Effects of Low Dose Radiation on Plant-Pathogen Interactions in Chernobyl Zone

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Low dose chronic radiation may represent some threats to agriculture because it could induce mutations or speed up a pace of race formation in pathogen population [Dmitriev et al., 2002]. The aim of this study was to investigate the effects of radionuclide contamination in Chernobyl zone (CZ) on plant-pathogen interactions. Puccinia graminis, the causal agent of cereal stem rust, is most damaging disease of these crops. We found the fungus in CZ on cultural plants (wheat, rye and oat) and susceptible grasses. Incidence and pathotypes of P. graminis were determined. The data obtained suggest that population structure of P. graminis has been changed in CZ by appearance of a new population with high frequency of more virulent clones. Low dose radiation has also affected plant disease resistance. Radionuclide contaminated wheat seeds (M3) collected in CZ were sowed in uncontaminated soil. Plants grown from the seeds were 2 - 2.5-fold more susceptible to powdery mildew than control ones. The data were confirmed in a set of experiments with artificial inoculation of wheat plants by other pathogens in greenhouse. Incidence and brown rust development were 2.6-fold higher in radionuclide contaminated seedlings than in control ones. To elucidate alterations in plant disease resistance field trials were carried out in CZ on three plots with matched soil parameters but differed in dose exposure rates. Wheat plants of three cultivars were artificially inoculated with brown rust spores. Incidence and extent of wheat rust was more severe on heavy contaminated plots. We analyzed biochemical mechanisms underlying the decrease in plant disease resistance. Activity of proteinase inhibitors in grains of wheat and rye under low dose radiation was decreased to 30-55 % as compared to control. The inhibitors form stable complexes with proteolytic enzymes of pathogens and restrict the disease extent. Decrease of proteinase inhibitor activities could diminish plant disease resistance. This assumption was confirmed by experiments with high lysine opaque-mutation of corn, which characterized by increased sensitivity to stress factors. In the mutant corn grains the proteinase inhibitor activity was 2-fold less than in irradiated plants of the original corn line and 4-fold less than in control unirradiated plants. Thus results obtained both in greenhouse and in field trials demonstrate the influence of low dose chronic radiation on plant-pathogen interactions. We believe that monitoring of evolution processes in plant pathogen populations in radionuclide contaminated areas should provide better understanding on how serious the threats to agriculture are.

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