นวัตกรรมในการผลิตมะละกอปลอดภัย
Innovations in Safe Papaya Production

รภัสสา จันทาศรี
Rapatsa Janthasri
สาขาเกษตรศาสตร์ คณะเทคโนโลยีการเกษตร มหาวิทยาลัยราชภัฏมหาสารคาม
อำเภอเมือง จังหวัดมหาสารคาม
Department of Agriculture, Faculty of Agicultural Technology, Maha Sarakham
Rajabhat University, Maha Sarakham, Thailand
Email: juntasri@hotmail.com

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บทคัดย่อ

การผลิตมะละกอเพื่อความปลอดภัย หรืออาจเรียกเป็นการผลิตมะละกอในระบบอินทรีย์ ซึ่งมีวิธีการปฏิบัติได้หลายแบบ อาทิ การเลือกช่วงเวลาปลูกที่เหมาะสม การจัดการธาตุอาหารและการควบคุมวัชพืช การผลิตมะละกอเพื่อความปลอดภัย สามารถทำได้โดยการปลูกผสมผสานกับพืชชนิดอื่นซึ่งสามารถควบคุมการเกิดโรคและป้องกันแมลงศัตรูพืช การผลิตมะละกอปลอดสาร การผลิตมะละกอระบบเกษตรอินทรีย์ การผลิตมะละกอตามแนวปฏิบัติที่ดี (GAP) และการผลิตมะละกอในระบบเกษตรยั่งยืน การประยุกต์ใช้รูปแบบใดขึ้นกับสภาพความเหมาะสมของพื้นที่ และเป้าหมายของผู้ผลิตมะละกอ เพื่อเน้นความปลอดภัยของทั้งผู้ผลิตและผู้บริโภค โดยมีผลกระทบต่อสภาพแวดล้อมน้อยที่สุด

นวัตกรรมการผลิตมะละกอ เพื่อความปลอดภัย โดยการนำภูมิปัญญาพื้นบ้านที่เป็นเสมือนมรดกตกทอดให้กับเกษตรกรรุ่นหลังได้นำเทคนิคเหล่านี้ไปประยุกต์ใช้ให้เข้ากับสภาพแวดล้อม ซึ่งไม่จำเป็นต้องอาศัยสารเคมีในการป้องกันกำจัดโรคแมลง แต่จะเป็นแนวทางช่วยส่งเสริมต่าง ๆ ได้แก่ การปลูกพืชแซม การปลูกพืชตระกูลถั่ว การใช้ปุ๋ยคอก ปุ๋ยหมักและสารไล่แมลงสมุนไพรต่าง ๆ ให้ระบบการผลิตมะละกอมีประสิทธิภาพและเพิ่มความปลอดภัย ให้กับผู้ผลิตและผู้บริโภคอย่างยั่งยืน

คำสำคัญ: การเกษตรตามแนวปฏิบัติที่ดี (GAP) การผลิตมะละกอเพื่อความปลอดภัย ระบบเกษตรยั่งยืน

ABSTRACT

Safe papaya production, also known as organic papaya production, involves various practices such as selecting appropriate planting seasons, nutrient management, and weed control. Safe papaya production can be achieved by intercropping with other plant species to control diseases and prevent insect pests. This includes residue-free production, organic agriculture systems, Good Agricultural Practices (GAP), and sustainable agriculture systems. The application of any specific model depends on the suitability of the area and the producer's goals; the priority is the safety of both producers and consumers while minimizing environmental impact.

Innovations in safe papaya production involve integrating local wisdom, a heritage passed down to future generations of farmers, to adapt these techniques to the local environment. This approach eliminates the need to rely on chemicals for disease and pest management. Instead, it employs supportive methods such as intercropping, planting legumes, and using manure, compost, and herbal insect repellents. These practices ensure the papaya production system is efficient and sustainably enhance safety for both producers and consumers.

Keywords: Good Agricultural Practices (GAP), safe papaya production, sustainable farming system

Introduction

Vegetable and fruit growing has long been a part of Thai society. Most rural Thai families grow their own fruits and vegetables for home consumption in their yards, around the house and around their rice fields or other cash crop production areas. Papaya is a multi-use crop. Unripe papaya is mainly used to make somtam, a popular dish for people of all ages and in all parts of the country. Somtam’s appealing spicy crunch has made it popular even in other countries and now it is almost as well-known as tomyam goong and pad Thai. Of course, papaya is also a fruit for eating ripe that has good vitamin content and mild laxative qualities. (Janthasri & Chaiyaboon, 2016). Lastly, papaya can be grown for industrial processing to make canned fruit or tomato sauce,

and the papain in papaya sap can be used in the leather tanning and cosmetics industries. Papaya is grown in tropical and subtropical areas all over the world. The places with great potential for increasing papaya production in the future are China and the Middle East. Papaya is easy to grow and grows quickly so it is found at almost every household, especially in northeast Thailand. It can be planted in any season and can flower and produce fruit all year round. It is not bothered by as many insect pests and plant diseases as some other plants are. The main diseases are PRSV and root rot and the main insect pests are aphids and mites, but they normally are only a problem at the end of the rainy season and beginning of the dry season. (Food and Agriculture Organization, 2019).

People all over the world have become increasingly aware of the problems with chemical approaches to agriculture. The overuse of fertilizer, pesticide, fungicide and herbicide can have damaging effects on farmers, consumers and the environment. (Hueso, et al., 2019). More and more consumers are concerned about their health and are demanding safer agricultural products. There is strong demand for pesticide-free or organically grown fruits and vegetables.

Up to now, research on papaya has focused on 5 areas : 1.Control of PRSV 2. Increasing yield and improving fruit quality 3. Producing papaya for the export market 4. Producing papaya for processing industries and 5. Producing papaya for papain extraction. Safe papaya production touches on almost all these areas. The author's personal observation of papaya growing areas in northeast Thailand seemed to show that when papaya was intercropped with other plants it tended to reduce the incidence of PRSV. However, one research study in which papaya was intercropped with mango trees found the opposite. The study was an observation of an 8,000 square meter plantation where 800 Kaek Dam Si Sa Ket variety papayas were grown interspersed with Kaew variety mango trees for 2 years. It was found that the incidence of PRSV was even higher than in non-intercropped papaya plantations. This may have been because the farmer did not provide enough water and fertilizer for the papaya plants and didn't weed, so they were not strong. (Somsri, 2014)

In contrast, another study in which 800 papaya plants were intercropped with custard apple trees on a 6,400 square meter plot found that the incidence of PRSV was reduced by 80% and the farmer gained more income. For comparison, on another papaya plot the papaya plants were not intercropped but were sprayed with an organic

pesticide made from custard apple tree leaf extract, and it turned out this had no positive effect on PRSV incidence. Papaya can be intercropped with other plants to reduce PRSV damage. For instance, bananas are a good choice. This is partly because the banana pseudostems and leaves are mostly made of tissues that contain a lot of water, and when aphids carrying PRSV bite banana plants and suck out their juices, it tends to wash away or dilute the virus. Marigolds, basil and mint are also good choices to plant around the edges of the field and around the bases of papaya plants. Some plants act as a natural barrier, keeping the aphids from entering the papaya plantation. Marigolds are said to help maintain soil moisture and fend off nematodes that could damage the papaya roots. Nematode damage in papaya makes the plants slow growing and stunted with yellow leaves. If nematodes attack the roots before the plant begins to flower, it will never flower. There are also some plants that tend to harbor and invite PRSV-carrying aphids, such as chili pepper, eggplant and cucurbits. These plants should never be planted near papaya plantations. (Janthasri & Chaiyaboon, 2015). The purpose of this article is to compile information related to papaya cultivation or the technologies used to produce safe papaya for the benefit of farmers and other interested parties.

Guidelines for safe papaya production.

1. Plantation area

Papaya is a tropical plant in the family Caricaceae. It is tree-like but only lives 1 to 3 years. It is the most productive in the first year and fruit production declines after that, so for commercial production most farmers only keep the plants for 2 years. However, for casual household growers they tend to let it keep growing until it dies naturally. For safe papaya production, you should choose a place where PRSV has not been seen. It should be far from residential communities because most households grow papaya, and most of it is infected with PRSV. (Abeysinghe et al.,2016). The plantation area should be bordered all around by large trees because that is a windbreak and a barrier against aphids. You can also plant trees along the edges or around the sides such as banana, custard apple or rubber trees. There should be a water source that can provide water even in the dry season. A pond on the plantation can be used to store rain water and receive excess water during heavy rains. Papaya does not tolerate

flooding. If the soil is clay, trenches should be dug. If the soil is sandy, it may require more treatment with manure and compost. A research study found that beneficial soil fungus can promote the strong growth and productivity of papaya plants. In an experiment where mycorrhiza were added to the soil, the papaya plants grew taller, had thicker stems, produced more fruit and were more resistant to disease because the fungus helps the plants absorb more nutrients from the soil. (Janthasri, 2021). (Figure 1).

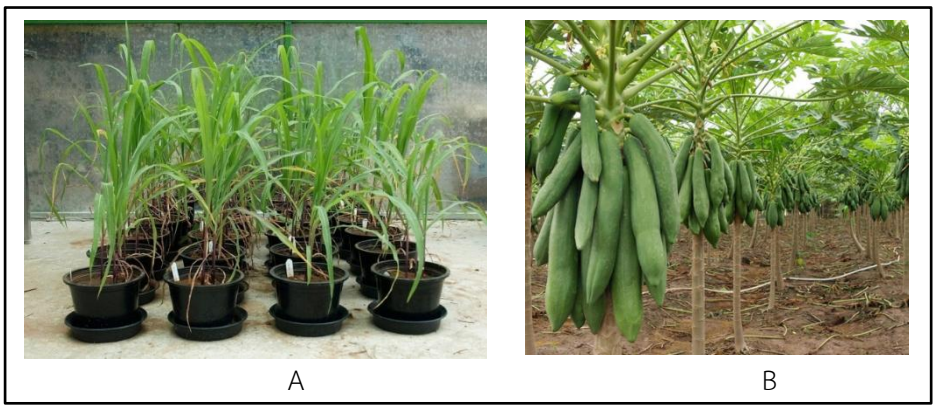

Figure 1. A: Corn grown to raise *arbuscular mycorrhiza* for adding to the soil
B: Papaya grown with arbuscular mycorrhiza added

Before planting papaya, it is a good idea to increase the organic matter in the soil by plowing under green manure. Organic matter gives the soil more air spaces that promote good drainage and help the plant roots access nutrients better. Leguminous crops such as peas or beans can be grown and plowed in while they are flowering (about 45-60 days after planting). That is the time they have the highest nitrogen content. Some legumes have a beneficial kind of bacteria called rhizobium growing in their roots in a symbiotic relationship. The rhizobium get carbon and energy from the legume plant, and the legume plant gets easily absorbable nitrogen from the rhizobium. If you are planting a leguminous crop for the first time, it is a good idea to add commercially prepared rhizobium to the soil. After a few years there will be a sufficient population in the soil so you don't need to add more rhizobium bacteria for your legume crop. Green manure helps increase the nitrogen content of the soil and also improves the soil

structure. It is also useful for controlling weed growth and preventing soil erosion. You can mow the legumes before plowing under and spread the chopped dead plant parts on top of the soil after planting. (Janthasri, 2021).

2. Season

Papaya can be grown at any time of the year, but the best planting time varies with the geographical and climatic conditions. If the land is in the highlands or on a plateau, at a higher elevation compared to the flood plains, and the farmer is relying mainly on rain water, then the papaya plants should be transplanted at the beginning of the rainy season. Plentiful rain will reduce the labor input for irrigation. For instance, seeds could be started in July and transplanted in August and then the farmer would be able to harvest fruits starting in January, which is a season when the prices are higher. If the land is in the flood plain area, papaya seedlings should be transplanted in the dry season or the end of the rainy season to avoid flooding. Seeds could be started in January and transplanted in February. The first harvest would be in July. (Janthasri, 2015).

3. Maintenance Practices

Irrigation systems :The most popular kinds of irrigation systems are mini sprinklers and drip irrigation. When papaya plants grow larger, high-pressure sprinkler systems that sprinkle from higher up rather than just at the plant bases can be used to help spray the bottoms of the leaves to keep off aphids. When the seedlings are first transplanted, they should be watered every other day or 3-4 times a week. (Estrella-Maldonado et al.,2019) In the first few months they should be watered whenever it doesn't rain for a day. However, the amount of water given each time should not be enough to flood the plantation or pool around the stems, because that may encourage root rot. If they are not given enough water, the papaya plants will be small and stunted. Later, when they start to flower, they should not be allowed to dry out for more than a week. If they do not get enough water the flowers might drop early or might not get fertilized and will not produce fruit, or the fruits will be small. Even if they are watered later they will still suffer the after-effects of the dry spell for quite some time. So it is important to water them every 5 or 6 days. If the plants are watered well during the dry season then usually the fruit produced at that time will be good quality with good flavor. (Janthasri, 2021).

Plant nutrient management :Two months after transplanting seedlings you should start to feed them with organic fertilizer supplemented with small amounts of chemical fertilizer. In areas where papaya or other crops have been grown for a long time, the soil

fertility may be depleted. Also in places with sandy or clay soil, it may lack organic matter, so it is very important to add large amounts of manure, compost, and green manure. Usually one kilogram per plant per month is required. Organic growers normally add fermented organic liquid fertilizer every two weeks and also add beneficial microorganisms to the soil. For manure, dry chicken manure is preferable to pig manure or cow manure because it contains more nutrients. (Janthasri & Chaiyaboon, 2016).

Weeding: Weeds are very dangerous, especially when papaya seedlings are small, because the papaya plants need time to establish themselves and grow stronger. The weeds compete with the papaya plants for water and nutrients, and sometimes they attract insect pests and plant diseases. Weeds can be chopped out with a hoe or mowed out and the dead plant parts piled around 50 centimeters from the base of the papaya plants to help retain soil moisture. (Junthasri & Suwanseree, 2022). Organic growers also often grow cover crops, and that is a good way to reduce weeds without using herbicides.

4. Prevent Disease Occurrence

Growing mixed orchards with many kinds of crops in the same area is a good way to reduce the severity of plant diseases and insect pests. In monocrop orchards the insect pests have a large amount of the food they want, but in mixed orchards there is only a small amount of each kind of food. There are fewer of each kind of plant, so the smell of them will not be so strong as to attract insects from far away. Even if some insects are there to feed on a specific kind of plant, if there is not a large food supply for them, they will not be able to reproduce quickly and their population will not rise quickly. Also, some of the plants may be home to beneficial insects that prey on some of the insect pests. Some of the plants that can be intercropped with papaya and have proven to be useful in controlled studies are banana, custard apple and lemongrass. (Martin, et al., 2019)

Some appropriate cover crops that can be planted before transplanting the papaya seedlings are basil, ivy gourd and Malabar spinach. Vine-type cover plants such as ivy gourd should be allowed to climb part way up the papaya plants to discourage red spiders from nesting in the papaya leaves, but the tips should be nipped back at least once a month so they don’t cover too much of the papaya plants. (Janthasri, 2015).

The organic growers at Srisa-asoke Community in Ubol Ratchathani pile dry hay almost a foot deep all over the area for growing papayas before transplanting and plant

banana plants around all four sides of the plantation as well as intercropping with bananas. The hay will slowly decompose, adding humus to the soil. Soon mushrooms come up from the hay. The farmers add large amounts of liquid fermented organic fertilizer to the plantation every week and they don't need to use any chemical fertilizer or pesticide (Anwar et al., 2019). (Figure 2-3).

Figure 2. Papaya intercropped with banana at Srisa-asoke Community

Figure 3. Papaya intercropped with Asiatic pennywort (*Centella asiatica*) and other herbs

Other plants should be intercropped with papaya seedlings while they are small because it will take 7 to 8 months for them to start producing fruit. In the mean time the farmer can use the land around and between the seedlings to grow something else that will provide food or income, rather than letting the areas go to weed and then

having to expend more labor for removing the weeds. They should be fast growing annual plants such as beans or other vegetables and should only be grown if they don't interfere with the health of the papaya plants. When the papaya plants reach productive age, additional intercropping is not recommended because growing other crops may interfere with the papaya's roots. However, a cover crop like calopogonium, centrosema, or pueraria can be grown to prevent erosion, maintain moisture and add nitrogen to the soil. (Sharma, Mitra, & Saran, 2016).

5. Local wisdom and safe papaya production

Papaya has been grown in Thailand for generations and the popular dish somtam, which uses unripe papaya as the main ingredient, has become a part of the local culinary culture. There are now many variations on somtam with different ingredients added, such as peanut somtam, fermented fish somtam, salted crab somtam, seafood somtam, wild herb somtam, salted egg somtam, pickled crab somtam and even live crab somtam. (Janthasri, Janloon., & Suwanseree, 2017).

5.1 Folk wisdom about papain

Thai cooks have passed down a method for making boiled meat very tender. They add a small unripe papaya to the pot. The reason it works is that the papain in papaya sap is an enzyme that helps break down the proteins in meat, making it softer. Papain is also used in leather tanning. Research by showed that when papaya farmers extract sap from papaya plants for obtaining papain, they can get more sap if they tap the plants in the morning between 8:00 and noon than if they tap them in the afternoon or evening. The plants exude sap at the rate of about 100 milliliters in 5 hours. Papaya plants can be tapped for sap from the age of 5 months up. (Choudhary, 2025).

5.2 Use of papaya tips and leaves to lure cherry snails that are a pest in rice fields

Cherry snails (so named because of the pretty color of their eggs) are a serious pest in rice paddies. One effective way to destroy them is to plant papaya plants around the rice paddies and place papaya leaves and growing tips down in the rice field. The snails will come to feed on the papaya tips and will lay their eggs there or on the papaya plant stems instead of rice plants. Then the farmer can more easily gather the adult snails and eggs and burn them to destroy them. (Janthasri, 2021).

5.3 Wrapping with cloth

Some farmers wrap developing papaya fruits in cloth, tying a piece of cloth to the top of the fruit stem and letting it hang down to cover all the fruits (Figure 4). Farmers in the central region tend to use thin white cloth while those in the northeast often use checkered loin cloths. This practice was believed to increase productivity, but the actual benefit is to prevent sunburn, which can cause unsightly brown specks on papayas. (Janthasri, 2015)

Figure 4. Cloth wrapping papaya in Thailand

5.4 Using papaya leaves as cricket food

Some farmers raise crickets in cement pipes for extra food and income. Papaya leaves are a good additive to the cricket food and they can be obtained for free when the farmers thin out some of the leaves. Crickets survive well on papaya leaves and can be sold every 4 months.

5.5 Renewing papaya plants

There is a way to encourage new growth from old papaya plants and make them productive again. These are the steps:

1. During the rainy season, select papaya plants that are healthy and have been productive.

2. Harvest all the remaining fruits, then cut off the top of the plant, cutting the stem to just 50 cm from soil level, and make holes for rain water drainage.

3. New stems will grow up from buds in the old stem.

4. From among the new stems, choose just 2 or 3 strong ones from different sides of the plant so it will be balanced, and cut off the others.

5. Add 15-15-15, 16-16-16 or 32-10-10 fertilizer and manure. Water well on days it doesn't rain and otherwise treat as you would newly transplanted papaya seedlings.

The new stems will start to produce fruit after about 4 months and can continue producing for about 2 years. You can repeat the renewing process once more by cutting down the same plant, but not more than twice (Figure 5).

Figure 5. Renewed papaya plant

5.6 Intercropping with marigolds

Nematodes have become a problem in some areas of the northeast with sandy loam soil. Nematodes make galls on the papaya roots and then the plant cannot absorb water and nutrients from the soil. It will turn yellow and die. Nematodes can spread around a whole plantation by moving in the soil when it is irrigated. One way to stop nematodes is by intercropping with marigolds. Marigolds synthesize natural chemicals

that give them their characteristic smell, and those chemicals are repellent to nematodes. Marigold flowers can also be sold for additional income. (Janthasri,R., & Chaiyaboon, 2016)

Conclusion

Safe papaya production can mean an organic growing system, sustainable farming methods, following good agricultural practice or GAP standards, or just reducing the use of agricultural chemicals. Which methods are used depend on the conditions of the growing area and the intentions of the grower, but the main idea is to make papaya growing safe for consumers and the natural environment.

Safe papaya growing methods may include intercropping and the use of manure, compost and herbal insect repellents. These innovations can enable farmers to increase the value of their products by promoting them as safe for consumers and the environment.

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