



Review

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

William F. Grant^{a,*}, Elizabeth T. Owens^{b,1}

^aDepartment of Plant Science, P.O. Box 4000, McGill University, Macdonald Campus, 21, 111 Lakeshore Blvd., Ste. Anne de Bellevue, Quebec H9X 3V9, Canada

^bNanoscale Science and Devices Group, Life Sciences Division, Oak Ridge National Laboratory, Oak Ridge, TN 37830, USA

Received 2 December 2005; received in revised form 19 April 2006; accepted 21 April 2006

Available online 7 July 2006

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.

© 2006 Published by Elsevier B.V.

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

Contents

1. Introduction	18
2. Description of the karyotype	26
3. The assays	29
4. Suggested protocol for using <i>Z. mays</i> in genotoxic studies	30
4.1. Seed preparation.	30
4.2. Production of plants for mitotic and meiotic studies	30
4.2.1. Mitotic cycle (MC)	30

* Corresponding author. Tel.: +1 514 398 7863; fax: +1 514 398 7897.

E-mail address: william.grant@mcgill.ca (W.F. Grant).

¹ Oak Ridge National Laboratory, managed by UT-Battelle, LLC, for the US Department of Energy under contract DE-AC05-00OR22725.

4.3.	Treatment solution	30
4.4.	Recovery period	30
4.5.	Pretreatment	30
4.6.	Fixation	31
4.7.	Staining	31
4.8.	Maceration	31
4.9.	Slide preparation	31
4.10.	Temporary sealing	31
4.11.	Permanent slides	32
4.12.	Controls	32
	4.12.1. Water control	32
	4.12.2. Solvent control	32
	4.12.3. Positive control	32
4.13.	Collection of data	32
4.14.	Statistical analyses of data	32
4.15.	Dose/exposure units	32
5.	Survey of <i>Z. mays</i> literature	32
	5.1. Sensitivity: comparison with other species	44
	5.2. Comparison between specific agents using <i>Z. mays</i> as the test plant	45
	5.3. Age of seed	46
	5.4. Combined treatments	46
	5.5. Chemicals reported to have an antimutagenic or radiosensitizing effect	46
	5.5.1. Chemicals exhibiting an antimutagenic effect	46
	5.5.2. Chemicals exhibiting a radiosensitizing effect	46
	5.6. <i>Z. mays</i> : an assay for in situ monitoring	48
	5.7. <i>Z. mays</i> : an assay for the detection of mutations	48
6.	Test performance	49
7.	Correlation of clastogenicity, mutagenicity and carcinogenicity	49
8.	Decline in the number of maize genotoxic studies	52
9.	Conclusions	52
	9.1. Advantages and disadvantages of the <i>Z. mays</i> test system	52
	9.1.1. Advantages	52
	9.1.2. Disadvantages	52
10.	Recommendations	52
	Acknowledgement	52
	References	52

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

Download English Version:

<https://daneshyari.com/en/article/2149895>

Download Persian Version:

<https://daneshyari.com/article/2149895>

[Daneshyari.com](https://daneshyari.com)