THE EFFECT OF DRIFT IN PESTICIDE APPLICATIONS ON THE ENVIRONMENT

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Abstract

Pesticides are widely used in agricultural production to enhance the quality and yield of agricultural products and/or to reduce losses caused by pests. In pesticide applications, it is desired to use small droplets for better coverage and uniform distribution. Therefore, in pest control, small droplets are generally more effective than large droplets. However, there is a problem with small droplets. This issue is referred to as drift. In pesticide applications, the movement of sprayed droplets outside the target due to air velocity is defined as drift. Factors affecting drift include meteorological factors as well as application equipment and methods, with tractor speed, spray pressure, and spray height having negative impacts on droplet drift. When drift occurs during pesticide applications, human health and the environment are negatively affected by the pesticide. Therefore, pesticide applications in pest control should be carried out very carefully. Variables affecting drift include the physical properties of the pesticide, droplet size, weather conditions, and pesticide application methods. Among these, the most important factor affecting drift is droplet diameter. In general, small-diameter droplets provide a smoother coverage area than large-diameter droplets. Small droplets (<100 mm) tend to drift due to their lower mass, as they fall to the ground more slowly, evaporate, and are more easily carried away even by light winds. In pesticide application methods, the speed of the tractor and the spraying height also affect drift. When the tractor's speed is higher, droplet drift increases. In studies conducted, to reduce drift during pesticide application, it is recommended that the distance between the spraying nozzle and the plant canopy should not exceed 50 cm, the wind speed should be <5 km/h, the tractor speed should be <7 km/h, and spraying should be done with large droplet sizes.

Key Words: Agriculture, Droplets, Meteorological factors, Nozzle, Pest

Introduction

In modern agricultural production, pesticides are applied for protecting the quantity and quality of agricultural crops. in pest control, small droplets are generally more effective than large droplets. However, there is a problem with small droplets. In pesticide applications, the movement of droplets outside the target is defined as drift. Factors affecting drift include meteorological factors as well as application unsuitable equipment and methods, with tractor speed, spray pressure, and spray height having negative impacts on droplet drift. The movement of droplets outside the intended area by air mass transport of diffusion is defined as drift by ASAE S327.3 (2007). Although, small droplets, < 100 µm, can move downwind, they can however easily be transported within a crop canopy by air turbulence and be deposited on leaves (Matthews, 2000). In chemical crop protection, using pesticide overdose or incorrect pesticide products may cause serious problems on human health and the environment (Matthews, 2006, Damalas & Eleftherohorinos, 2011, Yarpuz-Bozdogan, 2018). This study will investigate the effects of meteorological factors and application equipment on pesticide drift. Meteorological factors include variables such as wind speed, air temperature, air humidity, and evaporation. Variables in application equipment include forward speed, spray pressure, spray height, spray nozzle, and droplet diameter (Yarpuz-Bozdogan, 2011).

Meteorological Factors

Wind Speed: It is recommended that pesticide applications be carried out in the early morning or late afternoon when wind speeds are low. The effect of wind speed on spray drift is complex. Higher wind speed influences the distance the droplet drift, but may improve deposition in the canopy due to increased turbulence and enhanced catching efficiency. Drift can be shown to increase with increasing wind speed (Anounymous, 2026).

Evaporation: Evaporation losses in spray vary depending on air temperature and relative humidity. Droplets of 150 µm and larger can reach the target regardless of weather conditions. As droplet diameter decreases, the droplet settling velocity also decreases. Thus, time is lost before the droplet reaches the plant, and evaporation increases (Vergucht at al., 2006; Yarpuz-Bozdogan, 2011).

Air Temperature and Air Humidity: Temperature and relative humidity are important environmental factors that affect droplet properties. Under low relative humidity and high temperature conditions, droplet diameter decreases. As temperature increases, water-based formulations and mixtures are subject to greater evaporation. This leads to the formation of smaller droplets and consequently increases the risk of drift (PISC, 2002, Yarpuz-Bozdogan and Bozdogan, 2009). Pesticide application is not recommended when relative humidity is below 40% and air temperature is above 25°C (Anounymous, 2026). These climatic conditions may also promote changes in the population dynamics of agricultural insect pests, including the emergence of additional generations under warmer and drier conditions (Szabó et al., 2025).

Application Equipment

Forward Speed: Increased travel speeds generate greater turbulence and wind shear, which can displace spray droplets from the intended target area. Reducing operating speed improves coverage and canopy penetration, resulting in better efficacy and reduced drift potential Yarpuz-Bozdogan, 2011; Anounymous, 2026). In pesticide application, sprayer speed is an important factor affecting spray drift. Spray drift increases as the sprayer speed increases.

Spray Pressure: To reduce spray drift potential, the operating pressure should be kept as low as possible while still meeting nozzle specifications and coverage requirements. Lower spray pressures produce larger (coarser) droplets, which are less likely to drift. Nozzle manufacturers typically specify a recommended pressure range for each nozzle type. Using the lowest recommended pressure helps minimize spray drift while maintaining effective spray coverage (Yarpuz-Bozdoğan and Bozdogan, 2009).

Spray Height: Boom height is an important factor affecting spray drift. The boom should be kept as low as possible while remaining consistent with nozzle specifications, spray coverage requirements, and pesticide label directions. Lower boom heights reduce the distance that spray droplets travel before reaching the target, thereby minimizing spray drift (Yarpuz-Bozdogan, 2011, Anounymous, 2026).

Spray Nozzle: Droplets under 150 µm are particularly prone to drift but offer better coverage (Anounymous, 2026). Choosing the right nozzle is crucial in reducing drift in pesticide applications. The selected nozzle type directly affects the amount of pesticide applied per unit area, the homogeneity of application distribution, the level of coverage achieved on the target surface, and the drift rate. For example, air-assisted application systems such as fan-assisted spraying stand out as an effective method for reducing drift (Yarpuz-Bozdogan, 2011). These systems provide more effective coverage, especially on the undersides of leaves, allow for the treatment of larger areas with a single tank fill, and contribute to reducing the risk of drift. In recent years, nozzle types that produce a low drift effect have been developed. Examples of these nozzles include low drift nozzles and air inclusion nozzles (HARDI, 2026). Designed to minimize drift, low-drift nozzles create larger droplets, reducing the likelihood of droplet carryover by wind. The use of these nozzle types can reduce spray drift by approximately 50% to 95% compared to conventional nozzles (Anounymous, 2026).

Droplet Size: In pesticide applications, small spray droplets are more prone to drift because they can be carried by air currents in the direction of the wind. However, within vegetation, air turbulence also carries these droplets, allowing them to settle on leaf surfaces. Even when coarse sprays are produced using standard hydraulic nozzles, a portion of the spray volume still consists of fine droplets prone to spray drift. Small-diameter droplets (< 100 µm) are considerably more susceptible to drift than large-diameter droplets (> 100 µm) (Matthews, 2000).

In addition to optimizing application equipment, regular monitoring of pest populations and the early detection of invasive species are essential for determining the appropriate timing of pesticide applications, thereby improving treatment efficacy and reducing unnecessary pesticide use (Szanyi et al., 2016; Molnár et al., 2019; Takács et al., 2022).

Conclusion

For successful pesticide application:

Apply pesticides during suitable weather conditions. Pesticide applications should preferably be carried out during the early morning hours when air temperatures are lower and wind speeds are minimal. These conditions reduce evaporation and spray drift, thereby improving application efficiency and deposition on the target.

Select the appropriate nozzle. The nozzle should be chosen according to the application method and target crop. Low-drift (drift-reducing) nozzles, which produce larger droplets, are recommended because they minimize spray drift, improve pesticide deposition on the target, and reduce environmental contamination.

Protect human health and the environment. Pesticide applications should be performed carefully and responsibly, with all necessary safety precautions in place to protect human health and the environment. Applicators should strictly follow the pesticide label instructions, wear appropriate personal protective equipment (PPE), and implement measures to prevent spray drift and contamination of non-target areas.

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