American Society of Agricultural and Biological Engineers

An ASABE Section Meeting Presentation

Paper Number: AA10-001

Role of Air-Induction Nozzles in Aerial Application Conditions

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Written for presentation at the
2010 ASABE/NAAA Technical Session
Sponsored by ASABE Technical Committee PM-23/6/2
44th Annual Convention & Exposition
Savannah International Trade & Convention Center, Savannah, GA
December 6, 2010

Abstract. *Air induction nozzles have been used for several years in ground spray applications as a means of generating large droplets and reducing the potential for off-target movement of sprays. Like any new technology, it is important to gain a thorough understanding of how these air induction nozzles work in high speed airstreams before placing them on aerial application equipment. Several air induction nozzles were evaluated under fixed-wing aerial application conditions to determine the effects of nozzle type and airspeed on spray droplet size. Through a combination of pictures and droplet size data, guidelines will be generated to help aerial applicators make informed decisions about the use of air induction nozzles in their particular operation.*

Keywords: Air induction nozzles, air induction, droplet size, aerial application, ai nozzles, spray atomization

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Citation of this work should state that it is from an ASABE Section Meeting paper. EXAMPLE: Hoffmann, W.C., B.K. Fritz, W.E. Wolf, D.E. Martin, Y. Lan. Role of air induction nozzles in high speed airstreams. ASABE Section Meeting Paper No.AA10-001. St. Joseph, Mich.: ASABE.

Research Objective: To measure the spray droplet spectra from air-induction nozzles under aerial application spray scenarios.

Research Background and Methods: Air induction nozzles have been used for several years in ground spray applications as a means of generating large droplets and reducing the potential for off-target movement of sprays. Some of the advantages of AI nozzles are larger droplets sizes and less fines at normal operating pressures, better efficacy with some products, and some AI nozzles can operate over a larger range of pressures without significant changes in droplet size. However, these advantages have only been proven for ground applications at this point so this research project focused on aerial. Like any new technology, it is important to gain a thorough understanding of how these air induction nozzles work in high speed airstreams before placing them on aerial application equipment.

All nozzle evaluations were made using a spray solutions containing water with 0.25% volume/volume (v/v) of a 90% nonionic surfactant (NIS) (R-11, Wilbur-Ellis Company, San Antonio, TX). The water plus NIS solution was used because it is a good simulant of most water-based insecticide sprays. A Sympatec Helos laser diffraction droplet sizing system (Sympatec Inc., Clausthal, Germany) was used to measure the droplet size downwind of the tested nozzles. The laser system has two components, the emitter and the receiver, which were positioned across from each other and outside of the wind tunnel (Fig. 1). The laser was horizontally positioned so that the beam was in the center of the wind tunnel outlet. For each airspeed tested (120, 150, and 180 mph), the spray plume from each nozzle was traversed vertically through the laser beam and measurement of the droplet sizes generated were measured.

Figure 1. USDA-ARS high speed wind tunnel testing facility with wind tunnel outlet and laser-based droplet measurement system.

Results: A total of 6 different AI nozzles, 1 conventional hydraulic nozzle, and 3 airspeeds were evaluated. For each of the 6 AI nozzles tested, the volume median diameter decreased by about 50% as the airspeed was increased from 120 to 180 mph (Fig. 2). Similarly, the portion of the spray comprised of small droplets, expressed as percent of spray volume contained in droplets less than 100 µm in diameter (%<100µm), significantly increased as the airspeed increased (Fig. 3). When the droplet sized created by AI nozzles in high speed airstreams was compared to a conventional flat fan nozzle (Table 1), there were no significant differences between the AI and conventional nozzle. This is a result of the high air shear that is placed on droplets once they exit the nozzle and are impacted by the high speed air.

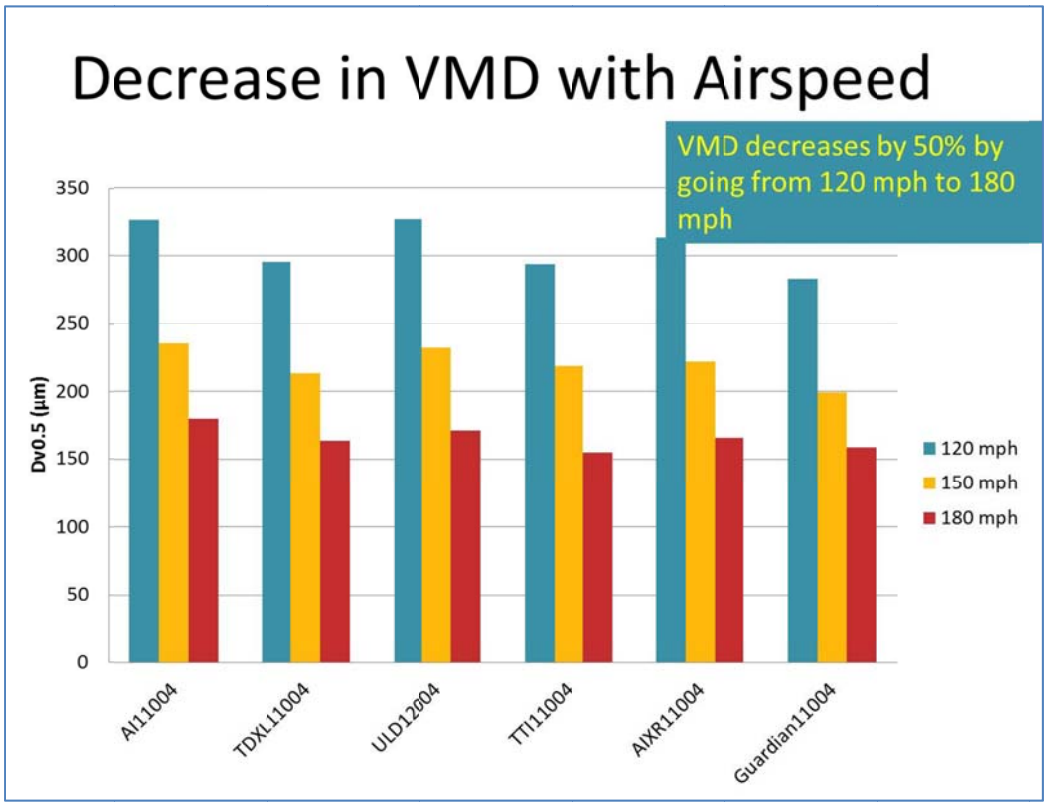

Figure 3. Decrease of volume median diameter (VMD) for each AI nozzle as the airspeed increased from 120 to 180 mph.

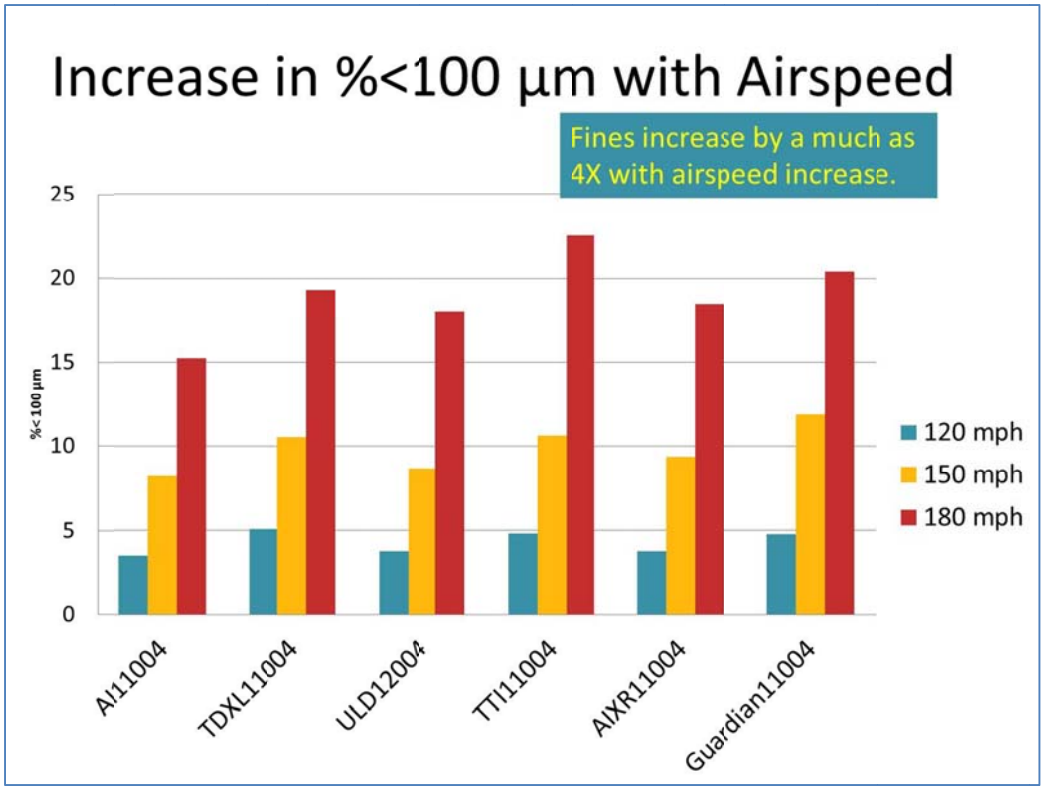

Figure 3. Increase of fine droplets with each AI nozzle as the airspeed increased from 120 to 180 mph.

Table 1. Comparison of droplet sizes measured for two AI nozzles and on conventional flat fan nozzle.

150 mph	Dv0.1 (µm)	Dv0.5 (µm)	Dv0.9 (µm)
AI11004	109	235	384
TDXL11004	97	214	354
CP4004	107	242	415
180 mph			
AI11004	81	180	296
TDXL11004	71	164	277
CP4004	84	190	328

Conclusions: Based on the results of these studies, the AI nozzles did not increase droplet size or decrease fine spray particles as compared to a conventional flat fan nozzle. We speculate that there is little differences between the two nozzle types due to a combination of the high speed air negating the air induction system of these nozzles and the high air shear placed on the spray droplets under 120-180 mph airspeeds.