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Review

Zea mays assays of chemical/radiation genotoxicity for the study of environmental mutagens

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Abstract

From a literature survey, 86 chemicals are tabulated that have been evaluated in 121 assays for their clastogenic effects in Zea mays. Eighty-one of the 86 chemicals are reported as giving a positive reaction (i.e. causing chromosome aberrations). Of these, 36 are reported positive with a dose response. In addition, 32 assays have been recorded for 7 types of radiation, all of which reacted positively. The results of 126 assays with 63 chemicals and 12 types of radiation tested for the inductions of gene mutations are tabulated, as well as 63 chemicals and/or radiation in combined treatments. Three studies reported positive results for mutations on Zea mays seed sent on space flights. The Zea mays ($2n = 20$) assay is a very good plant bioassay for assessing chromosome damage both in mitosis and meiosis and for somatic mutations induced by chemicals and radiations. The carcinogenicity and Salmonella assays correlate in all cases. The maize bioassay has been shown to be as sensitive and as specific an assay as other plant genotoxicity assays, such as Hordeum vulgare, Vicia faba, Crepis capillaris, Pisum sativum, Lycopersicon esculentum and Allium cepa and should be considered in further studies in assessing clastogenicity. Tests using Zea mays can be made for a spectrum of mutant phenotypes of which many are identifiable in young seedlings.

Keywords: *Zea mays* (maize); Zea species; Plant genotoxicity bioassay; Karyotype; Nuclear DNA amounts; Radiobiological data

Contents

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1. Introduction

Zea mays (maize), a member of the Poaceae, is the most economically important crop in the United States and the third most important crop plant (after rice and wheat) in the world [154,408]. It is a monoecious summer annual that is mostly cross-fertilized by wind-dispersed pollen. Maize is the oldest plant to have a fully established gene map with the basic genome consisting of 10 chromosomes ([146] and references therein). The maize bioassay to be described is a particularly favorable experimental assay for the study of chromosome aberrations that may be scored in both mitotic and meiotic cells and pollen [21,429,450]. Sister chromatid exchanges have been induced in root tips of maize [57,93,361]. Chromosome breakage caused by controlling (transposable) elements is not considered in this review [54,305].

Maize was used in early studies to induce mutants by means of X-ray and ultraviolet radiation [232,302,427,435] and to make comparisons between X-ray and chemically induced chromosomal mutations [9,172,309]. Chemical mutagenesis has yielded thousands of mutations for study [95,307,311]. A database of terminology has been established [249]. The maize plant is exceptionally well suited for the study of induced mutations since a large number of seedling mutants are known enabling one to score mutations in the seedling stage without growing plants to maturity. Numerous loci have been identified and assigned to specific chromosomes [97,99,100,311]. Among the many mutations that have been described are those