the study area are estimated to be 2.585 TJ. This amount of losses is equal to 422.5 BOE (Barrel of Oil Equivalent), also the total pre-harvest strawberry losses are equal to 1,673,412.3 $. Tools and techniques are needed to assist in developing strategies that can lead to higher food production, prevent crop production losses, and ensure minimal greenhouse gas emissions while maintaining soil fertility. [Journal of American Science 2010;6(5):257-260]. (ISSN: 1545-1003).

Key words: *Botrytis*; energy losses; Kurdistan; Iran; *Rhizopus*; strawberry

1. Introduction

The increasing world population has led to increased demand for food and reduced per capita availability of arable land and irrigation water. Compounding this problem is the fact that most farmers in the developing world own only small plots of land that have the potential to feed one family and generate income. Low soil fertility and crop losses from pests and droughts have reduced harvests to below subsistence levels (Vasil, 1998; Conway and Toenniessen, 2003). Small-scale farmers in developing countries are faced with many problems and constraints. Pre- and postharvest crop losses due to insects, diseases, weeds, and droughts result in low and fluctuating yields, as well as risks and fluctuations in incomes and food availability (Tonukari, and Omotor, 2010).

Significant to the goal of increasing productivity per unit area is the need to reduce crop losses occurring at different stages of production. Crop losses occur during the pre-harvest period mainly due to either the wrong application of cultivation techniques or natural factors such as frost, flood, plant diseases and pests. These are potential losses and generally are reported as low productivity (Tatlidil et al., 2005).

Assessments of crop losses despite actual crop protection strategies are required to demonstrate where action is needed and for decision making (Smith et al., 1984).

Most often, losses due to pests are the major limiting factor for sustaining the increase in crop productivity and production. On average, the avoidable crop losses caused by pests, such as insects, diseases, weeds and others in India, have been estimated to range from 10% to 30% of the total production. To keep pace with the demand for food commodities, adoption of appropriate strategies that include effective, economical, safe and environmentally sound plant protection technology in sustainable agriculture is a critical requirement (Chandurkar, 2001).

In the United States, the pre-harvest crop losses to pests including arthropods, weeds, diseases, and nematodes, were estimated to be about 37 % of the maximum potential yield (Pimentel et al. 1993).

When soil conditions are altered so that the overall soil community that buffers the ecosystem is influenced negatively, soilborne pests and pathogens proliferate and cause tremendous yield losses. To ensure long term sustainable, effective land use management is essential (Abawi and Widmer, 2000).

Strawberry is an important small fruit, grown throughout the world. It is deep red in color with unique shape and flavor. The major strawberry producing countries of the world are USA, Spain, Japan, Poland, Korea and Russian Federation. The estimated production of strawberries in the world during 2007 was 5822 thousand tons (Sharma et al., 2009).

Losses can be categorized on the basis of cause into three classes: Mechanical damage, physiological damage (storage disorders), and biological damage (insect and pathogen diseases) (Ferguson et al., 1999). Biological damage is the most important portion of pre-harvest losses of strawberry production in Iran.

The most common decay of strawberry is Botrytis rot, also called Gray Mold, caused by *Botrytis cinerea* (Ceponis et al., 1987). The disease can begin pre-harvest, remaining as latent infections, or begin postharvest. This fungus continues to grow at 0 °C (32 °F). However, growth is slow at this temperature. Rhizopus rot caused by *Rhizopus stolonifer* is another important disease of strawberry. This fungus cannot grow at temperatures below 5 °C (41 °F) (Sommer et al., 1973). Depending on the cultivar, untreated strawberries can quickly become infected, damaging both yields and fruit quality. Of all the diseases, perhaps the most important is Botrytis fruit rot (Botrytis cinerea), causing pre-harvest losses of up to 15% of the fruit on susceptible cultivars (Legard and Chandler, 1998, 2000; Legard et al., 2000).

Crop diseases caused by fungi, bacteria, viruses, and plant parasitic nematodes inflict a significant amount of losses on crops. For instance, according to the field study by Holeta Agricultural Research Station (1986), losses on field crops ranged between 32-52%. Similarly the average loss on industrial crops ranged between 22 and 44%, and on horticultural crops ranged between 35 and 62% (Amera and Abate, 2008).

Life is a continuous process of energy conversion and transformation. The accomplishment of civilization has largely been accomplished due to the increasing efficient and extensive harnessing of various forms of energy to extend human capabilities and ingenuity. Energy is thus one of the indispensable factors for continuous development and economic growth (Mohamed et al., 2006).

In developing countries like Iran, agricultural growth is essential for fostering the economic development and meeting the ever-higher demands of the growing population. Energy in agriculture is important in terms of crop production and agro processing for value adding (Karimi et al. 2008).

Energy use in agriculture has been developed in response to increasing populations, limited supply of arable land and desire for an increasing standard of living. In all societies, these factors have encouraged an increase in energy inputs to maximize yields, minimize labor-intensive practices or both (Esengun et al. 2007).

The aim of this paper was to estimate the amount of energy losses caused by pre-harvest strawberry losses in the Kurdistan province of Iran. These losses were caused by *Botrytis cinerea* (Gray Mold) and *Rhizopus stolonifer*.

2. Materials and methods

In this study, the data were collected from 110 farmers in 13 villages growing strawberry in Kurdistan province, Iran by using a face-to-face questionnaire in August-September 2009. The province is located in the west of Iran, within 34° 44´–36° 30´ north latitude and 45° 31´–48° 16´ east longitude. The total area of the Kurdistan province is 2,820,300 ha. The average rainfall of the province is 450 millimeters (Salami et al., 2009).

The total land area cultivated for strawberry crop was 3800 ha in Iran and this amount was 2500 ha in Kurdistan province in 2007. In this year, the total production of strawberry was 38500 tones, while this amount was 30951 tones in Kurdistan province, thus about 80% of total strawberry production in Iran was obtained from Kurdistan province (FAO, 2007; Ministry of Jihad-e-Agriculture of Iran, 2007).

The amounts of strawberry losses were calculated per hectare and then, these data were multiplied with the coefficient of energy equivalent. Energy equivalent of strawberry is equal to 1.9 MJ kg^{-1} (Singh and Mittal, 1992).

3. Results and discussion

The average annual yield of strawberry farms was 9071.6 kg ha^{-1} in the study area. The average pre-harvest losses of strawberry production were found to be 6% in this study, thus the average losses is about 544.3 kg ha^{-1}. The total land area cultivated for strawberry crop in Kurdistan province is 2500 ha, so the total pre-harvest strawberry losses in Kurdistan province are evaluated as 1360.75 ton. As the energy equivalent of strawberry is equal to 1.9 MJ kg^{-1}, thus the total energy losses of strawberry production in Kurdistan province are estimated to be 2.585 TJ. This amount of losses is equal to 422.5 BOE (Barrel of Oil Equivalent). Also the total pre-harvest strawberry losses are equal to 1,673,412.3 $.

Oerke and Dehne mentioned the estimates of the worldwide loss potential of fungal and bacterial pathogens in wheat, rice, maize, barley, potatoes, soybeans, sugar beet, and cotton totaled 16%, 16%, 11%, 15%, 22%, 11%, 14%, and 9%, respectively (Oerke and Dehne, 2004).

Van Leeuwen et al. evaluated the pre- and post-harvest yield losses caused by *M. fructigena* in two susceptible apple cultivars. They notified that the final pre-harvest yield losses in both apple cultivars ranged from 2.7% to 4.4% over both years. In conclusion, yield loss caused by *M. fructigena* did not exceed 5% in the pre-harvest stage (Van Leeuwen et al., 2000).

Total crop loss to tomato farmers in the Ayaş district represented 25.92% of production; whereas in the Nallihan district it represented 27.51%.The breakdown of this total crop loss for Ayaş involved 14.78% loss during the seedling period, 5.99% during the field production period, and 5.15% during the harvest period. The breakdown for Nallihan was 12.76% for the seedling period, 4.92% for the field production period, and 9.83% for the harvest period, with the harvest period breakdown being 4.44% represented by fruit cracking, 2.9% by fruit rotting, and 2.49% by sun scalding (Tatlidil et al., 2005).

This study evaluated the amount of energy losses caused by pre-harvest strawberry losses. It seems that the amount of post-harvest strawberry losses is much higher than pre-harvest losses, thus another study is needed to determine the energy losses caused by post-harvest strawberry losses.

4. Conclusions

The average pre-harvest losses of strawberry production were found to be 6% in this study. As the average annual yield of strawberry farms was 9071.6 kg ha^{-1}, thus the average losses are about 544.3 kg ha^{-1}. As the total land area cultivated for strawberry crop is 2500 ha in the study area, so the total pre-harvest strawberry losses are evaluated as 1360.75 ton, thus the total energy losses of strawberry production in Kurdistan province are estimated to be 2.585 TJ. This amount of losses is equal to 422.5 BOE (Barrel of Oil Equivalent). Also the total pre-harvest strawberry losses are equal to 1,673,412.3 $.

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