



Research Highlight

Impact of Downy Mildew Disease on Biochemical Compounds of Cucumber and its Management

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Cucumber (*Cucumis sativus*) belongs to family *Cucurbitaceae* and it is world's second largest cultivated food crop of the cucurbits after watermelon¹. The word cucumber was derived from the Dutch word 'Komkommer'. Total area of world under cultivation of cucumber is 2.09 million hectares with 0.31 million tons production while in Pakistan it is cultivated on area of 3.397 thousand hectares with a total production of 0.000051 million tons². China is largest producer of cucumber and provides about two-thirds of the global supply³. It is a good source of calcium (14%), iron (0.2%), vitamin B (3%), C (4%), K (19%) and consumed as common salad ingredient. It is widely grown all over the world and is attacked by different fungal, bacterial and viral diseases. Among fungal diseases, Downy mildew disease is a potential threat for cucumber which is caused by *Pseudoperonospora cubensis*⁴.

Yield losses due to Downy mildew disease are about 30-40% which may increase upto 100% under favorable conditions⁵. Symptoms of downy mildew are characterized by appearance of oily and necrotic lesions on the upper surface of leaves, enclosed in leaf veins. In hot and dry

weather, these necrotic lesions express angular appearance⁶. As infection progresses, death of leaves may occur within few days. Development of reduced canopy occur which ultimately affects the crop yield and quality of fruit⁷.

Different biochemical changes like enzymatic changes, protein, chlorophyll, ionic changes, phenolic and sugar changes are produced in cucumber plants after attack of *P. cubensis*. These changes can be used as biochemical marker to identify source of resistance in plants. Accumulation of defense-related enzymes in plants makes them immunized before the attack of pathogen. Different enzymes perform different functions to defend the plants against pathogens. Peroxidase is defense related enzyme which is used to catalyze the oxidation of substrates like phenol and its derivatives. Generally peroxidases enhance their activity after the attack of downy mildew disease because they participate in synthesis of phenolic compounds and lignifications which are effective against pathogens.

Peroxidase (POD) activity in resistant variety (Hilton) increased from (0.75-1.42)

after inoculation. While in Moderately susceptible varieties i.e., HCU-163A, Panda India, Anmol, Captan, Local it enhanced from (0.92-1.82), (0.92-1.82), (0.93-1.05), (0.97-1.70), (0.32-1.29) and (1.35-2.41). In susceptible varieties Sancanto, Nakrsan, Kargil, Cucumber-363 this activity increased from (0.47-0.73), (0.20-1.38), (0.18-2.35) and (0.64-2.06). Catalase enzyme decomposes the hydrogen peroxide to water and oxygen. In moderately susceptible varieties amount of Catalase (CAT) measured was (1.35, 1.60, 1.78, 0.76 and 3.16) which enhanced to (2.67, 2.28, 3.07, 2.40 and 5.07) respectively after inoculation. In resistant (Hilton) and susceptible Sancanto, Nakrsan, Kargil, Cucumber-363 its concentration enhanced to 2.48, 2.25, 3.41, 2.45 and 4.19 from 1.75, 0.57, 0.27, 0.36 and 1.11 in uninoculated leaves of cucumber.

Superoxide dismutase is also involved in plant defense response because it synthesizes the hydrogen peroxide from very reactive and toxic compounds like Superoxide anion, hydroperoxyl radical and proton (Svabova and Lebeda, 2005). Increased activity of Superoxide dismutase (SOD) has been observed in resistant cultivars of cucumber as compared to susceptible varieties. Amount of superoxide dismutase (SOD) in susceptible cultivars such as Sancanto, Nakrsan, Kargil, Cucumber-363 was higher (9.80, 9.80, 1.67 and 2.66) as compared to healthy ones (7.40, 8.85, 1.44 and 1.07). While in resistant variety (Hilton), its activity altered from 4.06 to 12.50 and in moderately susceptible varieties HCU-163A, Panda India, Anmol, Captan, Local it changed from 7.96, 1.05, 8.03, 1.29 and 7.29 to 8.72, 1.08, 8.85, 6.99 and 8.03 respectively.

Level of hydrogen peroxide H_2O_2 in susceptible varieties Sancanto, Nakrsan, Kargil, Cucumber-363 climbed from 0.89, 0.90, 1.01 and 5.51 to 9.29, 8.70, 13.19 and 21.86, respectively which in moderately susceptible HCU-163A, Panda India, Anmol, Captan, Local increased from 12.21, 2.93, 3.06, 4.04 and 4.95 to 14.41, 7.75, 6.09, 6.44 and 6.14. In resistant (Hilton) it changed from 0.75 to 2.27. Proteins which are involved in defense mechanisms are called pathogenesis related proteins (PR-proteins). These proteins form complexes with the fungal pathogens like *P. cubensis* and inhibit their activities (Metraux *et al.*, 1988). Amount of protein in resistant variety (Hilton) decreased from 4.15 to 3.56 in diseased leaves of cucumber. In moderately susceptible its level was estimated in healthy leaves of HCU-163A was 3.93, Panda India (2.63), Anmol (4.73), Captan (3.86) and Local (3.96) as compared to diseased leaves in which its concentration was 3.35, 3.84, 4.16, 3.01 and 3.66 while in susceptible varieties its concentration was changed from 3.83, 4.17, 3.76 and 4.42 to 3.45, 2.54, 2.82 and 2.22, respectively.

When the cucumber plants are infected by downy mildew disease, a decrease in growth parameters of plant like plant length, total yield per plant, fresh and dry weight of the plant are observed. Horticultural parameters play an important role for the selection of resistance varieties against disease. Resistant varieties can be selected on the basis of data regarding growth parameters like plant weight, fresh weight of shoot and root, dry weight of shoot and root, plant height, shoot and root length and total yield.

Out of 10 varieties/lines, one variety (Hilton) expressed resistance response with 18.26% disease incidence and disease rating of 3. Anmol showed highest fresh weight of roots (2.63 g), No. of leaves (30 per plant), plant yield (485.60 g) and plant weight (15.86 g). Panda India and Captan expressed highest dry weight of roots (0.17 g) and root length (0.18 m). Highest fresh (13.76 g) and

dry weight of shoots (8.60 g), Shoot length (3.15 m) and plant height (3.23 m) were expressed by Nakrsan and Cucumber-363.

Different management strategies are being used against downy mildew disease. In present study management of downy mildew disease was done through applications of four plant activator (Salicylic acid, K_2HPO_4 , Calcium chloride and Ascorbic acid) with three concentrations which provide significant results. Plant activators provide signals to plants via signal transduction pathway for activation of defense genes. They have no direct antifungal activity. These agents protect plants by making their plant-pathogen interaction incompatible and by activating systemic acquired resistance (SAR) in them.

Out of four plant activators, Ascorbic acid showed minimum diseases incidence (28.37%) followed by K_2HPO_4 (31.18%), Calcium chloride (37.33%) and Salicylic acid (43.94%) as compared to control (68.27%). The interaction between treatment and concentration showed that at 0.5% concentration, Ascorbic acid expressed minimum disease incidence (37.47%) and at 0.75 and 1% concentrations, it gave 28.22% and 19.42% disease incidence. Interaction between treatment and sprays showed that after first spray Ascorbic acid showed 31.53%, after second spray (28.16%) and after third spray it expressed 25.42% disease incidence.

Results indicated that at 0.5% concentration disease incidence was observed after first application (48.80%) after second application (47.21%) and after third application (44.86%). First application with 0.75% concentration showed (42.61%) disease incidence, after second, third application disease incidence was recorded as 40.94% and 39.96%. At 1% concentration minimum disease incidence was observed after first, second and third applications that is 39.10%, 37.03% and 35.86%, respectively.

It is concluded that Anmol variety can be used for breeding programme with good horticultural parameters. Antioxidants (SOD, CAT, POD, H_2O_2 and Protein) should be used as biochemical marker for identification of resistant source. Ascorbic acid is found most effective against downy mildew disease of cucumber.

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