***ASTA Statement on***

***Field and Greenhouse Planted Seeds and Human Pathogens***

***January 30, 2017***

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 ASTA is in agreement that providing a safe and sound 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 its 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 paper 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 (Hanning et al 2009), which are generally associated with harvest or post-harvest activities. Due to their low risk, seeds, other than those used for the production of sprouts, are currently not included in the Food and Drug Administration’s (FDA) Food Safety Modernization Act (FSMA) regulations or the United Fresh Producers Association’s food safety guidelines.

Summarizing over 100 scientific articles, the research conducted to date supports the premise 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 to the primary sources of contamination that can occur after the seed is planted (e.g. at harvest or post-harvest). And, to date no outbreak of human illness linked to eating fresh produce or fresh vegetables has been traced back to the planting contaminated seed. Therefore, 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.

A few scientific studies have suggested the potential for human pathogens to colonize plants through the roots, but so far there is no confirmation of translocation of these pathogens to the stem, petioles, or leaves of the colonized plants. Furthermore, in almost all cases, the studies have not been replicated using normal field conditions but are based on artificially high inoculation levels and sterile conditions. Warriner et al (2005) reported that artificially inoculated seeds sown in soil supported E. coli populations on the exterior and interior of the roots and to a limited extent hypocotyl, but no E. coli was recovered from edible leaves of mature plants. Plus the level of colonization was directly correlated to the concentration levels of the pathogen applied which was artificially high and has never been observed under natural conditions.

A similar study (by Vin der Linden et al (2013) implicated seeds as a source of bacterial (Salmonella) contamination on cultivated leafy vegetables. However, the seed used in this study was artificially inoculated by immersion in bacterial suspension resulting in a level of contamination that has never been observed under normal field conditions. Furthermore, the Salmonella contaminated seeds were germinated under mostly sterile conditions, increasing the probability of positive test results due to lack of microbial competition.

Holden et al (2009) reviewed the mechanisms involved in the colonization of plants by members of the Enterobacteriaceae family of bacteria (e.g. Salmonella, E. coli). The researchers concluded that colonization directly from contaminated seed was not considered a factor.

Cooley et al (2003) found differences in plant colonization based on serotypes and went on to show that extensive colonization of the roots was achieved, but systemic movement of the bacterial was not observed. The researchers also artificially contaminated seeds and planted the seeds in autoclaved (sterile) and unautoclaved soil with no detection of S. enterica or E.coli O157:H7 after 30 days.

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. Extensive research shows that, under typical field conditions, seed poses a minimal risk. Therefor testing of seed lots, for the presence of human pathogens will not improve food safety.

**Frequently Asked Questions**

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

**Answer:**  For the spout industry, seed has been identified as a primary source of inoculum in many of the foodborne illnesses associated with fresh sprout consumption.   For the other fresh vegetable/fruit industries 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.  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.  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).

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 serovars that have flagella-mediated motility.  This movement is thought be slower under field conditions in the presence of wide variety of micro flora competing for the same niche.  It is not known if there is a threshold of seed contamination required to ultimately have movement to the leaves and flowers.

**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.

**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 aerosols.

**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 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.