Review

Physiological disorders of tomato- an overview

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ABSTRACT

Tomato is one of the important crops of family Solanaceae and is adversely affected by various abiotic factors. The physiological disorders of tomato are abnormalities in fruit crop such as colour, shape and size which are not caused by infectious diseases and insects. The fruit abnormalities are due to the result of environmental stress on the plant growth. Physiological disorders are distinguished from other deficiencies of a single nutrient, physical, chemical or other injury due to herbicides. Physiological disorders are the result of genetic susceptibility, cultural practices, nutritional management and environmental factors. These are major causes of economic losses. These abnormalities occur due to adverse environmental conditions coupled with inadequate amount of nutrients in the plant. In the present paper two most important physiological disorders of tomato, blossom end rot (BER) and fruit cracking, have been described along with their management to minimise the economic loss.

Keywords: Tomato; physiological disorders; blossom end rot, fruit cracking; control measures

INTRODUCTION

Tomato is a very important vegetable which belongs to family Solanaceae. It is cultivated in both open field and protected conditions in India. Any deviation from the normal behaviour of the crop plant is known as a disorder which is either caused due to environmental changes (nutritional deficiency or toxicity, inappropriate cultural operations etc) or due to genetic factors.

Physiological disorders are not caused by living organisms rather are the results of involvement of non-living, abiotic situations which deviate the plant from normal growth. Physiological disorders are distinguished from diseases caused by microorganism like a virulent disease or plant (Sharma et al 2016). These cause the physical or chemical changes in a plant which is normal and are generally due to external factors. Once they have occurred most of the physiological disorders are not reversible.

Under both the conditions (open field and protected), tomato encounters a number of diseases and physiological disorders which affect its yield and ultimately the production. Most of the physiological disorders are the results of environmental stress which is due to unpredictable weather conditions. These disorders drastically reduce the final produce to be obtained. In a number of cases the exact cause of the disorder is not understood properly as it involves a combination of factors. Some of them are identified easily while some others are difficult or even impossible to manage.

Physiological disorders may be caused by rapid fluctuation in temperature, nutrient deficiency, improper irrigation during cultivation, genetic susceptibility etc. The review explains the two important disorders of tomato viz blossom end rot and fruit cracking that adversely affect tomato crop and the control measures which should be followed to minimise them.

Blossom end rot (BER)

It is the result of Ca deficiency and is related to incapability of the plant to translocate required amount of Ca to the plant parts rather than to unavailability of adequate amount of Ca in soil. BER is a major disorder of tomato and develops specific symptoms (Adams and Ho 1995, Adams and Holder

1992, Saure 2001). BER is caused by localized Ca deficiency in tomato fruits (Hochmuth and Hochmuth 2009). Calcium is not the only cause but also excessive moisture in the soil makes the calcium unavailable to the plants. The deficit condition also reduces the uptake of Ca by plants.

Symptoms of BER start as a small spot later which grows darker and larger with fruit growth. It can be identified very easily by a discoloured, sunken spot at the blossom end of the fruit (Hochmuth and Hochmuth 2009). These water soaked spots enlarge and can cover half of the fruit or even whole fruit sometimes. Spots dry out and turn leathery. The tissues turn light brown to dark brown. This disorder appears about the time the fruits begin to ripen (Saure 2001). The spots become darker and lesions may show concentric rings as the fruit matures. Above all the leathery and firm portion of the fruits make pathway for invasion by secondary decay organisms. The fruits get affected with secondary pathogens and appear black in colour.

BER usually causes pre-mature ripening of fruit and makes it inedible. BER in fruits is further enhanced when higher light intensity gets coupled with moisture stress condition (Stadler 2012). Tomato varieties differ in responding to BER incidence in their fruits with some being more susceptible than others (Ho et al 1993, 1995; Kirkby 1979, Nonami et al 1995, Nukaya et al 1995). Early cultivars are more susceptible to BER (Magan et al 2008). Larger fruited varieties are more susceptible than small fruited ones (Johnson 2019).

Along with water, Ca moves in the plant; therefore instead of applying higher amount of Ca fertilizer, the grower may decide to enhance the irrigation level. Excessive application of N fertilizers should be restricted. It is because the plant undergoes more of vegetative growth (proliferation of leaves and branches) due to higher application of N; plants with unnecessary vegetative growth are more likely to suffer from Ca deficiency (Hochmuth and Hochmuth 2009).

Possible control measure is to add on Ca to fruits by sprays or dips but this is very difficult practically. It is advised to avoid fluctuations in soil moisture and water logging. It has been reported (Kennelly 2009) that providing even and adequate soil moisture during fruit set reduces the incidence of BER. Dorais et al (2001) reported that avoiding high temperature of roots (>26^{o}C), low oxygen concentration, deleafing (to avoid excessive transpiration through canopy), shading, greenhouse fogging, roof sprinkling, maintaining a proper fruit-leaf ratio and spraying immature developing fruits with a calcium chloride solution of 0.5-0.65 per cent help in minimising BER disorder. The applications of foliar sprays of Ca salts have given unpredictable results (Goldberg 1995). Excess nitrogenous fertilizer application is to be avoided especially the ammonia formulation and selection of varieties that possess tolerance to BER are the possible means of avoiding the disorder (Kennelly 2009).

Fruit cracking

Fruit cracking in tomato is of immense importance as it leads to severe loss of marketable yield. Although the effects due to environment are not well understood (Peet 2007), it is assumed to appear when environmental conditions change drastically which affect the rate of growth such as fluctuations in temperature and moisture (Guichard et al 2001). It can be explained as a physiological disorder where splitting of the epidermis around the calyx or stem scar occurs (Guichard et al 2001, Solankey et al 2015).

There are two types of cracking in tomato fruit viz radial cracking and concentric cracking. The one that starts from the stem end and develops downwards is known as radial cracking. The other which develops round the shoulder of the fruit is called concentric cracking (Kalloo 2012). Cracking in tomato fruits occurs due to rapid growth when there is availability of sufficient water after a long dry spell. Fruit cracking is generally associated with rapid movement of water and sugars towards the fruits when cuticle elasticity and resistance are weak (Dorais et al 2001, Fentik 2017).

Dorais et al (2001) reported that the fruit cracking phenomena has been implicated when there is an imbalance between water supply (influx) and water loss (efflux). Cracking interferes with the quality of tomato as it leads to poor appearance, rough skin and reduces the shelf-life ultimately. Immediately it makes the fruit unmarketable for fresh consumption (Dorais et al 2004).

As per Olson (2004) fruit cracking can occur at all stages of fruit growth but as fruits move towards maturity they become more susceptible especially during colour development. The earlier the fruit cracks, the deeper the cracks become (Yadav et al 2017). High temperature accompanied with high humidity especially after long dry spell favours cracking. Boron deficiency and genetic factors also contribute towards fruit cracking (Sharma et al 2019, Azzi et al 2015). Radial cracking is more frequent and occurs at red ripe stage whereas concentric cracking develops at mature green stage. Concentric cracking is severe in fruits exposed to sun as compared to fruits covered with foliage.

Lichter et al (2002) found that cherry tomatoes harvested in evening are less prone to fruit cracking. The incidence of cracking varies with cultivars (Abbot et al 1986, Mullins and Straw 1992, Maroto et al 1995, Fernandez-Munoz et al 1995, Sperry et al 1996). As per Sadhankumar et al (2001) cultivars possessing crack resistance are usually associated with a thick cuticle and compact skin type as evidenced by high penetrance values.

Low concentric cracking is associated with determinate growth habit whereas indeterminate growth habit has been found to have diverse concentric cracking (Hu et al 2012). Ehret et al (2008) reported that fruit cracking starts at the time of maximum growth rate (two weeks after its initiation) and increases steadily thereafter till harvesting. This suggests that rapid growth of plant may be the reason for fruit cracking.

Fruit cracking can occur due to prevailing high temperature as there is an increase of assimilates supply to the fruit and increase in fruit growth (Dorais et al 2004). Kiyofumi et al (2006) found that sharp fluctuations in temperature and humidity were closely associated with fruit cracking. As there are many advances done in breeding of resistant varieties, cracking in less susceptible cultivars can be prevented until the breaker stage.

More tolerant cultivars do not crack until red ripe stage and resistant varieties rarely crack. Fruit cracking can be minimised by using cultivars that are less prone to cracking and providing adequate water and balanced nutrition (Kennelly 2009). This disorder can be managed by genetic control (Yadav et al 2017, Sharma et al 2019). Some of the preventive measures include ensuring proper water management and practising good nutritional programmes and preventing defoliation so as to limit fruit exposure to sun. Studies have shown that application of calcium and gibberellins minimise the problem (Larson et al 1983, Peet 1992). The cracking associated with boron deficiency can be minimised by soil application of borax @ 15-20 kg/ha and also by spraying borax (0.25%) 2-3 times during fruiting to ripening stage.

CONCLUSION

Blossom end rot (BER) and fruit cracking are two important disorders of tomato. The environmental disturbances are likely to increase the incidence of these disorders as the climate changes. There is need to manipulate the environment and use locally available materials to control the disorders as per ecological zones. Also growing in protected structures or chambers can be adopted to prevent these disorders as there is a wide scope of controlling the micro-climate. Under open field condition, it is advisable to adopt proper horticultural practices along with using resistant or tolerant varieties.

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