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# Determining drift in spray tips evaluated under different wind speeds[1]

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**ABSTRACT** - The application of pesticides is essential in modern agricultural production. The concept of drift refers to the undue displacement of a product, which moves to areas outside the intended target, usually due to air currents. The aim of this study was to evaluate the drift potential of conventional spray tips and those incorporating drift reduction technology, at wind speeds both suitable and unsuitable for application. The following spray tips were used: ConeJet TXVS12, Teejet TT 110-02, Teejet TTI 110-02, and Hypro GA110-03. A wind tunnel was used to generate and control the flow of air. The pressure used was 300 kPa. The wind speeds were 6 and 10 km h$^{-1}$. The spray bar was mounted with the spray tip 50 cm from the ground. The spray solution included water and tracer dye. Polyethylene thread was used for the collectors, which were placed at four different distances (1, 2, 3, and 4 m) and five different heights (0.1, 0.2, 0.3, 0.4, and 0.5 m). The liquids were analysed in a spectrophotometer. At a wind speed of 10 km h$^{-1}$, a distance of 1 m and a height of 0.1 m, the drift values were 13.41%, 7.15%, 3.13%, and 5.11% for the ConeJet TXVS12, TT 110-02, TTI 110-02, and GA110-03, respectively. It was found that drift potential increased with the increase in wind speed but was reduced with  the increase in distance and height. Drift reduction technology using air induction proved to be the best strategy when choosing the correct spray tip for reducing drigt.

**Key words:** Pesticide application. Drift reduction technology. Wind tunnel. Spectrophotometer.

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## INTRODUCTION

The application of pesticides is essential in modern agricultural production to increase the quality and productivity of crops. According to the ISO (International Organisation for Standardisation), drift is defined as the undue displacement of the product during pesticide application, carried to locations outside the intended target, usually by air currents during application (ISO 22.866, 2008). In any application, around 30% to 50% of the sprayed pesticides may be carried through the air. The displacement of these products to other crops, water, or the air can have significant consequences in both rural and urban areas (Brankov *et al*., 2023; Giahi; Bergstrom; Singh, 2023; Kullmann; Dias, 2020; Li *et al*., 2022; Moazzam *et al*., 2023; Wang *et al*., 2020; Xun *et al*., 2023).

With growing public awareness and concern over environmental pollution, new strategies are being developed to reduce drift during application, such as the development of new spray tip technology. Previous studies have shown that droplet size plays a fundamental role in spray deposition and drift behaviour (Jensen; Jorgensen; Kirknel, 2001; Shan *et al*., 2021; Wang *et al*., 2023). Drift potential is directly related to droplet size, with smaller droplets having a higher drift potential (Li *et al*., 2022; Wang *et al*., 2018). It is therefore essential to select the appropriate droplet size and consequently the correct spray tip at this stage. There are spray tip models that use drift reduction technology, such as air induction and pre-orifice designs, which are based on producing larger droplet diameters that promise to reduce drift during application (Li *et al*., 2022; Wang *et al*., 2023; Xun *et al*., 2023).

Experimental strategies for studying spray drift employ wind tunnels or field sprayers with a variety of sampling techniques. There is, however, a significant limitation to field studies, as their repeatability is low due to the uncontrolled atmospheric conditions. A wind tunnel generates and artificially controls air flow to simulate actual field conditions, with the advantage of efficiently controlling wind speed and direction. Wind tunnel experiments have therefore proved to be important in providing valuable data for the study of drift potential (Giahi; Bergstrom; Singh, 2023; Wang *et al*., 2020, 2022, 2023).

As reducing pesticide drift and improving product use efficiency, thereby reducing the environmental impact, have always been important issues when applying pesticides, studies are needed to explore newly available spray tip technologies (Giahi; Bergstrom; Singh, 2023; Li *et al*., 2022; Wang *et al*., 2020, 2022, 2023). The aim of this study, therefore, was to evaluate the drift potential of anti-drift spray tips under different working pressures and windspeeds.

## MATERIAL AND METHODS

### Site of the experiment

The experiments were conducted at the Pesticide Application Laboratory of the Department of Agricultural Engineering, Federal University of Viçosa (UFV), Viçosa, Minas Gerais.

### Spray spray tips under evaluation

Four spray tips were selected to evaluate their operational characteristics: a conventional tip giving fine droplets that are more susceptible to drift (ConeJet TX-VS12) and three with drift-reduction technology (TeeJet TT-11002, TeeJet TTI-11002, and Hypro GA110-03). The ConeJet TX-VS12 is recommended for herbicides, fungicides and contact insecticides, while the TeeJet TTI-11002 and Hypro GA110-03 are suitable for systemic use. The TeeJet TT-11002, in turn, is recommended for both contact and systemic use in all cases. The chosen working pressure was 300 kPa. Three repetitions were carried out for each treatment.

Table 1 shows the characteristics of each selected spray tip according to the manufacturer, together with their respective droplet size.

### Characteristics of the droplet spectrum

A Spraytec laser particle analyser (Malvern Instruments Ltd) was used to determine the following

**Table 1** - Characteristics of the spray tip models used in the experiment, according to the manufacturer

| Make and model | Material | Jet | Technology | Drop |
|---|---|---|---|---|
| ConeJet TX-VS12 | Stainless steel | Empty cone | Conventional | F |
| TeeJet TT-11002 | Polymer | Simple flat fan | Drift Reducer - Impact | M |
| TeeJet TTI-11002 | Polymer | Simple flat fan | Drift reducer - With air induction | EC |
| Hypro GA110-03 | Polyacetal | Simple flat fan inclined 15° | Drift reducer - With air induction | C |

Where: F: fine; M: medium; EC: extra coarse; C: coarse spectrum parameters: relative amplitude (SPAN), volume median diameter (VMD), percentage of droplet volume with a diameter less than 100 µm (%V < 100) and with a diameter greater than 500 µm (%V > 500). Droplet size was classified by comparing the VMD obtained by the analyser with the ASABE S572.3 standard.

***Determining the drift***

Collectors were placed inside an open-circuit suction wind tunnel, measuring 7.0 x 1.4 x 1.5 m (area of 9.8 m² and volume of 14.7 m³), together with an airflow speed control system and a spray bar with pressure gauge. Airflow speeds of 6.0 and 10.0 km h$^{-1}$ were used, as recommended by ISO 22856. The spray bar was mounted inside the tunnel with the spray tip 0.50 m above the ground.

Polyethylene thread with a diameter of 2 mm and a length of 1.40 m was used for the collectors and arranged in the tunnel as per ISO 22856. Four distances were defined relative to the spray tip: 1, 2, 3, and 4 m, with the polyethylene threads placed at five different heights for each distance: 0.1, 0.2, 0.3, 0.4 and 0.5 m.

The KR285 thermohygrometer (Akrom) was used to monitor the temperature and relative humidity, and the TAFR-180 hot wire anemometer (Instrutherm) was used to monitor the wind speed. Temperature and relative humidity were measured as recommended by ISO 22856.

The working solution consisted of distilled water and Brilliant Blue artificial food dye (tracer) at room temperature (Chechetto *et al*., 2013). The dye was weighed on a 0.01g precision balance (GEHAKA, model BG 2000) and 3 g L$^{-1}$ of the dye was added to the distilled water, following the methodology proposed by Palladini (2000). Studies using the same dye were carried out by Chechetto *et al*. (2013), Moreira Júnior (2009), Oliveira *et al*. (20-21) and Palladini (2000), showing good results in their respective experiments for measuring the deposition.

Each spray took 30 seconds, determined by digital timer. After the fan was switched off, two minutes were allowed to pass, the estimated time for the environment within the test section to fully stabilise and for the droplets deposited on the collectors to settle (ISO 22856). Once spraying was complete, the collector wires were removed and stored in plastic bags.

To wash the threads, 50 mL of distilled water was added to the plastic bags, which were shaken by hand until the dye in the samples had been completely removed. The water added to wash the samples was measured using a graduated cylinder with an accuracy of 0.1 mL. The stored liquids were analysed in a Biospectro SP-22 spectrophotometer at a wavelength of 630 ηm.

The volume deposited on the threads was determined from the spectrophotometer reading, based on an equation fitted to describe the dye concentration as a function of the absorbance. This volume was converted to a percentage as shown in ISO 22856. The drift deposits for the position of each collector in the wind tunnel were evaluated individually, making it possible to show the distribution of the analysed treatments throughout the test section (Chechetto *et al*., 2013).

***Statistical analysis***

The analysis was carried out in two stages. The first stage consisted of developing multiple regression models to estimate drift as a function of horizontal and vertical distance, represented on contour plots. A list of models was generated in the TableCurve 3D® software and were selected based on the coefficient of determination and least complexity.

The estimated models were used for the intervals between the collected data, i.e. the horizontal distance from 1 to 4 m and the height from 0.1 to 0.5 m (extrapolating to a height of 0.0 m due to the higher resolution used for collection). The adjusted estimated values were placed on the most appropriate scale for each type of spray tip making it easier to understand the effect of wind speed on each tip.

For the second stage, a cut was made in the response surface, assigning a height of 0.1 m in the previously generated models for a broader comparison of information from the literature. The contour plots and cuts were developed using the SigmaPlot® software.

## RESULTS AND DISCUSSION

***Characteristics of the droplet spectrum***

The drift potential of each selected spray tip was estimated in relation to the droplet spectrum, which was defined based on the ASABE S572.3 standard using the values for VMD (volume median diameter) given by the laser particle analyser (Table 2).

According to Wang *et al*. (2020), spray tips that produce droplets with a higher VMD are better at reducing drift. As such, the TeeJet TTI-11002, which had a higher VMD at each working pressure, had the best potential drift reduction using air induction technology. The second spray tip with a high potential for drift reduction was the Hypro GA110-03, albeit with coarse droplets due to the air induction technology, which increases droplet size.

The TeeJet TT-11002 was classified as producing medium-size droplets as it has no air induction. It does, however, have impact fan technology, which can increase droplet size compared to a conventional spray tip. The droplet size classification for each of the spray tips was in line with that of the manufacturer.

***Drift potential***

The ConeJet TX-VS12 spray tip had the highest percentage values for droplets with a diameter of less than 100 µm. Drift occurs mainly in droplet sizes smaller than 100 µm, meaning this spray tip has a high drift potential. It should be noted that, depending on the pressure used (300 kPa), this tip produces fine droplets.

As the airspeed increases, there is an increase in drift collected horizontally (Figure 1). The maximum drift was found at 10.0 km $h^{-1}$ with an estimated value of 15.64% at a distance of 1.0 m at ground level. In this case, the air speed is not suitable for applying pesticides since the air has more energy, which increases drift (Kullmann; Dias, 2020; Moreira Junior, 2009; Wang *et al*., 2023).

At a speed of 6 km $h^{-1}$ and at the above distance and height, the highest value was 13.46%. It is therefore essential to verify that the wind speed is between 4 and 6 km $h^{-1}$ (Wang *et al*., 2023), since at 10 km $h^{-1}$, there was a 16.20% increase in drift for the same distance and height.

In terms of drift potential, the ConeJet TX-VS12 had the worst performance of the spray tips analysed in the present study, with the most drift during the tests. Liu *et al*. (2023), Szarka *et al*. (2023) and Wang *et al*. (2023) also reported that conical spray tips had the worst performance in terms of drift during pesticide application using a wind tunnel for evaluation.

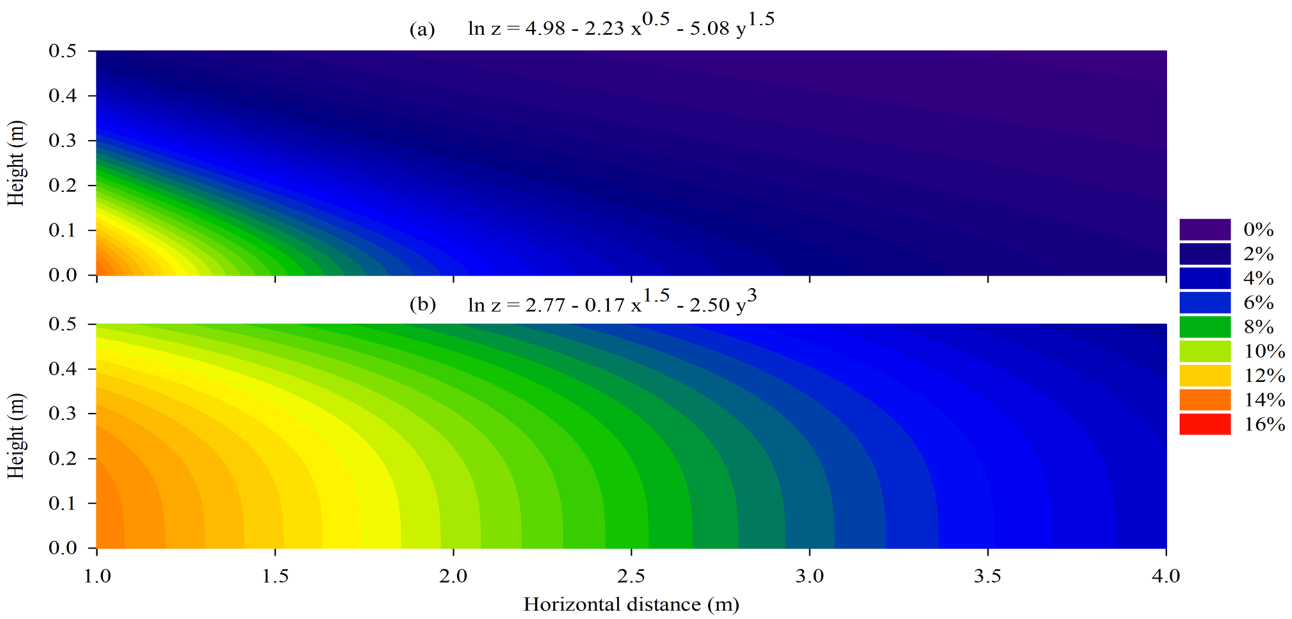
At a height of 0.10 m, the maximum estimated drift occurred at a horizontal distance of 1 m for both speeds

**Table 2** - Drop spectra from the hydraulic spray tips used in the experiment

| Hydraulic spray tip | Pressure (kPa) | SPAN (adm) | VMD (µm) | %V < 100 µm | %V > 500 µm | Drop size |
|---|---|---|---|---|---|---|
| ConeJet TX-VS12 | 300 | 1.19 | 135.58 | 24.79 | 0.91 | F |
| TeeJet TT-11002 | 300 | 1.91 | 236.68 | 12.43 | 9.00 | M |
| TeeJet TTI-11002 | 300 | 1.95 | 625.84 | 1.30 | 59.00 | EC |
| Hypro GA110-03 | 300 | 1.66 | 346.34 | 5.10 | 26.83 | C |

SPAN: relative amplitude, dimensionless; VMD: volume median diameter, µm; %V < 100 µm: Percentage of droplet volume for a diameter less than 100 µm; %V > 500 µm: Percentage of droplet volume for a diameter greater than 500 µm; F: fine; M: medium; EC: extremely coarse; C: coarse

**Figure 1** - Estimated drift based on the model fitted for the ConeJet TX-VS12 spray tip as a function of position (1, 2, 3, and 4 m), at a working pressure of 300 kPa. Where: (a) speed of 6 km $h^{-1}$ and (b) speed of 10 km $h^{-1}$

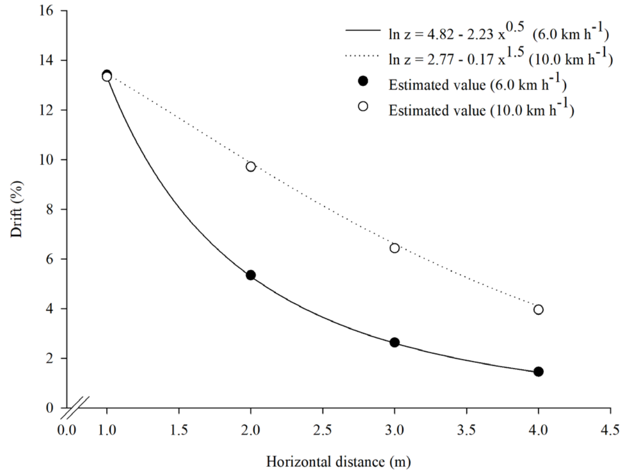



Where: z, drift (%); y, height (m); x, horizontal distance (m) under evaluation (6 and 10 km h$^{-1}$), 13.34% and 13.41%, respectively (Figure 2). For each distance, the maximum estimated drift was seen at a speed of 10 km h$^{-1}$. In a wind tunnel experiment, Liu *et al*. (2021) and Vieira *et al*. (2019) reported that in all cases as the wind speed increased, the drift potential increased.

For distances of 2, 3, and 4 m, the drift at a speed of 6 km h$^{-1}$ was 5.34%, 2.63% and 1.45%, respectively. At 10 km h$^{-1}$, the estimated drift was 9.71%, 6.43% and 3.95% at a respective distance of 2, 3 and 4 m. therefore, with the increase in speed, there was an increase in drift of 81.84%, 144.49% and 172.41%, respectively, for distances of 2, 3, and 4 m. Crause *et al*. (2019) and Gandolfo *et al*. (2013), in wind tunnel experiments, also found that as the horizontal distance increased, the collected drift decreased.

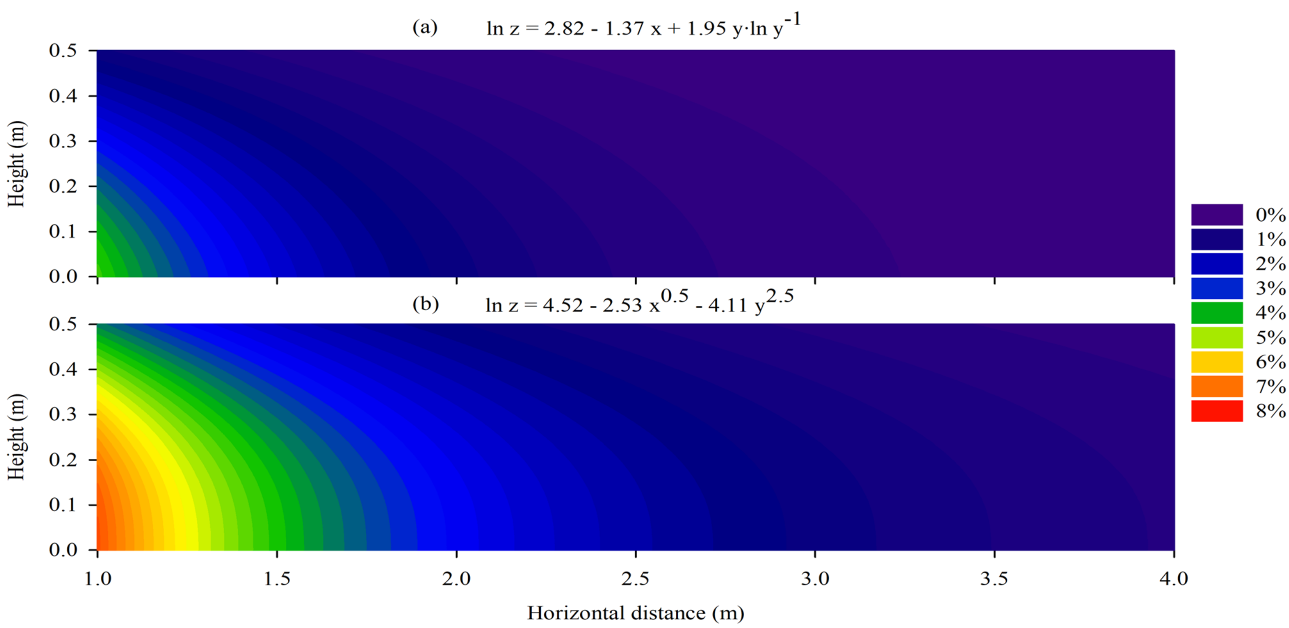
The TT-11002 spray tip has a flat impact jet, with an estimated drift lower than that of the ConeJet TX-VS12 (Figure 3). In this case, the drift was less than 2% and 6% at 2 m for speeds of 6 and 10 km h$^{-1}$, respectively. At a height of 0.3 m, the maximum drift, 5.91%, was seen at a speed of 10.0 km h$^{-1}$ and a distance of 1.0 m. At the same height and speed, a value of 2.01%, 0.91% and 0.47% was obtained at a distance of 2, 3 and 4 m, respectively. There was therefore a reduction in drift as the distance increased. Other authors also reported similar behaviour in experiments using a wind tunnel to evaluate drift, such as Chechetto *et al*. (2013), Gandolfo *et al*. (2013), Godinho Junior *et al*. (2017), Kullmann and Dias (2020), Szarka *et al*. (2023), Vieira *et al*. (2019) and Wang *et al*. (2023).

**Figure 2** - Estimated drift based on the model fitted for the ConeJet TX-VS12 spray tip as a function of position (1, 2, 3, and 4 m), at a pressure of 300 kPa and a height of 0.10 m at the two speeds under evaluation




Where: z, drift (%); x, horizontal distance (m)

**Figure 3** - Estimated drift based on the model fitted for the TeeJet TT-11002 spray tip as a function of position (1, 2, 3, and 4 m), at a working pressure of 300 kPa. Where: (a) speed of 6 km h$^{-1}$ and (b) speed of 10 km h$^{-1}$



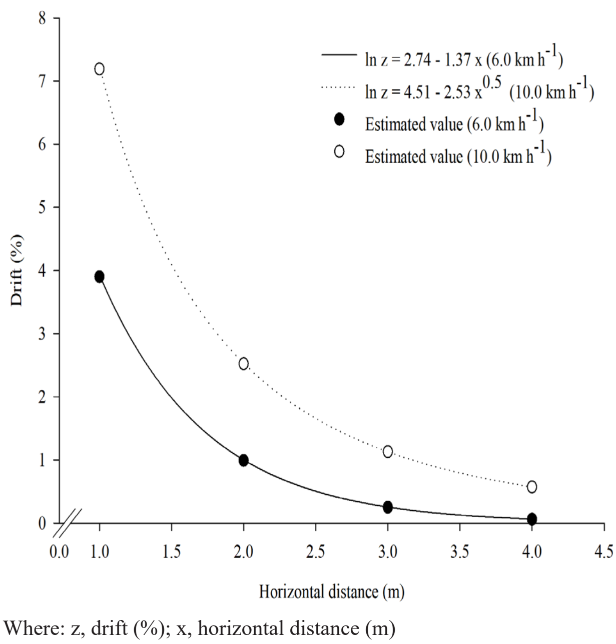

Where: z, drift (%); y, height (m); x, horizontal distance (m)

At a speed of 10 km h$^{-1}$, a horizontal distance of 2 m and a height of 0.5 m, the drift was 1.17%. In contrast, at a speed of 6 km h$^{-1}$, the drift was 0.25% under the same conditions, showing a reduction in drift which was only due to the lower airspeed. Szarka *et al.* (2023) reported the importance of wind speed on drift in wind tunnel experiments at speeds ranging from 6 to 24 km h$^{-1}$. The authors concluded that wind speed was essential for product application in pre-orifice spray tips. In a wind tunnel experiment, Liu *et al*. (2021) reported that as the wind speed increased, the drift potential increased in each case.

At a height of 0.10 m, the maximum estimated drift occurred at a distance of 1 m for the two speeds under evaluation (6 and 10 km h$^{-1}$), 3.92% and 7.15%, respectively (Figure 4). At each distance, the maximum estimated drift occurred at a speed of 10 km h$^{-1}$, which is in line with the first point evaluated.

The behavior of the equations can be explained by the exponential relationship between drift and horizontal distance, i.e. ln(z) decreases linearly with x, which results in a decreasing exponential function for drift (z). In simpler terms, the equations indicate a phenomenon where drift decreases exponentially with distance. This behaviour is important in such contexts as reducing the effects of drift trajectory in relation to environmental contamination. At distances of 2, 3, and 4 m, the drift at a speed of 6 km h$^{-1}$ was 0.99%, 0.25% and 0.06%, respectively. At 10 km h$^{-1}$, the estimated drift was 2.52%, 1.13% and 0.57% at 2, 3, and 4 m, respectively.

**Figure 4** - Estimated drift based on the model fitted for the TeeJet TT-11002 spray tip as a function of position (1, 2, 3, and 4 m), at a pressure of 300 kPa and a height of 0.10 m at the two speeds under evaluation




Where: z, drift (%); x, horizontal distance (m)

The TeeJet TTI-11002 features a pre-orifice and air induction, technologies that reduce drift by increasing droplet size. According to ASABE S572.3, the droplets from this tip are classified as extremely coarse, which explains why the tip shows no detectable drift after a horizontal distance of 1 m (Figure 5). Liu *et al*. (2023), Szarka *et al*. (2023) and Wang *et al*. (2023) evaluated air-induction spray tips in a wind tunnel and also found that this type of technology gave the best performance in terms of drift potential.

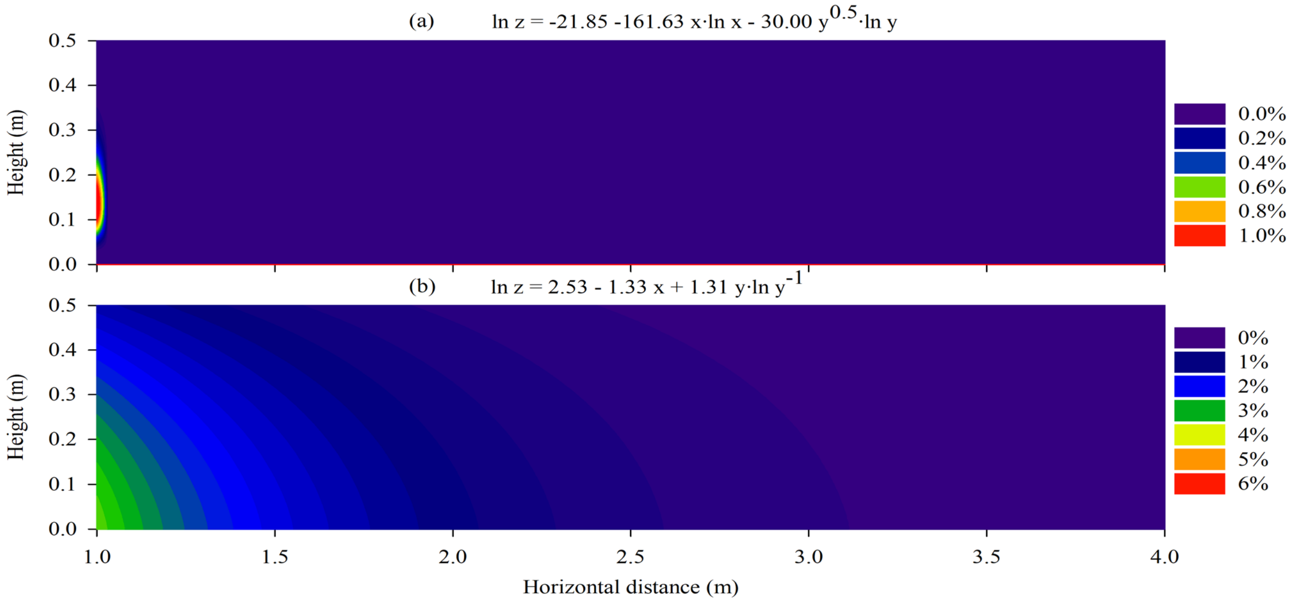
At a speed of 6 km h$^{-1}$, with the horizontal distance set to 1.0 m and the height to 0.3 m, the drift was 0.13%. On the other hand, under the same conditions, at a speed of 10 km h$^{-1}$, the value was 2.40%. The air induction technology was therefore effective in controlling drift at both wind speeds. Szarka *et al*. (2023) and Wang *et al*. (2023) also reported that air-induction spray tips showed excellent performance in terms of drift. Wang *et al*. (2023) concluded that the technology is ideal for use in spray UAVs precisely because of its results in relation to drift.

The maximum drift for the Teejet TTI-11002 was 3.32%, at a speed of 10 km h$^{-1}$, height of 0.00 m, and distance of 1 m. At a speed of 6 km h$^{-1}$, the estimated drift under the same conditions was zero. This result shows that regardless of wind speed, the tip had the lowest values for drift in the present study. Szarka *et al* (2023) evaluated air-induction spray tips in a wind tunnel and concluded that tips using this technology had the lowest drift. They recommend the tips be used when atmospheric conditions are unsuitable.

With the height set to 0.10 m, drift was only seen at a speed of 6 km h$^{-1}$ at a distance of 1 m, with a value of 0.99% (Figure 6). For the other distances the drift was zero. At a speed of 10 km h$^{-1}$, the drift was less than 4%, with values of 3.13%, 0.83%, 0.22% and 0.06% at a distance of 1, 2, 3 and 4 m respectively, showing the importance of air induction.

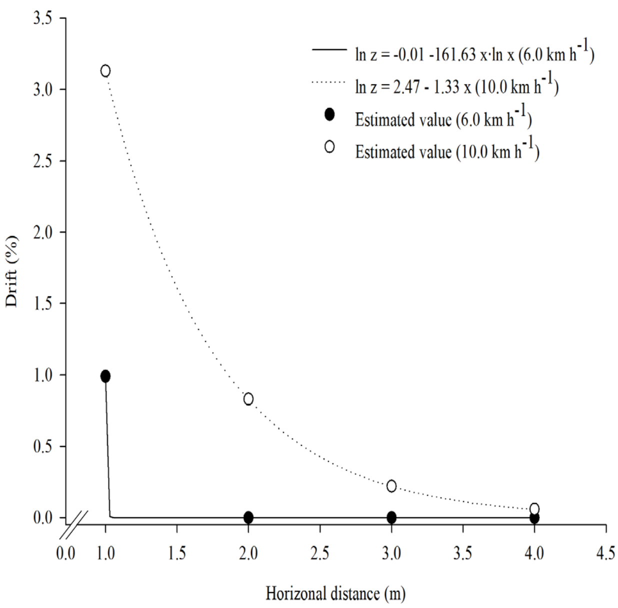
The Hypro GA110-03 also features air induction to reduce drift, forming droplets with larger diameters. At a speed of 10.0 km h$^{-1}$ and height of 0.00 m, drift was 5.10%, 1.78%, 0.81% and 0.41% for a horizontal distance of 1, 2, 3, and 4 m, respectively (Figure 7). At a height of 0.5 m, the values were 2.36%, 0.82%, 0.37% and 0.19% for the same horizontal distance, speed, and working pressure. This shows that as the height increases, the drift potential is reduced (Kullmann; Dias, 2020; Liu *et al*., 2021; Wang *et al*., 2023).

**Figure 5** - Estimated drift based on the model fitted for the TeeJet TTI-11002 spray tip as a function of position (1, 2, 3, and 4 m), at a working pressure of 300 kPa. Where: (a) speed of 6 km $h^{-1}$ and (b) speed of 10 km $h^{-1}$




Where: z, drift (%); y, height (m); x, horizontal distance (m)

**Figure 6** - Estimated drift based on the model fitted for the TeeJet TTI-11002 spray tip for deposition at the collectors as a function of position (1, 2, 3, and 4 m), at a pressure of 300 kPa and a height of 0.10 m, at the two speeds under evaluation



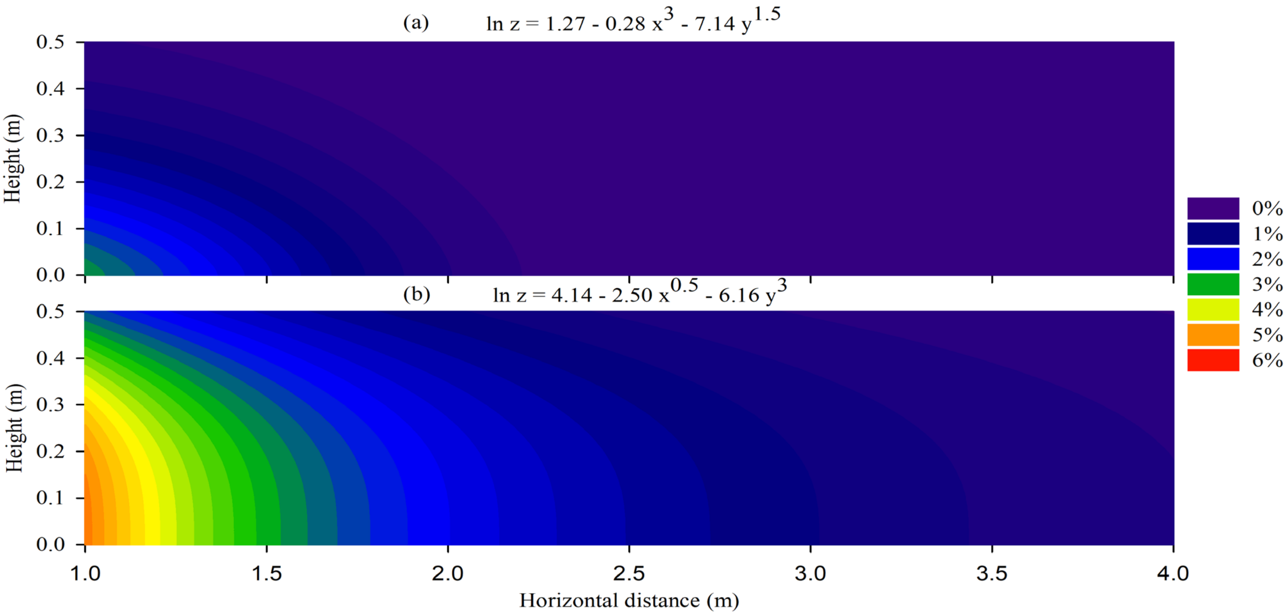

Where: z, drift (%); x, horizontal distance (m)

At a speed of 6 km $h^{-1}$, there is little drift: the maximum value is 2.72% at a distance of 1 m and a height of 0.0 m; while at a speed of 10 km $h^{-1}$, the maximum drift was 5.10% for the same distance and height, an increase of 187.50% in drift due to the increase in wind speed at the time of application. Nevertheless, based on the above values, this tip was characterised as the second best in terms of drift reduction. As such, the two best spray tips analysed in terms of drift potential were those with drift reduction technology (air induction). The same result was obtained by Chechetto *et al*. (2013), Gandolfo *et al*. (2013), Godinho Júnior *et al*. (2017), Szarka *et al*. (2023), Vieira *et al*. (2019) and Wang *et al*. (2023).

With the height set to 0.10 m, drift was only seen at a speed of 6 km $h^{-1}$ at a distance of 1 or 2 m, with values of 2.16 and 0.31%, respectively (Figure 8). For the other distances, the drift was zero. At a speed of 10 km $h^{-1}$, the drift was 5%. 11%, 1.81%, 0.82% and 0.42% at a distance of 1, 2, 3, and 4 m, respectively, showing the importance of air induction.

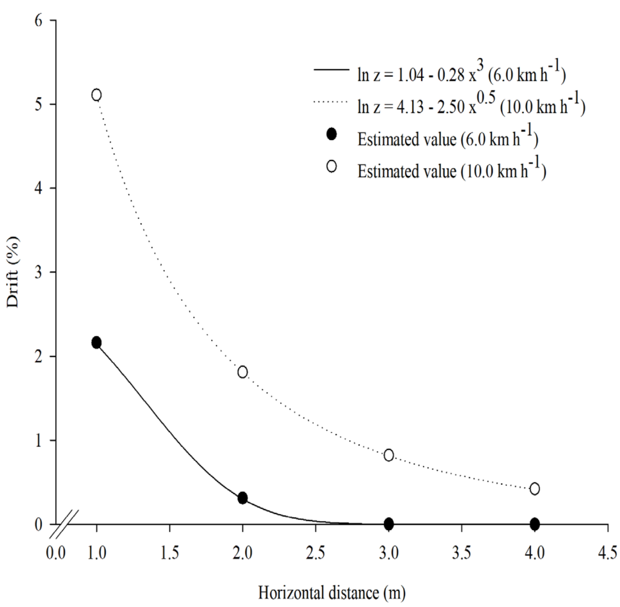
Gandolfo *et al*. (2013) quantified the drift generated by the AVI 110-015 (simple flat jet with air induction) and AXI 110-015 (simple flat jet) spray tips using herbicide and adjuvant in a wind tunnel. The authors evaluated drift using electrical conductivity at three horizontal distances (5, 10, and 15 m) and five heights (0.2, 0.4, 0.6, 0.8, and 1.0 m), maintaining the spray tip at 0.5 m. As in the present study, the authors found less drift as the horizontal distance and height increased, and classified the tip with air induction as having the least drift.

**Figure 7** - Estimated drift based on the model fitted for the Hypro GA110-03 spray tip as a function of position (1, 2, 3, and 4 m), at a working pressure of 300 kPa. Where: (a) speed of 6 km h$^{-1}$ and (b) speed of 10 km h$^{-1}$




Where: z, drift (%); y, height (m); x, horizontal distance (m)

**Figure 8** - Estimated drift based on the model fitted for the Hypro GA110-03 spray tip as a function of position (1, 2, 3, and 4 m), at a pressure of 300 kPa and a height of 0.10 m, at the two speeds under evaluation




Where: z, drift (%); x, horizontal distance (m)

Godinho Júnior *et al*. (2017) analysed herbicide drift in a wind tunnel at a speed of 2.0 m s$^{-1}$ using four spray tips: Jacto JSF110 (single fan), Magno AD110 (single fan with pre-orifice), Magno ADIA110 (single fan with air induction) and Magno ADIA110 (double fan with air induction). A horizontal distance of 2.5 m was chosen in relation to the spray tips and a height of 0.25 m from the floor of the tunnel. The authors found that regardless of the use of herbicide, the spray tips with air induction were more efficient in reducing drift than the other tips. The same was seen in the present study. The authors also reported that the double fan tip produced more significant drift compared to the single fan tip and to the two tips with air induction.

Crause *et al*. (2019) evaluated drift in the field using a hydropneumatic sprayer equipped with the BX-AP/90 spray tip (empty cone, as used in the ConeJet TX-VS12), with collectors at 17 different horizontal distances (from 5 to 50 m) and threads at six heights (from 0.15 to 0.90 m). The authors found that as the horizontal distance and height increased, there was a reduction in spray deposition, i.e. the drift decreased.

Vieira *et al*. (2019) analysed the drift and droplet spectrum of three spray tips (single fan, double fan, and double fan with air induction) with adjuvant in a wind tunnel at two wind speeds (1.0 and 2.0 m s$^{-1}$), and found higher drift values using the DL 11002 tip (double fan) and lower values for the tip with air induction (DLI 11002), while the present study found the highest values with the ConeJet TX-VS12 spray tip (empty cone). However, the same authors found an increase in drift values as the wind speed increased, as in the present study.

Kullmann and Dias (2020) evaluated the effect of three wind speeds (0.00, 2.22, and 3.33 m $s^{-1}$) on distribution uniformity using two flat fan jet spray tips (API 11003 and JAP 11002) at a pressure of 414 kPa, and concluded that airspeed affected distribution uniformity, which worsened for each of the spray tips as the wind speed increased. In the present study, the highest wind speed produced the greatest drift in each of the tips under analysis.

Chechetto *et al* (2013) evaluated drift potential in a wind tunnel using two anti-drift spray tips, one with a pre-orifice (DG 8003 VS) and the other with air induction (AI 8003 VS), with six types of adjuvant added to the spray solution. As in the present study, the authors found a reduction in drift as the distance from the spray tip to the collectors increased, with the air induction tip producing the least drift. In the present study, the least drift was produced by the TeeJet TTI-11002, which includes a pre-orifice and air induction. However, the tip with the second lowest drift was the Hypro GA110-03, which also uses air induction technology that proved to be the best option when choosing a spray tip to reduce drift. The same authors concluded that the spray tip and adjuvant have a direct affect on drift potential, as seen in the present study, where the drift potential was altered by the choice of tip.

## CONCLUSIONS

Spray tip selection is crucial to the quality of agricultural applications, especially for reducing drift. Air-induction spray tips, such as the TeeJet TTI-11002 and Hypro GA11003, increase droplet size, significantly reducing drift at different air speeds. Proximity to the ground and the area to be sprayed is directly related to drift, regardless of the type of tip used. Using the ConeJet TX-VS12 spray tip, which produces fine droplets, resulted in the most drift as it is more susceptible to wind. Research into new technology is crucial to the development of high-quality applications and the integration of available innovations.

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