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SHORT COMMUNICATION

Agronomic Requirements and Production Methods of Tomatoes in the Red River Delta of Vietnam

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Abstract

Tomato (*Lycopersicon esculentum* Mill.) (Solanaceae) is one of the most economically important vegetable crops in the Red River Delta (RRD) of Northern Vietnam. The recent market demands for tomatoes in both domestic and overseas markets have led to an increasing cultivated area for the crop in the RRD. To support growers in producing healthy and quality produce, this paper presents in detail the agronomic requirements of tomatoes regarding temperatures, light, water, suitable soil type and nutrients. Cultivation techniques are discussed to provide a general guide for developing appropriate management strategies, depending on specific soil types, cropping seasons, cultivars and availability of resources. In addition, six major pests have been identified, providing useful information for developing an integrated pest management (IPM) program for tomato production in the region.

Keywords: Agronomic requirements, cultivation techniques, management strategies, market demands, pest identification, sustainable production.

Introduction

Vegetable production provides major livelihoods of many people in rural and peri-urban areas of Vietnam (Ha and Nguyen, 2013; Ha et al., 2015c). Tomato (*Lycopersicon esculentum* Mill.) (Solanaceae) is among the most commercially important vegetable crops for both domestic and export markets in Vietnam (Johnson et al., 2008; Tran, 2005; Van Wijk, 2008). Compared to rice, tomato production could generate double economic efficiency (Tran et al., 2008) which helps to create more job opportunities for farmers (Tran, 2005).

The Red River Delta (RRD), a subtropical plain region in northern Vietnam, is the main vegetable production area where tomato cultivated area accounts for a significant proportion (Pham et al., 2002; Van Wijk, 2008). The recent increasing market demands have led to high percentage of growers shifting from rice to tomato production (Van Wijk, 2008).

This paper introduces agronomic requirements, cultivation methods and major pests on tomatoes in the RRD. These would be used as a general guide to support production and define appropriate pest management strategies.

Tomato Agronomic Requirements

Tomatoes can adapt to various climatic conditions, however the optimum temperatures for their growth and development lie between 21 and 27°C (Hanson, 2001; Shankara et al., 2005). In addition, tomatoes are day-length neutral plants (Nuruddin, 2001). Light intensity of 400-500 $\mu mol.m^{-2}.s^{-1}$ is optimal for growth and development. High light intensity may cause fruit cracking, sunscald and green shoulders (Jones, 1999).

Though tomatoes have high water requirement (Peet, 2008) water surplus may cause fruit rot (Jones, 1999) and bacterial wilt (Nuruddin, 2001). According to Jones (1999) tomato is most sensitive to water deficit at the flowering stage. Bud and flower drops might occur under a prolonged dry period.

Various soil types can be used for tomato production, preferably well-drained sandy loam soil (Hanson, 2001; Jones, 1999; Nuruddin, 2001; Peet, 2008). Suitable soil pH is between 6.0-7.0. If the pH is less than 5.5, plant disorders such as blossom-end-rot may occur (Hanson, 2001).

Due to their rapid growth in a long production period, tomatoes have high requirements of nutrients. For instance, to produce 1 ton of fruits the crop requires 1.36 - 3.63 kg N; 0.23 - 1.36 kg P_2O_5; 2.27 - 5.45 kg K_2O (Peet, 2008)

Production Methods

Cropping Calendar

Three traditional growing seasons in the RRD were reported by Tran (2005) (Table 1):

Table 1. Winter – spring cropping seasons for tomatoes in the Red River Delta, Vietnam

Seasons	Sowing seeds	Planting	Harvesting
Early season	July/ August	August/September	End of October or December (depending on cultivars)
Main season	Mid-September - End of October	November	February or March
Late season	November	December	March or April

Due to the recent high market demands for tomatoes, growers have started two additional seasons, spring to summer (sowing from early January to February), and summer to autumn (sowing from July to August) seasons with the harvesting times of May/June and October/ November, respectively. Special attention however needs to be paid to pest management in these seasons since hot temperatures and high humidity are favorable for development of pests and diseases (Tran, 2005).

Cultivar Selection

There is a range of varieties used for the winter-spring season crop such as local varieties, Indian cultivars, SB3 and some exotic F1 hybrids such as S902, Delta, VL2000, HP5 and S901. Some cultivars are suitable for hot and rainy seasons such as KBT4, SO12, SB2, S901 (Nguyen, 2004), and virus-resistant such as VL3500, VL642, DV2926, Kim Cuong, Savior, Trang Nong-05 (Le, 2013). Six new cultivars produced by the Fruits and Vegetables Research Institute are also recommended, depending on the market demands including Lai 09 and HPT10 for main and late seasons, VR2, FM20, and FM29 for early and late seasons, and XH5 for early season (VISTA, 2009).

Soil Preparation and Planting Density

Seed-bed preparation: prepare raised seedbeds (15 cm high) with a 3-4 cm rice straw layer to improve drainage and to avoid soil-borne disease problems. Sow seeds in rows (750-900 seeds.m^{-2} or a 6 cm distance between seeds). Cover seedbeds with a thin compost or a rice straw mulch layer to conserve moisture (Hanson et al., 2001).

Field preparation: prepare raised beds (1 m wide) with furrows (50 cm wide) in between. Bed height may range from 20 cm (in dry seasons) to 35 cm (in wet seasons). Mulching materials such as rice straw can be used to prevent weed development, keep moisture and reduce leaching of fertilizers (Hanson et al., 2001).

Planting density: depending on plant growth habit, the Asian Vegetable Research and Development Center (AVRDC) recommended the following spacing:

Table 2. Tomato plant spacing according to plant habits (Hanson et al., 2001).

Plant habit	Spacing	Plant density (number of plants per ha)
Indeterminate (pruned)	2 rows per bed (1 m wide); 40 cm between plants	33,333
Determinate (not pruned)	One row per bed (1 m wide); 40 cm between plants	16,666

Fertilization and Irrigation

Depending on soil conditions, the amount of fertilizers applied per hectare are N, P_2O_5 and K_2O of 60 – 120 kg; 60 -140 kg and 60 – 120 kg, respectively, as recommended by the AVRDC where half of each element is applied at planting as the basal fertilizer. The second half is applied after the first fruit-set. Further, combination of organic matter (farmyard manure) and chemical fertilizers is recommended (Hanson et al., 2001). Tran (2005) recommends the following fertilizer formula for tomatoes in the RRD:
Irrigation should be provided on regular basis to maintain field moisture at around 60% (Tran, 2005). In dry seasons, weekly watering is needed for the first month after transplanting and then every 10 days until the end of the crop season. Water-logging should be avoided in rainy seasons (Hanson et al., 2001).

Staking & pruning

Bamboo poles or wooden stakes (1.2 m) can be used for staking tomatoes to keep foliage off the ground (Hanson et al., 2001; Tran, 2005). Staking is provided when the plants reach 30 cm tall. Plants should be rebound every 5-7 days. Moreover, old and damaged leaves should be removed to maximize light interception (Peet and Welles, 2005), air circulation (Hochmuth, 2008; Koske et al., 2008) and to decrease disease incidence (Navarrete, 2000). Shoot topping (pruning) should also be carried out 5-8 weeks prior to harvest (Peet and Welles, 2005).

Harvesting

Timing of harvesting is important as it affects fruit nutritional composition and quality. Fruit maturity can be categorized into four stages (Table 4), and harvesting at stages 3 and 4 is recommended to obtain quality fruits (Shankara et al., 2005).

However, for long distance markets, fruits can be harvested at earlier stages where less than 10% of fruit surface is tannish-yellow, pink or red (Hanson et al., 2001).

Identification of Major Pests on Tomatoes in the Red River Delta, Vietnam

Pest management is an integral component in agricultural production to reduce crop losses due to pest damages. Pests are defined as “organisms such as weeds, insects, bacteria, fungi, viruses and animals which unfavorably influence human lifestyles” (Ha, 2014e).

The insects, diseases and weeds that have been reported as the major pests that caused serious problems in tomato production in the RRD of Vietnam are presented in Table 5.

Table 3. Fertilization method for tomatoes in the Red River Delta, Vietnam

Method of fertilizer application	Amount of fertilizer applied per hectare	Remarks
Basal (applied once)	15-20 tons of decomposed manure; 400-500 kg of SSP; 195-200 kg of Potassium; 70 kg of Urea.	Mix the fertilizers then apply into holes, cover with a soil layer before transplanting seedlings into the holes.
Top-dressing (4 - 5 times)	10 tons of decomposed manure; 130-200 kg Urea.	Additional fertilizer is applied when roots have developed, at flowering, and at fruit setting stage.

Table 4. Maturity stages of tomato fruits (Shankara et al., 2005)

Stage	Description
1	Seeds are white in color (immature) and can be cut when fruits are sliced. There is no juice inside the fruits.
2	Seeds have tanned color (mature) and some juice present.
3	Seeds are pushed aside when cut. The color inside is still green.
4	Juice color becomes red.

Table 5. Major pests on tomato crops in the Red River Delta (RRD), Vietnam

Pest groups	Common & botanical names	Names in Vietnamese	References
Insects	Silver-leaf Whitefly (*Bemisia tabaci)*	Ruồi trắng lá bạc	CABI, 2015; Smith, 2003; Tran, 2005.
	Vegetable leaf miner (*Liriomyza sativae* Blanchard)	Ruồi đục lá	Hofsvang et al., 2005; Tran, 2005.
Diseases	Tomato early blight (*Alternaria solani)*	Bệnh tàn lụi sớm cây cà chua	Nguyen, 2008; Tran, 2005.
	Tomato yellow leaf curl (pathogen: tomato yellow leaf curl virus) (a gemini virus from Geminiviridae family).	Bệnh vàng xoăn lá cà chua	Nguyen, 2008; Tran, 2005.
Weeds	Billy-goat weed, Chick weed, Goatweed, Whiteweed *(Ageratum conyzoides* L.)	Cây hoa cứt lợn	Burgess et al., 2008; Waterhouse, 1994.
	Spiny amaranth (*Amaranthus spinosus* L.)	Dền gai	Waterhouse, 1994.

Recently, eco-friendly production practices have been embraced as one of the appropriate strategies in agriculture (Bosch et al., 2015; Ha, 2007, 2014b; Ha et al., 2015a, 2015b) particularly in Vietnam vegetable production (Ha, 2011, 2014a, 2014c, 2014d) in which IPM is an essential part in crop protection towards sustainable production systems (Ha, 2014e). Therefore, developing an IPM program for tomatoes in the RRD is of crucial importance to ensure high product yields and quality in addressing the market demands, particularly in terms of food safety, and other benefits such as improved environment, human health, more secure income and livelihoods for smallholder farmers in the region. Details of the IPM program for tomatoes will be described in the forthcoming paper.

Conclusion

This paper has presented an overview of the agronomic requirements of tomatoes, which include temperatures, light intensity, water, soil types and nutrients. Special attention should be paid to its high water requirement at flowering time, and balanced amount of fertilisers to warrant plants' healthy growth, high yield and quality. Suitable cultivars should be selected in hot seasons to reduce fruit sunscald and cracking. In addition, a general guide on cultivation techniques for tomatoes to support tomato producers having appropriate management strategies, depending on their soil types, cropping seasons, cultivars and availability of resources. This paper has described six major pests of tomato crops in the RRD region. Specific advice on production guidelines of new cultivars, and forecast of weather condition and emergence of potential pests should be updated from local departments of plant protection and extension stations.

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