AMERICAN SEED TRADE ASSOCIATION

ASTA Statement on Field and Greenhouse Planted Seeds and Human Pathogens February 5, 2019

Progress continues to be made to prevent contamination of fresh produce and vegetables with human food borne pathogens through the development of additional safeguards for our nation's food supply from "the field to the dinner table." Fruits and vegetables are essential components of a healthy diet, and providing a safe food supply, beginning with the seed, is a fundamental priority. Therefore, the seed industry continues to be vigilant by closely monitoring food safety pathogen outbreaks, evaluating and incorporating quality management systems and procedures into seed production programs where appropriate, and monitoring ongoing research activities to help ensure that seeds do not become exposed to, or contaminated with, human pathogens.

Research activities and outbreaks linked to eating fresh produce and vegetables continue to confirm that seeds play an insignificant role in the epidemiology of food safety pathogen outbreaks with the exception of seed used for the production of fresh sprouts. (This statement does not address sprout production.) Since the 2006 food safety outbreak linked to fresh spinach produced in California, there has been a tremendous amount of research focused on the primary sources of contamination for fresh fruit and vegetables. These include irrigation water, soil, compost, manure and animal wastes, and contaminated wash water. Due to their low risk, seeds for planting are currently not included in the food and Drug Administration's (FDA) Food Safety Modernization Act regulations.

Over 100 scientific articles support the conclusion that any source of contamination potentially associated with seed is negligible to non-existent when seed is planted under field or greenhouse conditions in comparison. Research conducted to date shows the primary sources of contamination occur after the seed is planted (e.g. during production of produce, or at harvest or post-harvest). To date no outbreak of human illness linked to eating fresh produce or fresh vegetables has been traced back to the planting of contaminated seed.

ASTA continues to support science-based research that prioritizes and focuses on the areas of greatest risk for human pathogens to enter the fresh produce supply chain. Because extensive research shows that, under typical field conditions, seed poses a minimal risk, the seed industry and ASTA continue to believe that there is no significant

value in requiring testing of seed lots for the presence of human pathogens and that such testing would not prevent future food illnesses emanating from produce.

Frequently Asked Questions:

Question: Will the use of seed contaminated with pathogens such as E. coli O157:H7 or Salmonella result in contaminated produce?

Answer: In studies done with leafy vegetables, researchers were unable to see translocation of root colonizing E. coli or Salmonella to the edible top portions of the plant (e.g. petioles, leaves, flower parts). For the sprout industry, seed has been identified as a primary source of inoculum in many of the foodborne illnesses associated with fresh sprout consumption. For fresh vegetables and fruit, seed is not thought to be a primary source of inoculum. When contaminated seeds are planted in soil there are numerous compounds (e.g. sugars, amino acids, organic acids, and phenolic compounds) released during the germination and ultimate emergence of the seedling. These seed exudates can be utilized by neighboring micro flora such as any E. coli or Salmonella serovars that may have been on the seed. As the populations of E. coli and Salmonella increase they will colonize the interior as well as the exterior of the roots and at a low frequency may colonize the developing seedling hypocotyl (seed stem). However, E. coli or Salmonella that colonize the roots of plants have not been found beyond the hypocotyl and colonization has reportedly been limited to motile serovars.

Colonization of E. coli and Salmonella on the exterior of roots has been shown to move on the outside of the plant ending up on the leaves and flowers. But, this was under lab conditions and only using serovars that have flagella-mediated motility. This movement is thought to be slower under field conditions in the presence of a wide variety of micro flora competing for the same niche.

References: 1. Barak, 2012; 3. Buck, 2002; 4. Cooley, 2003; 6. Gu, 2011; 9. Sharmas, 2011; & 11. Warriner, 2005

Question: Can seed become contaminated with human pathogens (e.g. Salmonella and E. coli O157:H7)?

Answer: Seed has been implicated as the primary source for human pathogens (i.e. Salmonella and E. coli) for the fresh sprout industry. Researchers have been able to artificially inoculate seed and detect the human pathogen up to two years after inoculation. Extensive testing of spinach seed after the 2006 outbreak of E. coli on baby leaf spinach failed to detect human pathogenic forms of E. coli or Salmonella. Research studies suggest that contaminated seed is the result of contaminants contacting the plant chaff and not from translocation, meaning that planting contaminated seed does not

seem to lead to the production of contaminated seed if the tops are kept free of human pathogens

References: 1. Barak, 2012; 3. Buck, 2002; 4. Cooley, 2003; & Van der Linden, 2013

Question: What is the source of contamination with human pathogens for fresh fruits and vegetables (excluding sprouts)?

Answer: There are many sources for contamination of fruits and vegetable. Before harvesting sources of contamination include irrigation water, soil, feces, water used to apply pesticides, fertilizer, dust, arthropods, incomplete composted manure, wild and domestic animals, human handling, cultivating equipment, and potentially aerosols. At harvesting or after harvesting sources of contamination include feces, human handling, harvesting equipment, transport containers, wild and domestic animals, arthropods, dust, rinse water, ice, transport vehicles, processing equipment and possibly aerosol's.

References: 1. Barak, 2012; 2. Brandl; 2013; 5. Fletcher, 2013; & 7. Hanning; 2009.

Question: Do human pathogens move systemically in plants?

Answer: There have been some research studies that suggest that E. coli and Salmonella serovars move internally in plants. However, many of those studies did not rule out the possibility of movement externally. The current thought is that E. coli and Salmonella serovars that have motility can colonize roots, leafs, or flower parts with no extensive movement internally. Roots can be colonized internally and on the exterior but the contamination rarely moves to the hypocotyl (seed stem) with no movement to the shoots, leaves, or flower parts. Inoculum that colonizes the leaves or flower parts do not seem to move downwards to the stem or roots.

References: 4. Cooley, 2003; 6. Gu, 2011; 8. Holden, 2009; 9. Sharmas, 2011; 10. Van der Linden, 2013; Sharmas, 2011; & Warriner, 2005.

Key to References (ASTA maintains a bibliography of over 150 references):

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3. Buck, J.W., R.R. Walcott, and L.R. Beuchet.2002. Recent trends in microbiological safety of fruits and vegetables. Plant Health Progress doi 10.1094/PHP-2003-0121-01-RV

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5. Fletcher, J., J.E. Leach, K. Eversole and R.Tauxe. 2013. Human Pathogens on Plants: Designing a multidisciplinary strategy for research. Phytopathology 103:306-315

6. Gu, G., J.M. Cevallos-Cevallos, S.M. Richardson, J.A. Bartz, and A.H.C. van Bruggen. 2011. Internal colonization of *Salmonella entrica* serovar Typhimurium in tomato plants. PlosOne 6(11):e277340

7. Hanning, I.B., J.D. Nutt, and S.C. Ricke. 2009. Salmonellosis outbreaks in the United States due to fresh produce: sources and potential intervention measures. Foodborne Pathogens and Disease 6(6): 635-648

8. Holden, N., L. Pritchard, and I. Toth. 2009. Colonization outwith the colon: plants as an alternative environment reservoir for human pathogenic enterobacteria. FEMS Microbiological Review 33(2009): 689-793

9. Sharmas, M. and S. Ferguson. 2011. ARS scientists study the ins and outs of *E. coli* contamination. Agricultural research April 2011

10. Van der Linden, I., B. Cottyn, M. Uyttendaeie, G. Vlaemynck, M. Maes, and M. Heyndrickx. 2013. Long term survival of *Escherichia coli* O157H7 and *Salmonella enterica* on butterhead lettuce seed, and their subsequent survival and growth on the seedlings. International Journal of Food Microbiology 16(2013): 214-219

11. Warriner, K. et al. 2005. Seed decontamination as an intervening step for eliminating *Escherichia coli* on salad vegetables and herbs. Journal of Science in Food and Agriculture 85: 2307-2313