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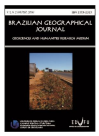

Scientific notes/Notas científicas/Notas científicas/notes scientifiques

Potential risk to wild plant species of the accidental seed germinations from transgenic varieties on roadsides

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ABSTRACT

Although there are security protocols for planting transgenic varieties, *e.g.* exclusion zones transgenic seed losses during road transport, may represent risk of genetic contamination. Brazil has one of the richest countries in the world in plant biodiversity, and annually loses millions of tonnes of grain in its highways, representing potential risk to native species such as cotton, *Gossypium mustelinum*. Despite the Brazilian problem has been the case study, this same ecological disturbance may also be occurring in other regions of the world. Improvement in methods of harvesting, storage and transport are necessary to minimize risk of vertical genetic contamination, especially in biodiversity hotspots.

PALAVRAS-CHAVE:
Conservação vegetal
Espécies nativas
Fluxo gênico
Hibridizacão

RESUMO: RISCO POTENCIAL PARA ESPÉCIES NATIVAS DA GERMINAÇÃO ACIDENTAL DE VARIEDADES TRANSGÊNICAS EM ACOSTAMENTOS DE RODOVIAS. Apesar de existirem protocolos de segurança para o plantio de variedades transgênicas, *e.g.* zonas de exclusão de transgênicos, perdas de sementes durante o transporte rodoviário, pode representar risco de contaminações genéticas. O Brasil um dos países mais ricos em biodiversidade vegetal no mundo, e anualmente perde milhões de toneladas de grãos em suas rodovias, representando risco potencial para espécies nativas, como o algodão, *Gossypium mustelinum*. A despeito do problema brasileiro tenha sido o estudo de caso, esse mesma perturbação ecológica também pode estar ocorrendo em outras regiões do mundo. Aperfeiçoamento em métodos de colheita, armazenamento e transporte são necessários para se minimizar riscos de contaminações genéticas verticais, especialmente em *hotspots* de biodiversidade.

Palabras clave:
Conservación vegetal
Especies nativas
Flujo génico
Hibridación

Resumen: Riesgo potencial para especies nativas de la germinación accidental de variedades transgénicas en acostamentos de carreteras. A pesar de existir protocolos de seguridad para el plantío de variedades transgénicas, por ejemplo, zonas de exclusión de transgénicos, pérdidas de semillas durante el transporte por carretera pueden representar riesgo de contaminaciones genéticas. Brasil es uno de los países más ricos en biodiversidad vegetal en el mundo y pierde anualmente millones de toneladas de granos en sus carreteras, representando riesgo potencial para las especies autóctonas, como el algodón, *Gossypium mustelinum*. Aunque el análisis haya se basado en estudio de caso brasileño, el problema debe ocurrir en otras regiones del mundo. La mejora en los métodos de recolección, almacenamiento y transporte, entre otros, son necesarios para minimizar los riesgos de contaminaciones genéticas verticales, especialmente en "hotspots" de biodiversidad.

Introduction

Transgenic crops are considerably grown in recent years, worldwide. In developing countries this phenomenon was driven by economic gains related to increased productivity and resistance to herbivores (CARPENTER, 2010). In some countries, it was observed that the increase in agricultural production, based on transgenic varieties was more effective for different reasons, *e.g.*, greater investment in scientific research, trade regulation, and the adoption of environmental and food regulatory measures (RANEY, 2006). Nevertheless, the planting of transgenic crops should be performed including measures to prevent gene flow between transgenic crops and their cultivars relative, and natural species, as the implementation of exclusion zones for cultivation of transgenic varieties (BORÉM et al, 2003; CAPALBO et al, 2009). The reason for these security managements is related to frequent production of interspecific hybrids among plants (STACE, 1991).

Faced with the economic benefits from planting transgenic crops, a new issue should be discussed. Can the spontaneous germination of transgenic seeds lost during road transport elevate the risk of genetic contamination of native species? This doubt should be seriously considered, particularly in Brazil. This South American country is home to remarkable biodiversity (MYERS et al, 2000), including numerous wild

relatives of cultivated species, such as *Gossypium mustelinum* Miers ex Watt (wild cotton), *Oryza grandiglumis* (Döll) Prod. (wild rice), and *O. latifolia* Desv. (swamp rice) (WENDEL; ROWLEY; STEWART, 1994; ALBUQUERQUE; NASS, 2009), *Manihot* spp. (wild cassava) and *Arachis* spp. (wild peanut). However, Brazil is not an example of efficiency with respect to grain transport. According to the Brazilian Institute of Geography and Statistics (IBGE, 2004), approximately 10 million tonnes of grain are lost from each Brazilian harvest due to old and unsuitable trucks for transporting grain, long distances, and rutted paved or unpaved roads. In Brazil, 67% of freight is transported through an extensive network of highways (FEARNSIDE, 2002).

On major highways for outflow of Brazilian agricultural produce, such as BR-163, BR-153 and BR-365, too often cotton, maize, millet and sorghum can be found flowering and fruiting on the roadsides, as a result of accidental germination and vigorous growth (Fig. 1). Of these four crops, only cotton and maize have transgenic varieties which are cultivated in Brazil authorized by the National Technical Commission on Biosecurity (CTNBio).

Figure 1. Partial view of specimens of *Gossypium* sp. vegetating on coasting of the BR-365 road after spontaneous germination, near Ituiutaba town, Minas Gerais state (18°56'52" S and 49°27'33" W).

If genetic contaminations are possible among transgenic crops and wild species, that may occur by genetic flow in the absence of correct agricultural management practices for planting transgenic crops (FREIRE, 2002; BORÉM et al, 2003), then the concern with preserving plant genetic populations of Brazilian biota is correct (ELLSTRAND, 1992). This concern is understandable face the excessive grain loss along Brazilian highways, could be a significant increase in the risk of genetic contaminations of wild plant populations found in vegetation remnants near roads, considering unexpected factors such as grain dispersion through biotic agents, which can be found outside of areas destined for planting transgenics crops (Fig. 2).

Figure 2. Millet with grains at the roadside of the BR-365 road near Monte Alegre de Minas town (18°51'44" S and 48°51'51" W), Minas Gerais state. In smaller image, ants carrying soybean and corn grains found on roadsides of the bridge Tietê River (SP-294 road), São Paulo state (22°19'13" S and 48°43'41" W).

Supporting this problem, it should be emphasized that currently Brazilian farmers have been expanding the area of genetically modified cotton. In addition, there is interest to the CTNBio authorises genetically modified rice (FERNANDES, 2009), which would join the list of transgenic crops that are currently cultivated in Brazil, which includes corn and soybean (JAMES, 2011). Nevertheless, we believe that in Brazil, buffer zones or transgenic exclusion zones (BARROSO et al, 2005) could be suggested for the protection of wild plant populations of economic value. The current loss of grain during road transportation charges even would endanger the genetic integrity of populations of native species, such as *Gossypium mustelinum*, found in the Northeast region of Brazil (WENDEL; ROWLEY; STEWART, 1994), a wind-blown seed. Hence, it is urgent that biosecurity measures could be complemented with the increasing number of railways for long distance transport, adequacy of trucks to transport grain fleet, and ongoing maintenance of roads.

A worldwide problem?

The risk of possible vertical contamination by pollen from transgenic plants that germinated in berms of roads after losses during transport unfortunately not restricted to Brazil. Its possible that in Africa, for example, a continent that also hosts native plants of economic interest, such as pearl millet (*Pennisetum glaucum*) and sorghum (*Sorghum bicolor*) (WET; HARLAN, 1971), the risk of genetic contaminations is a real possibility (SCHMIDT; BOTHMA, 2006). In Brazil, vigorous specimens of sorghum and millet can be found fruitful in important routes for disposing of their crops, like BR-365 and BR-153 road, frequently by massive loss of grains (Fig. 3).

A study conducted by HODGES; BUZBY; BENNETT (2011) on post-harvest losses of grains, indicated that between the years 2005 and 2007, were lost, respectively, 0.55 and 0.2 million tonnes of pearl millet and sorghum , considering the regional average of 16 East and Southern African countries. The considerable numbers may rise further, given the longed increase agricultural productivity in Africa (PRETTY; TOULMIN; WILLIAMS, 2011).

Figure3. Accumulation of lost sorghum seeds in the roadside of BR-153 road (19°08'27" S and 48°57'54" W).

Despite the economic benefits arising from the cultivation of transgenic crops in the world, especially in tropical regions, which owns high biodiversity, can not ignore the further development and improvement of practical storage and transportation (LAURANCE; SAYER; CASSMAN, 2014), besides the adoption of biosecurity measures which, together, can safeguard native species vulnerable to possible genetic contamination, specially in biodiversity hotspots.

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