

## **Managing Pollen Drift in Maize Seed Production**

P. R. Thomison<sup>1</sup>

### **Abstract**

Managing pollen drift in maize has received considerable attention in recent years largely as the result of the development and adoption of new seed technologies. Various practices are used to control maize pollination in maize seed production fields. Current AOSCA isolation standards focus on use of separation distance and pollinator rows to manage pollen drift from adjacent maize and limit adventitious pollen intrusion into maize seed production fields. The objectives of this paper are 1) to review current methods for managing pollen drift, especially guidelines of seed certification organizations on isolation requirements for commercial hybrid seed production as well as those used in production of specialty maize grown for IP markets, and 2) to assess the efficacy of these isolation methods in minimizing maize pollen drift from external pollen sources based on past research. Recent studies evaluating pollen flow have concluded that current isolation standards properly implemented can be effective in the production of seed with high levels of genetic purity.

### **Introduction**

Managing pollen drift in maize has received considerable attention in recent years as the result of the development and adoption of new seed technologies. There are concerns that pollen from maize containing transgenes or genetically modified organisms (GMOs), such as Bt maize, may contaminate landraces and wild relatives of maize (Luna *et al.* 2001). Commercial hybrid seed producers are re-evaluating isolation methods currently used to ensure genetic purity of seed and minimize potential pollen contamination of nearby maize, especially when GMO maize seed is produced (Burris, 2001). Controlling pollen drift has become important consideration in specialty maize production (Thomison, 2000). Growers of value added identity preserved (IP) grains need to control pollen contamination in order to optimize expression of value added traits in specialty maize and thereby obtain premiums. Similarly, for growers producing non-GMO maize as an IP grain, isolation is critical to prevent pollen contamination of their crops by neighboring fields of GMO corn.

---

<sup>1</sup> Department Horticulture and Crop Science, The Ohio State University, Columbus, OH 43210-1086, thomison.1@osu.edu; Salaries and research support provided in part by State and Federal funds appropriated to the Ohio Agricultural Research and Development Center, The Ohio State University.

Seed certification agencies have established minimal separation distances between seed production fields and adjacent maize to ensure pollination control and genetic purity of seed (AOSCA1971, Ohio Seed Improvement Association, 2000). These guidelines have proven to be very useful when genetic purity of seed was defined by the morphological phenotype and when 95 to 98% purity was satisfactory (Burris, 2001). However, as detection technology improved, the applicability and efficacy of the current isolation standards have been questioned. Seed producers want to achieve purity levels higher than 95% when producing GMO herbicide resistant seed, whereas end-users importing U.S. maize may specify that non-GMO grain can contain no more than 1% or less GMO grain. Will current distance isolation techniques used to prevent pollen contamination in grain and seed insure seed purity levels of 99% or higher or will it be necessary to implement new standards?

The objectives of this paper are 1) to review current guidelines of seed certification organizations on isolation requirements for commercial hybrid seed production, as well as those used in production of specialty maize grown for IP markets, and 2) to assess the efficacy of these isolation methods in minimizing maize pollen drift from external sources based on past research.

### **Current Isolation Standards**

Commercial hybrid maize seed producers employ various practices to control maize pollination including: crop rotation to minimize volunteer maize plants and reduce the need for roguing; selection of parent seed of high purity; vigorous roguing of both male and female rows to insure only the desired parents remain; aggressive detasseling of the female parent or use of cms female grain parents to prevent self pollination; temporal isolation of the silking period so as not to coincide with corn in nearby fields; planting of pollen parent border rows around the seed production field to insure that the field is flooded with the appropriate pollen and to dilute adventitious pollen; and adequate isolation distance to insure acceptable levels of protection from adventitious pollen (Burris, 2001)

The Association of Official Seed Certification Agency distance isolation requirement for certified hybrid maize is not less than 201 m (660 ft) from other corn of a different color and texture, i.e. yellow dent from white dent; flint from dent; waxy from dent, etc (AOSCA, 1971). However, in the case of the same color or texture maize, the distance may be reduced to 125 m (410 ft) and further modified by the planting of pollen parent border rows, the number of which is to be determined by the acreage of the specific cross (Table1). The minimum distance from other maize in fields less than 8.1 ha (20 A) is 25.8 m (85 ft) providing a minimum of 16 pollen parent border rows are provided. In fields larger than 8.1 ha (20 A) where a minimum of 10 border rows are provided, no additional distance isolation is required. The Organization for Economic Cooperation and Development (OECD), an international trade organization to which the US government subscribes, recommends schemes for the varietal certification. The OECD scheme distance isolation requirement for certified hybrid maize is not less than 200 m (660 ft), and border row substitution for distance is not allowed (Ingram, 2001). These separation distances aim to limit cross-pollination of male sterile or detasselled grain parent in the seed production field to 0.5%.

### **Evaluation of Past Research**

Ingram (2001) reviewed past field experiments that measured the effect of separation distance on levels of cross-pollination of maize. He concluded that cross-pollination could be limited to 1% or less on a whole field basis by a separation of 200 m (660 ft). While a barrier on the receptor crop (i.e. the seed production field) will reduce the separation distance, the effect would be small. Cross-pollination could be limited to 0.5% or less on a whole field basis by a separation distance of 300 m (984 ft) separation. Cross-pollination could not be limited to 0.1% consistently even with isolation distances of 500 m (1640 ft). According to Ingram (2001), the levels at which wind borne maize fertilizes adjacent maize crops is strongly affected by the size of “emitting” crop, the strength of the wind and any barriers that may intervene.

In a recent Mexican study, Luna *et al.* (2001) investigated the effectiveness of isolation requirements for controlling gene flow in conjunction with the duration of pollen viability and longevity. Isolation distance efficacy was evaluated by growing 12.8 m<sup>2</sup> plots of maize at various distances from a 4000 m<sup>2</sup> pollen source. They found that cross-pollination occurred a maximum distance of 200 m (660 ft) from the source planting and only a limited number of cross-pollinations occurred at the shortest distance (100 m or 328 ft). No cross pollinations were detected at 300 m (984 ft) from the source planting.

Burris (2001) recently presented results of a three-year industry-wide study of adventitious pollen intrusion under normal seed production conditions. This study initiated by AOSCA had two goals - one was that current certification isolation requirements be either validated or modified to improve their efficacy and the other was to acquire more knowledge about pollen movement and impact on production. Outcross (OC) values from the margins of seed production field, “OC Margin”, were compared to the OC value from the midpoint or 200 m into the seed production field which was characterized as the “OC Background” (Table 2).

Results of the study suggest that pollinator border row number may not be as important as previously thought, but the true relationship is likely masked because of the tendency of border row number to go up when male quality goes down. Distance to the contaminate source is important but its contribution to reducing adventitious pollen intrusion is often overshadowed by other factors such as wind intensity, direction, and the protective strength of the field pollen cloud (Table 2). The study concluded that exceptionally high quality seed could be produced when reasonable precautions are implemented.

### **References**

- Association of Official Seed Certifying Agencies. 1971. Seed certification handbook. Assoc. of Off. Seed Cert. Agencies., Raleigh, NC.
- Burris, J.S. 2001. Adventitious pollen intrusion into hybrid maize seed production fields. *In* R.J. Falasca (ed.) Proc. of Fifty-Sixth Annu. Corn and Sorghum Indus. Res. Conf., Chicago. 10-11 Dec. Am. Seed Trade Assoc., Washington, D.C.

- Brown, W.L., M.S.Zuber, L.L. Darrah, and D.V. Glover. 1984. Origin, adaptation, and types of corn. The National Corn Handbook. Purdue University Cooperative Extension Service. NCH-10.and
- Ingram, J. 2001. The separation distances required to ensure cross-pollination is below specified limits in non-seed crops of sugar beet, maize, and oilseed rape. *Plant Varieties and Seeds* 13: 181-199.
- Jones, M.D. and J.S. Brooks. 1950., Effects of tree barriers on outcrossing in corn. P.3-11. In *Oklahoma Agric. Exp. Stn, Tech. Bull. T-45.*
- Jones, M.D. and J.S. Brooks. 1950. Effectiveness of distance and border rows in preventing in preventing outcrossing in corn P.3-18. In *Oklahoma Agric. Exp. Stn, Tech. Bull. T-38.*
- Jugenheimer, R.J. 1985. Corn - improvement, seed production, and uses. Robert E. Krieger Publishing Co., Malabar, FL.
- Luna, S., V.J. Figueroa, M.B. Baltazar, M.R. Gomez, L.R. Townsend, and J.B. Schoper. 2001. Maize pollen longevity and distance isolation requirements for effective pollen control. *Crop Sci.* 41:1551-1557.
- Ohio Seed Improvement Association. 2000. Ohio certification and procedures manual.p57-60. The Ohio Seed Improvement Assoc., Dublin, OH.
- Thomison, P., A. Geyer, L. Lotz, and H. Siegrist. 1997. Using TC Blends® in high oil corn production. p.283-298 *In* R.J. Falasca (ed.) *Proc. of Fifty-Second Annu. Corn and Sorghum Indus. Res. Conf.*, Chicago. 10-11 Dec. Am. Seed Trade Assoc., Washington, D.C.
- Thomison, P.R. 2000. Specialty grain production: agronomic performance and management considerations. *Ohio's Challenge* 12:22-27.
- Wych, R.D. 1988. Production of hybrid seed corn. p. 565-607. *In* G.F. Sprague and J.W. Dudley (ed.) *Corn and corn improvement*, third edition. ASA, CSSA, and SSSA, Madison, WI..
- Zuber, M.S., and L.L. Darrah. 1987. Breeding, genetics, and seed corn production. p.31-51. *In* S.A. Watson (ed.) *Corn: chemistry and technology.* American Assoc. of Cereal Chemists, Inc. St. Paul, MN.

Table 1. Minimum border rows of isolation for hybrid corn production according to AOSCA standards.

Minimum Distance From Other Corn (feet)	Field Size	
	1 - 20 Acres Border Rows (minimum)	20 Acres or More Border Rows (minimum)
410	0	0
370	2	1
330	4	2
290	6	3
245	8	4
205	10	5
165	12	6
125	14	7
85	16	8
0	Not permissible	10

*Managing Pollen Drift in Maize Seed Production*

Table 2. The effect of distance to the contaminate source on the percentage of outcross (OC) occurrence in hybrid corn seed production fields averaged across years.

Distance to Contaminate (m)	Number of Fields	Mean OC Margin	Mean OC Background	Standard Error Mean
1 - 50	119	1.84	0.92	0.16
51 - 75	67	2.79	1.79	0.31
76 - 125	163	1.62	1.11	0.15
> 125	13	0.73	0.55	0.21

Source: Adapted from Burris (2001)