

Analysis of the Impact of Climatic Conditions on Potato Cultivation in Shangdu County

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Abstract Based on the environmental conditions for the growth and development of potatoes, the impact of climatic conditions on potato cultivation in Shangdu County was analyzed. Due to significant fluctuations in temperature during the seedling stage of potatoes, less precipitation, and uneven temporal and spatial distribution of precipitation, the yield of potatoes is unstable. Therefore, scientific planting suggestions and meteorological service countermeasures were proposed.

Key words Potato; Climatic conditions; Impact; Meteorological disaster

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Among natural resources, climate is one of the conditions that have a significant impact on agricultural production. Meteorological elements such as light, heat and water play a crucial role in the production potential, planting system, planting layout, yield and quality of crops. Potatoes have strong adaptability, are widely distributed, and prefer a cool climate. The average temperature in the hottest month in the planting area should not exceed 21 °C, and especially during the period of potato formation, a large temperature difference between day and night is required. Shangdu County is located in the center of Inner Mongolia Autonomous Region and on the Inner Mongolia Plateau. The terrain is mainly composed of shallow mountains and hills. It has a mid-temperate continental monsoon climate, with abundant sunlight and a large temperature difference between day and night. The incidence of crop pests and diseases as well as animal diseases is low, so it can provide an excellent ecological environment for the development of healthy and green food and agricultural and livestock products. Potatoes are the main grain crop in Shangdu County. The annual planting area exceeds 13 333.33 hm². The potatoes produced here are of high quality, have strong disease resistance and great potential for increasing production. In recent years, Shangdu County has successfully cultivated 10 leading enterprises in the potato industry such as Xisen Potato Industry, Fujingtang, and Deyi Vermicelli, formed a complete industrial chain from seed potato breeding, planting to processing and sales, and achieved a close connection between potato planting and processing. Potato industry is developing vigorously, injecting strong impetus into the industrial development of rural revitalization in Shangdu County. In this paper, according to the environmental conditions required during the growth and development of potatoes, the impact of climatic

conditions on potato cultivation in Shangdu County was analyzed to better scientifically plant potatoes based on local climatic characteristics.

1 Environmental conditions for the growth and development of potatoes

1.1 Temperature Potatoes like a cold and cool climate^[1], requiring a cool climate in the planting area. They are highly sensitive to temperature throughout their growth period, and the most suitable range of daily average temperature is 17–21 °C. There are obvious differences in the temperature requirements of potatoes at different growth stages. When temperature rises to 5 °C, the tubers of potatoes break their dormancy and sprout. After the tubers are sown, the young buds start to grow as the temperature of 10 cm soil layer reaches 7–8 °C. When temperature is 10–12 °C, young buds grow rapidly, and emerge from the soil soon. The suitable temperature for the growth of potato seedlings is 13–18 °C. At this time, too high temperature is not conducive to the growth of potato seedlings, and is prone to cause seed potatoes to rot. When temperature drops below 4 °C, their germination will be inhibited. The seedlings are prone to cold damage and death as temperature drops below 0 °C and late frost occurs. The suitable temperature for the vigorous growth of potato stems and leaves is 18–21 °C. In the flowering period, temperature should be 15–18 °C. The most suitable temperature for the expansion and growth of tubers is 20 °C. If temperature exceeds 21 °C, the normal development of potato tubers will be hindered, and their growth will be slowed down. Moreover, the greater the temperature difference between day and night during this period, the more conducive it is to the accumulation of nutrients in the tubers.

1.2 Sunlight Potatoes love sunlight. During their growth and development period, they respond strongly to the intensity and duration of sunlight. When sunshine duration reaches 11–13 h, sunshine can meet the growth requirements of potato stems and

leaves, and at the same time promote the formation of tuber yield. Similar to the temperature requirements at different stages, the light requirements for potatoes vary at different growth stages. During the germination period, they are not light-tolerant, and can grow in the dark. Light is not conducive to the elongation of young buds; instead, it leads to the thickening of buds, tissue hardening and pigment formation. From the seedling stage to the emergence stage of potatoes, long sunshine is conducive to the growth of stems and leaves and the spread of stolons. Under strong light, the area of stems and leaves increases, enhancing photosynthesis and forming a powerful assimilation system, which is beneficial for the distribution of assimilated substances and the development of plants. Short sunshine and strong light are needed in the growth period of tubers. During this period, short sunshine can inhibit the growth of stems and leaves and accelerate the formation of tubers, increase the accumulation of dry matter in tubers and plants, and be conducive to the formation of large tubers.

1.3 Water Potatoes have a high demand for water. During their growth process, they must have sufficient water to ensure high yields. Studies show that the water requirement for potatoes throughout their entire growth period is 450 – 700 mm^[2]. The water requirements vary at different growth stages. During the germination period, the growth rate is slow, and the demand for water is not high. It can grow normally relying on the water stored in the tubers. During the seedling stage, if soil remains moist, that is, the soil moisture content is 50% – 60% of the maximum field capacity, the root system can develop deeper into soil, which is also conducive to the formation of strong seedlings and early formation of tubers. Insufficient water will delay the emergence of seedlings, while excessive water is prone to causing rotten potatoes. During the tillering period, the demand for water begins to increase, accounting for approximately one-third of the total water requirement. In the early stage, soil moisture content should reach 70% – 80%, and gradually decrease to 60% in the later stage. The growth of stems and leaves should be appropriately controlled, and the tuber formation period should be entered at the right time. During the swelling period of potato tubers, a relatively large amount of water is required, accounting for more than half of the total water requirement. During this period, sufficient, uniform and continuous water supply is conducive to the expansion of tubers. Water deficiency is very likely to cause deformed stems, resulting in reduced yield. During the mature period, namely the later stage of potato formation, soil water holding capacity should be 50% – 60%. Excessive water can cause the stems and leaves of potatoes to grow excessively, consume too much nutrients, and make them prone to diseases. Excessive soil moisture can cause tubers to lack oxygen in soil and breathe poorly, which can lead to rotten potatoes in the field and also rough potato skins and is not conducive to storage.

2 Impact of climatic conditions on potato cultivation in Shangdu County

Shangdu County is a major agricultural county, with an average altitude of 1 400 m. It is cold and long in winter and short in summer. The terrain is gentle, and the soil is mostly composed of chestnut calcareous soil, which is sandy, soft and clean in texture. It is rich in minerals and trace elements. The geographical location, climate and soil conditions all provide unique natural conditions for the growth of potatoes, making it the core planting area of "China's Potato Capital". The potatoes produced here are rich in starch. It is widely recognized as the golden belt of the potato industry. The potatoes in Shangdu County are usually sown in middle May and harvested in middle September. The whole growth period lasts for approximately 130 d, including sowing – seedling emergence period (from middle May to middle June), seedling emergence – branching period (late June), branching – inflorescence period (early July), inflorescence – flowering period (middle July – late July), and flowering – maturity period (early August – middle September).

2.1 Light and heat The annual average temperature in Shangdu County is 4.5 °C. During the growth period of potatoes (April to September), ≥ 10 °C annual average total accumulated temperature is 2 590.5 °C. The climate is cool, and average temperature is the highest from June to August in summer, reaching 18.4 °C. The annual average sunshine duration is 2 910.6 h, and the average sunshine duration in summer is 15 h. Abundant light resources and long hours of sunlight are conducive to the full photosynthesis of potatoes, the accumulation of a large amount of organic matter, and the acquisition of high-yield and high-quality potatoes. Moreover, appropriate light is conducive to the smooth skin and bright color of potatoes, and the commercial quality of potatoes is high. During the sowing-emergence period of potatoes in Shangdu County, due to the large fluctuations in temperature, low-temperature cold waves are prone to occur. After emergence, they will be affected by low-temperature frost damage. The temperature suitability coefficient during this growth period is relatively low, only 0.69. During the periods from branching to inflorescence, from inflorescence to flowering, and from flowering to maturity of potatoes, temperature and light are suitable and well-matched. The average coefficient of temperature suitability is 0.89, 0.78 and 0.79, respectively, and the average coefficient of sunlight suitability is 0.76, 0.75 and 0.78, respectively. Due to the suitable light and temperature conditions in the later growth stage, organic matter accumulates rapidly, which is conducive to the expansion of potato tubers.

2.2 Precipitation The annual average precipitation in Shangdu County is 329.0 mm. Precipitation is unevenly distributed in various seasons. Among them, the precipitation from June to August in summer can reach 60.7% of the annual precipitation, with an average of 199.6 mm. Although the precipitation in Shangdu County is less than the water demand for the growth and development of potatoes, precipitation is more in the crucial growth period for potatoes in fields. Uniform precipitation can ensure the normal growth of potatoes, and also avoid problems such as pests, disea-

