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REGULAR ARTICLE

STUDIES ON THE EFFECT OF TEMPERATURE ON THE DEVELOPMENT OF SOFT ROT OF CABBAGE (*BRASSICA OLERACEA* VAR. CAPITATA) CAUSED BY *ERWINIA CAROTOVORA* SUB SP. CAROTOVORA

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SUMMARY

Soft rot is one of the destructive diseases of vegetables including cabbage worldwide. Since the temperature is one of the important factors for destructive nature of disease during storage and transportation, experiments were conducted to standardize optimum temperature for the growth of pathogen which revealed pathogen could grow at all the temperatures from 15 to 40°C. Marked higher growth was recorded at 30°C and considerable growth was at 25 and 35°C. During the study of effect of temperature on soft rot disease after 4 and 6 days of storage at different temperatures it was concluded that 30-35°C mostly favor the soft rot in cabbage and thus emphasis is to be given to prevent the disease during the prevailing temperatures in the region, in order to prevent losses due to the disease in cabbage and other hosts of the same pathogen.

Keywords: Soft rot, cabbage, temperature, *Erwinia carotovora sub sp. carotovora.*
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1. Introduction

Soft rot is one of the destructive diseases, occuring worldwide wherever fleshy storage tissues of vegetables and ornamentals are found. The disease can be found on crops in the field, in transit, and in storage or during marketing; resulting in great economic losses. Soft rot causes highest total loss of produce amongst the bacterial diseases. Post harvest bacterial soft rot losses have been estimated to vary between 15-30 percent of the harvested crop (Agrios, 2007). Vegetables coming from the field may be already infected although they may not yet show visible symptoms at harvest which later on may cause severe damage at high temperature and humidity. A number of factors have been reported to be responsible for soft rot development viz., host injury due to bruises, insects damage, high humidity and temperature. Since temperature is an important factor for destructive nature of the disease it is imperative to study the disease development behavior and resulting economic losses incurred. So far no work has been done on this aspect in Kashmir, where 1,964 ha of land is under cultivation of the crop with a production of 39,280 tones (Anonymous, 2007) it was considered obligatory to standardize optimum temperature for causal organism with

respect to the development of disease under temperate conditions of Kashmir.

2. Materials and methods

The Pathogen

Diseased cabbage heads bearing typical soft rot lesions were selected for isolation of pathogen. The isolated pathogen was characterized on the basis of pathogenicity, morphological and biochemical characters.

Standardization of optimum temperature for the growth of pathogen

An *in-vitro* experiment was conducted to standardize the optimum temperature for the pathogen. Equal volumes of nutrient broth were dispensed in the test tubes, autoclaved (for 20 min. at 121°C) and inoculated by 0.5 ml of a uniform cell suspension, prepared from actively growing young cultures. These tubes were incubated at different temperatures viz, 15, 20, 25, 30, 35, and 40°C (±1°C) in incubators. Five replications were maintained in each case and one Uninoculated control was maintained for each temperature, After 24 hours of incubation, the optical density was measured directly with the help of spectrophotometer at 600 nm.

Effect of pathogen on host in storage at different temperature

Freshly cut pre-weighed cabbage heads were surface sterilizes by dipping in a solution of 0.1 % of sodium hypo chloride followed by serial washings with sterile water and were then air dried under the hood of laminar air flow. The heads were thoroughly sprayed with the uniform cell suspension of the pathogen, followed immediately by pricking with a wooden stick on which 5 entomological pins were mounted. Uninoculated controls were maintained through the studies. Three cabbage heads constituted one replication and seven replications were maintained in each treatment (temperature level). The heads were put in sterile plastic bags and were stored at three different temperatures. i.e., optimum temperature of the pathogen *in vitro* one level above and one blow blow. Observations were recorded as soft rot severity after 4 and 6 days and per cent loss in weight due the disease after 6 days. Per cent loss in weight was calculated, using digital electronic balance by washing off and removing macerated tissue of cabbage and recording the loss in weight. Physiological loss in weight was deduced with the help of un-inoculated controls. Disease intensity was measured as degree of tissue maceration on 0-5 scale.

3. Result and Discussion

Standardization of optimum temperature for growth of pathogen

The isolate of causal bacterium readily macerated the host tissue was found to be gram negative, rod shaped, facultatively anaerobic; catalase positive, oxidase negative, urease not produced. Starch was not hydrolyzed but the bacterium readily hydrolyzed gelatin and pectin. The bacterium could grow at 37°C. All the pathogenic, morphological, and biochemical observations agreed with the description for *Erwinia carotovora sub-sp. carotovora*

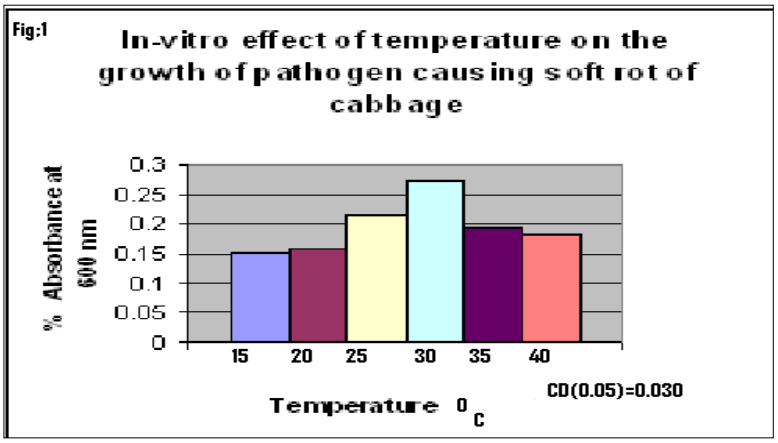
The standardization of optimum temperature data in the form of per cent absorbtion at 600 nm (Fig. 1) reveals the pathogen grows at all the tested temperature. However, there was a marked higher growth at 30°C. Therefore, this temperature was considered optimum for its growth. Growth also occurred at 25°C and 35°C respectvely. The growth at 40°C was statistically at par with 35°C.

It is explicitly known that in case of soft rot disease temperature exerts considerable effect on growth of *Erwinia carotovora sub-sp. carotovora*. With optimum temperature for this pathogen reportedly ranges from 27-30°C maximum varies from 32-40 °C (Bradbury, 1986). De boer and Kelman (2000) also reports that *E. carotovora sub-sp. carotovora* can grow at 37°C while *E. carotovora sub-sp. atroseptica* fails to grow at such a high temperature.

Effect of pathogen on host in storage at different temperature

Effect of three levels of temperature(25, 30, 35°C) as shown in Table-1, Fig. 2) reveals

that a higher severity of soft rot in cabbage heads stored at 30°C (23.80) after 4 days which rose to the highest of 39.99 after 6 days of storage which was statistically at par with the incidence disease severity of the samples stored at 35°C for 6 days (34.28).



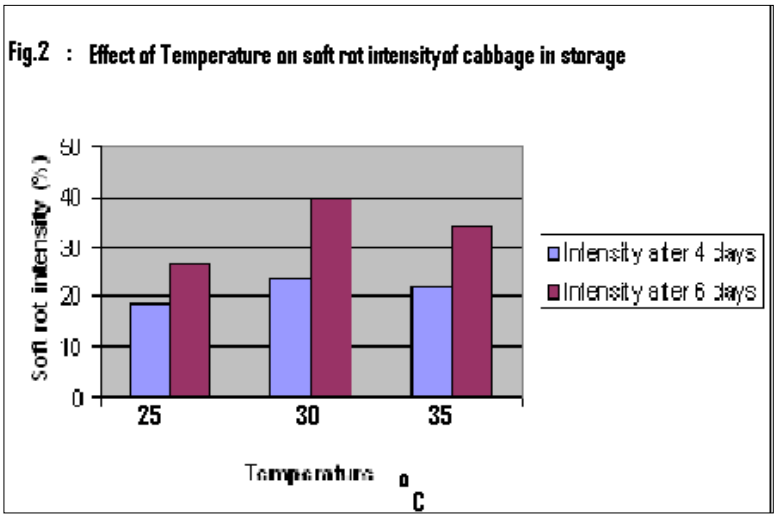


Table 1: Effect of temperature on soft rot intensity and per cent weight loss of cabbage(*Brassica oleracea* var. *capitata*) heads.

Temperature ^{0}C	Storage period (Days)	Disease Incidence	Disease Intensity	Weight loss
25	4	100*	19.04 (25.73)	N.D**
	6	100	26.66 (30.71)	21.64
30	4	100	23.80 (29.10)	N.D
	6	100	39.99 (39.17)	32.33
35	4	100	21.90 (27.85)	N.D
	6	100	34.28 (35.77)	25.93
$CD_{0.05}$			8.73 (5.36)	

** = Not detected (Observations after 6 days were taken on same heads from which observations of disease intensity were recorded after 4 days)

A disease severity of 19.04 and 26.66 per cent was also recorded at temperature of 25°C at 4 and 6 days of storage respectively, which was also considerably very high. Hence present study reveals that temperature of 30-35°C is more favorable for the disease development to cause the maximum devastation Our studies are in agreement with other workers. Bhattacharya and Mukherjee(1986) recorded complete rotting of potato, carrot, onion, and pine apple due to *E. carotovora subsp carotovora* at

high temperature (40°C) with 100 per cent relative humidity. Raju *et al*, (2008) reported that a temperature 20-35°C enhanced the rotting ability of *E. carotovora subsp carotovora* in radish.. The highest rotting was recorded when radish discs were incubated at 35°C and 100% relative humidity.The findings of Farrar *et al*,(2000) also reveals that a temperature range of 30-37°C was optimum for soft rot development in different vegetable species.. Walker (1998) has summarized that a high humidity coupled with a temperature of 80° F the pathogen is capable to cause the greatest injury. The optimum temperature for its growth was 85° F the maximum slightly over 100°F. For this reason much of the loss due to this disease occurs during middle of the summer. Under temperate conditions of Kashmir valley, maximum damage was there only during the months *viz*., June- August as the temperature remains quite high. This also aggravated damage due to soft rot considerably during this time. During other months the damage due to disease is comparatively low as temperature seldom goes to 30°C or above. It is worthwhile to mention that association of *E. carotovora subsp carotovora* with the disease also reflects the fact that disease would be more severe at higher temperature unlike *E. carotovora subsp atroseptica* which is considered a cold temperature variant of *E. carotovora subsp carotovora* (Agrios, 2007) Hence from our study it is concluded that a higher temperature of 30-35°C mostly favors growth of soft rot in cabbage. This has to be given emphasis for storage and transportation, keeping in view also the high humidity prevailing during the storage period(July, August).This necessitates the measures to be adopted at a very early stage before the crop is stored or transported to far flug areas. Utmost prevention measures should be directed to the control this disease to prevent huge losses in cabbage and other hosts of the same pathogen.

Conclusion

The temperature of 30°C and above is most favorable and destructive for the development of soft rot caused by *Erwinia carotovora sub sp. carotovora*, Hence preventive measures from the disease are to be taken during the period of prevailing temperature in Kashmir valley (June, July) to minimize the damage in cabbage due to the disease under storage.

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