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Impact of Climate Change in Capsicum Production: A Review

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Vegetable crops are sensitive to temperature, most of them require specific temperatures for optimum yield and quality. Climate change will effect capsicum production through increase in pollination failures, floral abortion, reduced fruit size and quality under higher temperature, increased incidence of physiological disorders (sun scald and blossom end rot), increased risk of soil borne diseases (leaf blight and fruit rot). Increasing temperatures will also influence greenhouse crop production, particularly in sub-tropical regions. In temperate areas there will be less effect and sowing time can be adjusted accordingly. Irrigation requirement will be high because of higher evaporative demand. So there is a need to adjust the sowing time according to changing temperatures. Selecting cultivars which are more tolerant are adaptable to changing environmental conditions. So polyhouses are best solution to avoid losses due to unfavourable climatic conditions like high temperature, heavy rains, strong winds and hailstones etc. Integrated pest and disease management (IPDM) will be an important tool to adapt to changing climate.

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Mulching with different mulching materials will help in reducing the incidence of soil born diseases like fruit rot and leaf blight. Scientists have to breed the cultivars, suitable to grow under changing temperature, resistant to insect, pest and diseases. To cope up with the effects of climate change we have to follow good production technology in capsicum and also to increase the yield and for good quality of the produce.

Keywords: Capsicum; climate change; polyhouses; mulching.

1. INTRODUCTION

Sweet pepper is botanically known as *Capsicum annuum* L. It belongs to family Solanaceae. South America, especially Brazil is thought to be the original home of Sweet pepper. It is grown in Central and South America, Peru, Bolivia, Costa Rica, Mexico and in almost all European countries. In India, it is cultivated commercially in Tamilnadu, Karnataka, Himachal Pradesh and in some parts of Uttar Pradesh. In Northern India it is also known as 'Simla Mirch' and is an important crop grown expensively in mid hills of Himachal Pradesh to supply to plains. Sweet pepper is rich in vitamin A and C Brhan [1]. Fruits may be eaten cooked or raw, sliced in salads. India is a major producer of chilli, and the production of chilli is highly influenced by climate change.

Climate change refers to a change in the state of the climate that can be identified by (e.g., by using statistical tests) changes in the meanings of the various climatic parameters, such as temperature, precipitation, relative humidity and atmospheric gas composition, etc. and/or the variability of its properties, and that persists for an extended period, typically decades or longer in larger geographical areas Cubasch et al. [2]. IFAD (International Fund for Agriculture Development) (2009) has reported that climate change is expected to put 49 million additional people at risk of hunger by 2020, and 132 million by 2050 Devendra. [3] due the crops being affected by climate change.

All vegetable crops are sensitive to temperature and most have specific temperature requirements for development of optimum yield and quality. Climate change generally shows impact on capsicum growth and yield characters in the following ways:

Increased rate of pollination failures, flower abortion will occur under higher temperature. Pollen viability and germination are known to be sensitive to higher temperatures. Pepper plants maintained under a moderate high temperature regime (32°C/26°C, day/night) for 8 days before flowers have reached anthesis showed reduced in vitro germination resulting in reduced number of seeds per fruit Aloni et al. [4]. Pre-anthesis temperature stress is also associated with developmental changes in the anthers, particularly irregularities in the epithesium and endothesium, lack of opening of the stromium, and poor pollen formation Peet et al. [5]. The increased temperature elivations might ultimately lead to no or drastic reduction in pollination Increased heat stress will adversely affect fruit size and quality. Saha et al. [6]. Cultivars are currently not as adaptable to higher or more variable temperatures as they were before. Increased incidence of physiological disorders like blossom end rot and sun scald causes the reduced yield and market value, ultimately causing losses to farmers Savvas et al. [7].

The bell peppers which were grown under high temperature (33°C) showed reduced fruit set Yanez-Lopez et al. [8], and flower malformation when grown in temperatures below 18°C resulting in the formation of parthenocarpic fruits and reduced fruit set Aloni et al. [9]. Even a moderate fall in temperature, causing no visible damage to chilling sensitive plants, may have up to 50% decrease in their productivity. Even a moderate fall in temperature, causing no visible damage to chilling sensitive plants, may have up to 50% decrease in their productivity quality. By frost damage, symptoms such as, Dead, water-soaked tissue in part or whole of a pericarp surface with pitting, shriveling and decay can be observed on Bell Pepper. An increasing incidence of out of season and extreme rainfall events will involve the timing of cultural patterns and negatively effects on yield and product quality. Increasing temperatures will impact greenhouse crop production, especially production in sub-tropical areas, where summer time temperatures are high and restrict production in the cooler months of the year In temperate regions there will be less effect and sowing time can adjusted accordingly. More irrigation water will be required because of higher evaporative demand.

Continued spicy and moist condition after the storm is very detrimental which increases disease incidence, particularly bacterial diseases Gordon Johnson [10]. Many diseases such as bacterial wilt, bacterial spot and anthracnose caused by *Ralstonia solanacearum, Xanthomonas campestris* pv. *vesicatoria* and *Colletotrichum acutatum,* respectively, whereas, the incidence of *Phytophthora* blight caused by *Phytophthora capsici* and also increased incidence of insect pests such as Thrips, Mites and White fly are observed under higher temperature and increased risk of spread and are common in capsicum. Proliferation of soil borne diseases like leaf blight and fruit rot, as a consequence of more intense rainfall events coupled with warmer temperatures are also observed in peppers.

2. MITIGATION

Knowing about the adverse effects of higher temperature and other climatic factors on capsicum, appropriate action should be under taken so, as to mitigate them. Some of the practices that can aid for a better crop growth under such conditions include.

Sowing dates of the crop can be corrected according to varying temperature. The crops should be grown under polyhouses to avoid losses due to unfavourable climatic conditions like high temperature, heavy rains, strong winds and hailstones etc.,. Integrated Pest and Disease Management (IPDM) will be an important tool to adapt to changing climate in a sustainable manner Bale [11]. Mulching with different mulching materials will help not only in reducing the incidence of soil borne diseases like fruit rot and leaf blight but also maintain the microclimate near the root zone. Scientists have to breed the cultivars, suitable to grow under changing temperature, resistant to insect, pest and diseases. Pick up the cultivars which are more adaptable to a changing and variable climate.

To cope up with the effects of climate change we have to follow good and an advanced production technology in capsicum that will increase the yield and good quality of the produce.

Cultivars: There are several cultivars of bell shaped, non-pungent, mild, thick fleshed sweet peppers or simla mirch. The important cultivars are California Wonder, Solan Bharpur, Yolo Wonder, King of North, Early Giant, World Beater, Chinese Giant, Arka Gaurav and Arka Mohini. Important hybrids are Bharat, Indira, Hira, Solan Hybrid-1 and Solan Hybrid-2 etc.

Soil: Sweet pepper can grow in almost all types of soil, but well drained clay loam soil is believed as ideal for cultivation of sweet pepper. It can withstand acidity to some extent. For commercial cultivation, leveled and raised beds were found more suitable than sunken beds. On sandy loam soil, crop can successfully be grown provided manuring is done to a great extent and the crop is irrigated properly and timely. The sweet pepper plant produced best when soil pH was 6-6.5.

Climate: Sweet pepper is a warm season crop. It requires 25^0C day and 18^0C night temperature for higher yield, fruit weight, length, girth, number of fruits per plant and pericarp thickness. Fruit development is found to be adversely affected at temperature of 37.8^0C or above. High temperature and low humidity at the time of flowering increase the transpiration pull resulting in abscission of flower buds and small fruits Cochran [12]. High night temperature has put up to be responsible for the higher capsaicin content.

Raising of seedlings and transplanting: With the increasing problems to the crop due to climate change, there is a need to minimize the wastage of seed. The optimum utilization of seed is best obtained through use of protrays. By using this protray technique we can get the seedling healthy and without any lanky growth, reduced incidence of soil borne diseases. The sources should be dressed with Thiram or Captain at the rate of 2g per kg of seeds before sowing to prevent seed borne diseases. Seed rate of 750- 900 g/ha (OPV) and 200-250 g/ha (hybrids) is wanted for one hectare cultivation. The seeds should be covered with a layer of FYM or soil, manure mixture and irrigate every day to maintain optimum soil moisture. In the hills the sowing time for sweet pepper is March- April and in southern states October -November. This seedlings having 4-5 leaves should be transferred. The nursery beds should be irrigated before lifting of seedlings. Transplanting is done in evening hours, followed by irrigation. The seedlings are transplanted to the field in rows at a distance of 60 cm and plant to plant distance is kept 45 cm.

Manures and fertilizers: Application of balanced dose of fertilizers is necessary for proper growth

and development of the plants. FYM-200-250 q/ha, CAN- 400 kg, SSP- 475 kg, MOP- 90 kilo per hectare is applied to capsicum crop. A full dose of FYM, SSP, MOP and half dose of CAN should incorporate at the time of field preparation and continuing dose of CAN is applied in two split doses at one month interval after transplanting.

Irrigation: The first irrigation should be applied just after transplanting. Subsequently, the area should be irrigated as and when needed. Optimum soil moisture should be preserved in the territory at the time of flowering, fruit set and yield growth. Drip irrigation can also be done to water use efficiency, reduced spread of diseases, weed reduced, therefore vectors also reduced.

Harvesting: The sweet pepper fruits are usually picked while they are yet green in colour, firm and crispy. Yield changes from 300-400 q/ha. Care should be taken during harvest with out damage to the produce.

Capsicum production under greenhouse: Growing capsicum under greenhouses is proving to be a very remunerative venture to greenhouse growers as it fetches maximum returns in the mart. Colored varieties of sweet pepper like red and yellow are being produced by farmers and sold in the markets at distant places. Agro techniques to grow capsicum under greenhouse are as under:

- ✓ In mid hills of Himachal Pradesh, two crops of pepper can be taken, one spring, summer crop (January to June) and another autumn, winter crop (July to December).
- ✓ In capsicum generally those varieties and hybrids are grown which give maximum productivity with good condition and size of fruits and suits of year round production. These cultivars should receive a longer harvest duration. Indira (green), Orebelle (yellow), Bombay (red) are suitable varieties for cultivation under.
- ✓ Seeds are sown in well prepared nursery beds or plastic trays having uniform growing media comprising of soil and compost/FYM. The seedlings are ready after 4-5 weeks for transplanting depending upon the season of growing. The transplanting of seedlings after their hardening is done in an existing greenhouse in the evenings for the better establishment of plants in a growing medium comprising of soil, FYM/compost and sand (2:1:1). Closer spacing of 45 x 30 cm is kept in polyhouse.
- ✓ Training and pruning is an essential operation in greenhouse crops for better management and providing uniform light to the plants. It also aids in effective usage of resource and greenhouse environment by crops. In capsicum, to stem and four stem training system is followed. Temperature between 18-27 C and relative humidity ranging from 60-80% with more CO (900-1200 ppm) is considered ideal for good quality fruit production.
- ✓ Irrigation is done every day in the summers and every third day in winters by drip irrigation.
- ✓ Before transplanting, N, P and K are incorporated in soil @ 50 kg/ha.
- ✓ Fertigation is made out using water soluble fertilizers like poly feed @ 150 kg/ha (19:19:19) twice in week and is originated from third week after transplanting up to 15 days before last harvest.
- ✓ When fruits start attaining proper color may be harvested and firm and crispy. For long distance markets the fruits should be loaded down in secure containers to avoid any hurt in transit and warehousing. Generally harvesting starts 55 days after transplanting in most of the forms. A well managed crop of bell pepper under greenhouse conditions is expected to give a return of 10-13 kg/m^2.

3. CONCLUSION

Though the changes in climate is a continuous process, it has become recognizable in agricultural field from the past few years when it has started significant and lasting effect on crop production. The reasons for climate change are not completely known today, but as per the available information anthropogenic activities like industrialization and mechanization may contribute up to some extent. Selecting cultivars which are more tolerant are adaptable to changing environmental conditions. So polyhouses are best solution to avoid losses due to unfavourable climatic conditions like high temperature, heavy rains, strong winds and hailstones etc. Integrated pest and disease management (IPDM) will be an important tool to adapt to changing climate. Mulching with different mulching materials will help in reducing the incidence of soil born diseases like fruit rot

and leaf blight. Scientists have to breed the cultivars, suitable to grow under changing temperature, resistant to insect, pest and diseases. To cope up with the effects of climate change we have to follow good production technology in capsicum and also to increase the yield and for good quality of the produce.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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