Pepper

Cultivation Insights

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Improving Pepper Marketable Yield Efficiency

- The production of sub-premium pepper fruit lowers the profitability of a production operation.
- Optimizing growing conditions and production practices can minimize the percentage of non-marketable fruit produced.
- Alternative markets and uses for sub-premium and non-marketable fruit can improve profitability and reduce waste.

Genetics and Marketable Yield Efficiency

Pepper varieties can differ widely in fruit production characteristics and their responses to production practices and environmental conditions. In an evaluation of 15 pepper varieties grown under the same greenhouse conditions, one study found that the time to first harvest varied from 74 to 83 days, the number of premium quality fruit (commonly known as #1 fruit) varied from 2.0 to 7.25 per plant, the percentage of non-marketable fruit waste varied from 9.9% to 25.8%, and marketable yield varied from 44 to 77 tons per hectare.[1] It is important for growers to select varieties that are best suited for the production system used, the seasonal environmental conditions, and the market requirements. A variety that does well in a two-stem "V" system in a warm, high-light environment may not be well suited for a multi-stem production system or for cool-season production. Also, selecting varieties that are less prone to blossom end rot and stip and have thick-walled fruit that stand up well to transportation and storage conditions will improve the marketable yield efficiency level.

Pepper growers should evaluate varieties and determine which have the highest potential for marketable yield in their production system environments. Choosing varieties based on total-yield estimates alone may result in the production of a large percentage of non-marketable product.

Optimizing Growing Conditions

Lighting. Greenhouse pepper production is a long-term endeavor, taking eight to eleven months to complete a full cropping cycle. Short-term conditions and production practices can have long-term impacts. The use of supplemental light can be important for fruit retention, especially in the winter and early spring. The abortion of young fruit is directly tied to the products of photosynthesis, and low light conditions result in higher levels of fruit abortion.[2] Adding supplemental light can help increase fruit number, fruit weight, and total fruit yield per plant, especially at times of the year and geographic areas where the intensity and duration of natural light are low.[5] While the use of supplemental light can increase production and reduce the percentage of non-marketable fruit, it may not be economically feasible for all production systems.[2,3]

Conversely, high light levels in the summer can result in elevated greenhouse temperatures that also result in fruit abortion. Using shade cloth or whitewashing greenhouses can help keep temperatures near optimum, reducing fruit abortion problems.[2] The more diffuse light in shaded and whitewashed houses can also improve plant growth, increasing the size and number of fruit, and result in faster rates of fruit maturation. High temperatures can also result in lower fruit quality. For example, the movement of calcium into the fruit is reduced at higher temperatures, and this can result in higher levels of blossom end rot and stip.

Temperature. Nighttime temperatures are crucial for fruit production. With lower night temperatures, plants put more energy and resources into fruit production. With higher temperatures at night, more energy is put into vegetative growth. Optimal fruit production is usually seen with relatively cool night temperatures, 16 to 17 °C (61 to 63 °F), and moderately warm daytime temperatures, 21 to 23 °C (70 to 73 °F).[3] Lower night temperatures (at least 3 hours) also promote thicker fruit wall development. At higher temperatures fruit quality declines, especially when humidity levels are high, reducing the plant's ability to cool through evapotranspiration.

Figure 1. Malformed fruit from improper fruit-set conditions.

Planting Density. Fruit development is also affected by planting density. At higher densities, there is more competition among plants for light, and individual plants produce fewer leaves, which are needed to produce photosynthates that support fruit production. As a result, higher levels of fruit abortion occur as plant densities increase.[4]

Carbon dioxide. Increasing the rate of photosynthesis, and decreasing the proportion of non-marketable fruit can also be

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accomplished by elevating the level of carbon dioxide (CO_2) in the greenhouse, as the plant uses carbon dioxide, light, and water to make the sugars that support plant growth and fruit development. Even during periods of warm weather with full ventilation, levels of CO_2 in the greenhouse can drop below outside ambient levels (350 ppm).[5]

Several methods can be used to elevate CO_2 levels in the greenhouse. Natural gas CO_2 generators can be placed above the canopy where they burn natural gas and give off CO_2. Boiler stack recovery systems can recover CO_2 from the exhaust of clean burning, high efficiency boiler systems used to heat the house. The recovered CO_2 is delivered directly into the canopy through pipes. An advantage of liquid CO_2 is the lack of combustion by-products, which can be a problem when using the other two systems. The liquid CO_2 system also uses pipes to put CO_2 directly into the canopy. The drawback to this system is that liquid CO_2 can be expensive to purchase.[3]

Irrigation. Irrigation is another important process. A group of five to six pepper plants generally require about three liters of water per day, but the frequency amount of water per application affects plant growth and fruit production. High amounts of water (120 ml/application) applied less frequently promotes vegetative growth. This irrigation schedule is often used early in the season to promote root growth and strong plant establishment. Lower amounts of water (80 ml/application) applied more frequently promotes fruit production, and this schedule is used once the plants are established and starting to produce fruit.

Production Practices

Pruning systems. A pruning system should be selected that will result in the best match of fruit size and consistency of production to the intended market. A two-stem or "V" production system produces larger fruit but fewer fruit per plant as compared to a three– or four-stem system. Whichever pruning system is used, the goal is to balance the distribution of photosynthates (sugars) between vegetative tissues and fruit production. Pepper plants naturally cycle between periods of high fruit set and low fruit growth and periods of low fruit set and rapid fruit growth, resulting in periodic flushes of fruit.[4] Maintaining a balance through proper pruning helps reduce flower/fruit abortion and provides for a more continuous harvest. Because older fruit on the plant cause the abortion of nearby younger fruit, flower pruning to maintain five developing fruit per stem will help reduce fruit abortion and even out fruit production.[6]

Harvest period. Early and late in the harvest period fruit are typically harvested once per week, removing one fruit per plant. At the height of harvest, fruit can be harvested twice a week, still removing one fruit per plant at each harvest. Plants can be stressed to promote a flush of fruit in order to hit a particular market window. However, doing so will require a resting period before plants will begin setting fruit again, delaying future harvests. This practice also can reduce the quantity and quality of future fruit production.

Alternate Uses for Lower Quality Fruit

Even in well managed systems, there will be fruit produced that do not meet market specifications. Instead of discarding this fruit, growers should consider alternative uses to reduce waste and increase profitability. One option is to find a secondary market, such as the chopped and frozen or chopped and freeze-dried markets. Peppers also can be used to make vegetable oil. Sub-premium peppers can be donated to food banks or other charity outlets, and such a donation may be tax deductible.

Some operations use bio-incinerators to generate heat for the greenhouse, and unsaleable peppers can be used in such systems as energy sources. Finally, unusable peppers can be composted, which will reduce the amount of waste and provide organic matter for use in field applications.

Sources:

[1] Elizondo-Cabalceta, E. and Monge-Pérez, J. 2017. Evaluation of yield and quality of 15 bell pepper (*Capsicum annuum* L.) genotypes grown under greenhouse conditions in Costa Rica. Tecnología en Marcha. Vol. 30-4:3-14.
[2] Jovicich, E., Cantliffe, D., and Stoffella, P. 2004. Fruit yield and quality of greenhouse-grown bell pepper as influenced by density, container and trellis system. HorTechnology 14: 507-513.
[3] Production of sweet bell peppers. Alberta Agriculture and Forestry. http://www1.agric.gov.ab.ca/%24department/deptdocs.nsf/all/opp4523.
[4] Marcelis, L., Heuvelink, E., Hofman-eijer, L., Bakker, J., and Xue, L. 2004. Flower and fruit abortion in sweet pepper in relation to source and sink strength. J. Exp. Bot. 55: 2261-2268.
[5] Li, X., Kang, S., Li, F., Zhang, X., Huo, Z., Ding, R., Tong, L., Du, T., and Li, S. 2017. Light supplement and carbon dioxide enrichment affect yield and quality of off-season pepper. Agronomy Journal 109:2107-2118.
[6] Sanchez del Castillo, F., Moreno-Perez, E., Resendiz-Melgar, R., Colinas-Leon, M., and Rodriguez Perez, J. 2017. Bell pepper production (*Capsicum annuum* L.) in short cycles. Agrociencia 51:437-446.

For additional agronomic information, please contact your local seed representative.

Performance may vary, from location to location and from year to year, as local growing, soil and weather conditions may vary. Growers should evaluate data from multiple locations and years whenever possible and should consider the impacts of these conditions on the grower's fields. The recommendations in this article are based upon information obtained from the cited sources and should be used as a quick reference for information about greenhouse pepper production. The content of this article should not be substituted for the professional opinion of a producer, grower, agronomist, pathologist and similar professional dealing with this specific crop.