 DOI: 10.19601/j.cnki.issn1943 - 9903.2018.12.014

Impacts of Bad Weathers in Growing Season on Apples and Post-disaster Management Measures

Xueying LI, Jie HAO, Jianzhong FENG, Xinmin YAN, Xian'ge WANG, Wenzhang JI, Xuehua LI, Xiangmin SUO*

Shijiazhuang Pomology Institute, Heibei Academy of Agriculture and Forestry Sciences, Shijiazhuang 050061, China

Abstract Apple cultivation has special requirements for climatic conditions. The period from May to August is a key period for apple growth. During this period, extreme weather occurs frequently, such as extreme high temperature, strong wind, hail, and floods. This paper introduced these extreme weathers and came up with some corresponding management measures.

Key words Bad weather, Apple, Post-disaster management

1 Introduction

Some studies have shown that the climatic conditions directly determine the yield and quality of apple cultivation[1]. According to the study of Pu Jinyong, the increase in temperature accelerated the aging rate of fruit trees to some extent and shortened the years of apples during the best fruiting period[2]. In the case of the high temperature, the florescence would come earlier in Yan'an and western part of Weibei; as a result, it is more likely to suffer from frost damage during the florescence[3]. In view of these, we introduced these extreme weathers and came up with some corresponding management measures.

2 Months and typical cases of bad weathers

2.1 Strong wind and hail Strong wind and hail often occur in May and June. On May 12, 2018, 38 counties in Hebei Province suffered strong wind. The maximum instantaneous wind speed in Raoyang reached 32.2 m/s (grade 11), and eight counties (cities, districts) suffered hail. In Shijiazhuang, hail disaster occurred mainly in Shijiazhuang downtown, Zhengding, Pingshan, and Gaocheng, the hail diameter was 0.4 - 1.2 cm, and the fruit damage rate of some apple orchards in northern part of Shijiazhuang was up to 90%. Huining Town, Huangsi Town, Beixiaozhuang Town, and Nanshimen Town in Xingtai County suffered serious hail damage, most of the orchards were destroyed by the hail.

2.2 Hot and dry weathers Hot and dry weathers often occur in June and July. In June 2010, the central and southern areas of Hebei Province experienced a continuous high temperature above 40℃. This bad weather mainly occurred in central Baoding, large part of Shijiazhuang, most areas of Xingtai and the central part of Handan. More than 40 counties and cities were affected. Among them, the temperature in Xingtai County was up to 42.3℃, and that in Shijiazhuang was 41.7℃, and the ground surface temperature reached 72℃. Due to the high temperature and dry weather, the apple sunscald disease occurred in most of counties and cities in Hebei. Shijiazhuang Comprehensive Experimental Station of the National Apple Industry Technology System carried out a survey of 22 orchards in 6 counties and cities of Xingtang County, Shijiazhuang City, Shenzhou City, Xinji City, Xingtai City and Handan City in the central and southern areas of Hebei Province, and found that the fruits of all orchards suffered different degrees of sunscald symptoms. Among the 22 orchards surveyed, 20 orchards adopted fruit bagging, 17 orchards took excellent management measures and the sunscald rate was only 3% - 5%, while four orchards with poor management had the sunscald rate up to 8% and the disease spot was large; one orchard did not adopt fruit bagging, and its sunscald rate was 3%.

2.3 Heavy rainfall Heavy rainfall often occurs in July and August. On July 18 - 20, 2016, an unprecedented torrential rain occurred in Hebei. Due to its wide range, high intensity and high peak, torrents of water rush down the mountain, some villages and farmlands were flooded. The apple producing areas in Hebei also suffered different degrees of losses. From 12:00 of July 18 to 20:00 of July 20, the central and southern areas of Hebei Province suffered extra torrential rain since 1996, and the rainfall in Handan, Xingtai, and Shijiazhuang exceeded 500 nm, and that in 399 towns exceeded 100 mm, 58 towns exceeded 250 mm, and the largest rainfall in Taoquan Township in Cixian County of Handan City exceeded 630 mm. The torrential rain caused severe damage to the orchards in the Taihang Mountain area in Handan and Xingtai and western Shijiazhuang. The survey results showed that the orchards at the Hetao and the foot of the mountain were seriously damaged. Some orchards were washed away, and roots of some orchard were washed away or exposed. July and August of every year are the second flower bud differentiation period of apple trees and the fruit expansion period of mid-late ripe varieties. If there is high temperature and rain in this period, the soil moisture in the orchard is too high, it will lead to poor ventilation, and accordingly inhibit the growth and absorption of roots.

Received: September 17, 2018 Accepted: December 12, 2018

* Corresponding author. E-mail: suoxiangmin@126.com

After rain, the high soil and air humidity contributes to the occurrence of leaf and root diseases.

3 Post-disaster management measures

Apart from setting up hail prevention nets for orchards prone to hail, providing frames for areas vulnerable to strong winds, and digging drainage ditches for areas having frequent rains, it is necessary to take following post-disaster management measures.

3.1 Post-disaster management measures for strong winds and hail

3.1.1 It is recommended to promptly clean up and straighten up trees blown down by strong winds in the orchards, set up pillars as necessary, to prevent shaking or blowing down again. For the branches that have been blown by the wind, it is required to promptly trim; for young trees, it is required to set up pillar to tie the main branch. Besides, it is recommended to remove residual branches, fallen leaves and fruits, gather them together and deeply bury or burn, to prevent widespread of plant diseases and insect pests.

3.1.2 It is necessary to remove the hail that has not been thawed in the garden. After the hail disaster, the tree body growth balance and the reasonable distribution of branches are broken. It is recommended to sort out and cut off broken and injured branches, keep leaves as much as possible, to restore the tree growth as soon as possible.

3.1.3 Praying pesticide for protection. The hail disaster causes a large number of wounds on the fruit tree, and the bacteria will easily invade through the wounds. Therefore, immediately after the hail disaster, it is recommended to spray protective agents for general prevention and protection. The protective agents mainly include 500 – 800 times 75% chlorothalonil solution, 1 000 times 70% carbendazim solution, 1 000 times 80% mancozeb solution. Fruit trees can also be sprayed with 800 times 70% thiophanate-methyl solution or 10% poly-mycin. The seriously damaged orchards can be sprayed once every 10 – 15 d, and 0.3% potassium dihydrogen phosphate is added to supplement the nutrients every time. This period coincides with aphid occurrence period, it is recommended to spray fruit trees with fungicide and imidacloprid. During spraying, it is required to ensure to spray the whole tree, pay attention to the injured branches. When finding rotten parts, remove the disease spot first, then apply Guokangbao or Fubiqing agent to protect. In this period, it is required to focus on restoring the tree growth, so the concentration of agents should not be too high, to prevent pesticide damage. After the recovery of the tree body, it is recommended to spray 2 000 times 2.5% cyfluthrin solution, or 2 000 times 25% chlorfenapyr solution, or 4 000 times 2.0% quercetin solution, to control apple Lithocolletis ringoniella Mats, spider mites, twospotted spider mites, Stephanitis nashi Esaki et Takeya, Didesmococcus koreanus Borchsenius and other pests.

3.1.4 Topdressing in time. In the disaster affected orchards, the leaves are incomplete and the photosynthetic area is reduced. Therefore, it is recommended to conduct topdressing one time. The mature tree plants can be applied with 1.5 kg of diammonium phosphate + 0.6 kg of ternary compound fertilizer, small trees may be applied with less fertilizer accordingly. Besides, every 10 d, it is recommended to apply 0.3% potassium dihydrogen phosphate + 0.3% urea.

3.1.5 Intertillage. After the disaster, it is necessary to intertill to loosen the soil and improve the soil permeability.

3.2 Measures for preventing sunscald

3.2.1 It is recommended to strengthen the fertilizer and water, harden the roots and tree growth. If tree body is well nourished and has many branches and leaves, it will play a natural protective role for fruit trees. Therefore, it is required to strengthen the water and fertilizer management, supplement the nutrients of tree body and improve the protective ability of tree body.

3.2.2 Spraying water in the midsummer. It is recommended to spray proper amount of water on fruit leaves according to the growth of the trees in midsummer, to improve the microclimate in the orchards and reduce the incidence of sunscald. For orchards that bagging is not carried in time, the bagging time can be appropriately postponed to avoid the hot season. It is preferred to carry out bagging at the end of June or in the beginning of July, water one time 3 – 5 d before bagging. Besides, bagging should be carried out on sunny days at 9:00 – 16:00, should not be carried out in the morning or evening when there is dew.

3.2.3 Picking the sick fruits. It is necessary to pick the sick fruits with serious sunscald, to reduce the nutrient loss of tree body.

3.3 Management measures after floods

3.3.1 Prompt drainage. After heavy rain, it is recommended to dig temporary ditches to drain the accumulated water as soon as possible, to keep stable relative soil humidity of orchards.

3.3.2 Tree body management. It is recommended to promptly clean up and straighten up trees blown down by strong winds in the orchards, set up pillars as necessary, to prevent shaking or blowing down again. For the branches that have been blown by the wind, it is required to promptly trim; for young trees, it is required to set up pillar to tie the main branch. For the sand and sludge in the rhizosphere, it is recommended to remove in time, and improve the soil for bare roots. Besides, it is recommended to push aside the soil of rhizome and thick roots to dry the roots. Combined with summer pruning, it is recommended to improve the ventilation and light transmission conditions of the canopy, increase the photosynthetic efficiency of the leaves, and increases nutrient accumulation.

3.3.3 Soil management. It is recommended to promptly plough the tree tray or the whole orchards, to disperse the soil moisture, improve the soil aeration conditions to facilitate soil microbial activity, restore root development and promote new root growth.

3.3.4 Water and fertilizer management. Combined with ploughing, it is recommended to increase the nitrogen, phosphorus and potassium fertilizers. Besides, it is recommended to spray foliar fertilizer, to facilitate the restoration of tree growth. It is feasible to apply fertilizers such as superphosphate, potassium dihydrogen phosphate, ammonium phosphate, and photosynthetic

micro-fertilizers.

3.3.5 Prevention and control of diseases and insect pests. After the rain, pesticide spraying should be even and careful, and the pesticides should be sprayed to protect the trees, preserve the fruit and protect the leaf once according to the actual situation to prevent the spread of diseases and insect pests. In this period, the pesticide spraying can be combined with 1 000 times of pesticide spreading agent to prevent rain washing and improve the control effect. Commonly used agents include triadimefon, chlorothalonil, carbendazim, methyl thiophanate and *etc.* When finding rotten parts, remove the disease spot first, then apply Guokangbao or Fubiqing agent to protect. In addition, it is recommended to spray 2 000 times 2.5% cyfluthrin solution, or 2 000 times 25% chlorfenapyr solution, or 4 000 times 2.0% quercetin solution, to control apple Lithocolletis ringoniella Mats, spider mites, twospotted spider mites, Stephanitis nashi Esaki et Takeya, Didesmococcus koreanus Borchsenius and other pests.

4 Conclusions

Adaptability is a key factor affecting adaptive behavior decision-making of farmers in climatic changes. The quality of management of apple orchards directly determines the yield of apple. It is recommended to provide technical training, promotion and application for apple growers, raise the overall technical level of apple growers, to promote farmers to actively deal with the climatic changes.

References

[1] CHENG ZP. The influence of climate conditions on apple planting[J]. China Science and Technology Review, 2015, 16(17):286. (in Chinese).

[2] PU JY, YAO XY, YAO XH, *et al.* Impacts of climate warming on phonological period and growth of apple tree in Loess Plateau of Gansu Province[J]. Chinese Journal of Agrometeorology, 2008, 29(2):181 - 183. (in Chinese).

[3] LI XM, BAI QF, ZHU L. The influence of climate change on suitability of Shaanxi apple growth[J]. Quarterly Journal of Applied Meteorology, 2011, 26(2): 241 - 248. (in Chinese).

[4] FENG XL, CHEN ZX, HUO XX. Influencing factors of apple farmer adaptation to meteorological disasters[J]. Resources Science, 2015, 37(12): 2491 - 2500. (in Chinese).

[5] WEI QP, ZHANG Q, LIU SZ, *et al.* Effect of climate change on the growth of apple and the countermeasures[A]. Developing Low-carbon Agriculture to Cope with Climate Change[C]. Proceedings of the Seminar on Low-carbon Agriculture, 2010: 116 - 119. (in Chinese).

(From page 51)

[2] WANG JF. Study on emission characteristics and emission scale of pollutants from biomass straw burning in open air[D]. Hangzhou: Zhejiang University, 2017. (in Chinese).

[3] The annual straw output of China is 900 million tons and less than 40% is utilized[J]. Fujian Science and Technology of Rice and Wheat, 2017, 35(2):39 - 39. (in Chinese).

[4] YUAN C, GONG WC, KUANG HY. Research progress on concentration technology of biogas slurry membrane[J]. Agriculture & Technology, 2017, 37(21):166 - 169. (in Chinese).

[5] LIANG KQ, YAN Z, ZHU M, *et al.* Application research of reverse osmosis in concentrating biogas slurry from biogas projects[J]. Journal of China University of Mining & Technology, 2011, 40(3): 470 - 475. (in Chinese).

[6] WANG J. Application research of reverse osmosis in concentrating biogas slurry from biogas projects[J]. Urban Construction Theory Research, 2016, 6(15): 23 - 25. (in Chinese).

[7] DONG YL, ZHU WB, GUO P, *et al.* Characteristics and diversity of a microbial community decomposing wheat straw under aerobic conditions [J]. Chinese Journal of Environmental Science, 2010, 31(1): 249 - 254. (in Chinese).

[8] ZHAO HY, YU HR, CHEN D, *et al.* Impact of organic loading rate shock on operation and archaea communities dynamics in different anaerobic fixed-bed reactors[J]. Techniques and Equipment for Environmental Pollution Control, 2015, 9(10):4655 - 4663. (in Chinese).

[9] LIU JJ, YANG FY, WANG XF, *et al.* Composition diversity and metabolic characters of lactic acid bacteria community SGL[J]. Acta Microbiologica Sinica, 2015, 55(11):1475 - 1484. (in Chinese).

[10] WANG XJ, YUAN XF, WANG H, *et al.* Isolation and enzymatic characteristics of the microorganisms in lignocellulose-degradation microbial community WSD-5[J]. Microbiology, 2011, 38(4): 508 - 515. (in Chinese).

[11] KAFLE GK, SANG HK. Anaerobic treatment of apple waste with swine manure for biogas production: Batch and continuous operation[J]. Applied Energy, 2013, 103(1):61 - 72.

[12] ZHENG Z, LIU J, YUAN X, *et al.* Effect of dairy manure to switchgrass co-digestion ratio on methane production and the bacterial community in batch anaerobic digestion[J]. Applied Energy, 2015, 151 (1): 249 - 257.

[13] DONG BC, ZHAO LX, WAN XC, *et al.* Simulation experiment of volatility organic acids on biogas-producing characteristics under anaerobic condition[J]. Transactions of the Chinese Society of Agricultural Engineering, 2011, 27(10):249 - 254. (in Chinese).

[14] KAFLE GK, SANG HK. Anaerobic treatment of apple waste with swine manure for biogas production: Batch and continuous operation[J]. Applied Energy, 2013, 103(1):61 - 72.

[15] ZHENG Z, LIU J, YUAN X, *et al.* Effect of dairy manure to switchgrass co-digestion ratio on methane production and the bacterial community in batch anaerobic digestion[J]. Applied Energy, 2015, 151 (2): 249 - 257.

[16] WU SB, LI JX, LI W, *et al.* Effect of liquid digestate recirculation on biogas production and fermentation kinetics for anaerobic digestion of cattle manure[J]. Transactions of the Chinese Society of Agricultural Machinery, 2015, 46(10): 241 - 24. (in Chinese).