

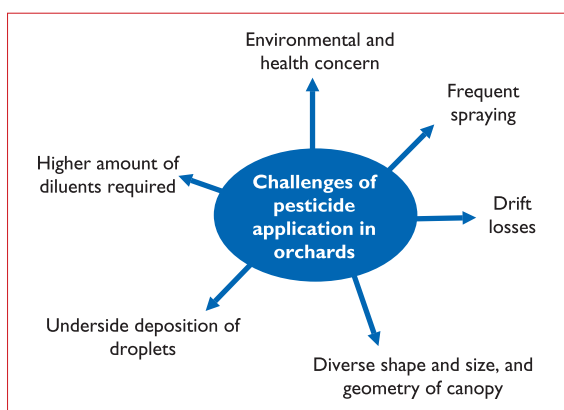
Precision spraying technologies for orchard crops

Crop protection using pesticide application equipment in orchards is a challenging task. Pesticides have become critical input for crop production, therefore efficient pesticide application is important. It is difficult to completely imagine the levels and security of today's crop yields without the use of pesticides. More precise spraying technologies such as Electrostatic spraying system (ESS) and Variable rate spraying has crucial role to play in future agriculture, considering reduction of input cost, environmental concern and safety of human health.

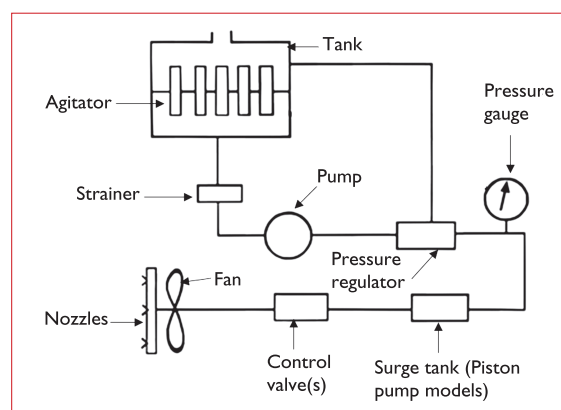
PEST refers to any agent (insects, microbes, plants, animals and abiotic factors) that causes damage to the crops. Pests and disease control are one of the most important component of crop production. The method or practice of eliminating, controlling and eradicating the insects, diseases, weeds and harmful animals that damage the crop which has significant effect on farmers livelihood, ecology and environment is called crop protection. Crop protection plays an important role in mitigating the threat of pest and weeds for enhancing the agricultural production. Time, location and application techniques are vital for effective control of pests. Fruit production losses occur to the tune of 25-30% due to pest and diseases. Chemical application is one of the widely used techniques for control of pest and diseases globally. Pesticide application method plays an important role in targeting precise quantity and quality of spray for economical and environmentally safe pest control. Non-judicious use of pesticides leads to several problems such as resistance development in insects/pathogens, resurgence of pest's due to destruction of natural enemies, toxic hazards due to pesticide residues on the edible products and deficient pollination due to destruction of pollinators resulting

in non-setting of fruits and low yields. Various kinds of pesticide application equipment are available based on the physical properties of pesticides, target pest, geometry of crops and meteorological conditions. The selection of a crop protection equipment is governed by various factors like capital investment, equipment cost, frequency of spraying, speed of operation, area to be sprayed, availability of diluents and physical and agronomical attributes of the plant.

Crop protection using pesticide application equipment in orchards is a challenging task considering various sizes, shape, and geometry of orchard canopies, underside droplet deposition, high diluents requirement, frequent spraying and off target drift losses. Sprayers that are currently available for orchards use axial, centrifugal and tangential fans for airflow support. The air-blast sprayer for orchards, uses heavy stream of air to carry droplets towards the target. The axial fan design is favoured because it is effective in a wide range/types of orchard and in a wide range of conditions and because the sprayers are simple, robust, reliable and of comparatively low cost of purchase and operation.



Challenges for pesticide application in orchards



Components of sprayer



Axial fan air assisted sprayer (Dragone Company, Italy)



Centrifugal fan sprayer (JS Drive Engineering, Malaysia)



Cross flow/tangential fan sprayer
(Weber GmbH & Co. Germany)



Electrostatic sprayer for orchard (Imported and marketed
in India by Eco Agro services)

Sprayer selection

Sprayers should at least meet the demands of spraying large, thick trees under the poorest conditions allowable for spraying. Reliability, maintenance history, and the ability to cover the projected acreage should be considered in selecting spray equipment. Tractor horsepower requirement is a very important consideration because the air delivery fans must move a considerable volume of air and materials. Sprayer manufacturers provide a recommended tractor horsepower range, but reliability and equipment longevity are often enhanced by selecting from the upper range of suggested tractor horsepower.

Conventional air assisted sprayers for orchard

These sprayers typically spray the entire field with a constant rate during the entire growing season, consequently, crops are either over-sprayed or under-sprayed. Also, their spray deposition quality inside canopies varies greatly with canopy growth conditions. When used in dense canopies the air stream will aid in deposition into the target by moving the canopy to

open it to allow deeper penetration. This sprayer uses pneumatic energy to aid in the atomization, transportation, penetration, and deposition of spray droplets. Used for applications of fungicides and insecticides in crop or orchard. Major types of sprayers are:

Axial fan orchard sprayer: In axial fan sprayer, air enters into the side of the fan and it rotates along the axis and produces large air stream which helps to reach the target area.

Centrifugal fan sprayer: It consists of rotating impeller which increases air velocity. Air speed is converted into pressure. Generally, it is suited for high flow and forced draft services. These sprayers are efficient more than 85%.

Cross flow/ tangential fan sprayer: Air enters the impeller at one part of the outer periphery, flows inward and exits at another part of the outer periphery. This sprayer has uniform discharge and high air rate characteristics. It can work in worst environment and can even handle dirty air and higher pressures. As far as cost is concerned, its capital and running cost is relatively high.

Table 1. Advantages and limitations of conventional air assisted sprayers

Advantages	Limitations
• Effective in wide range of orchard types and conditions • Easy to operate and modify as per requirement • Inexpensive to buy and maintain • Robust and reliable • Easy parts availability	• Excessive amount of air and often an inability to adjust airflow other than high and low • Potential risk of off-target contamination by spray drift (up to 23-45%) • Relatively high-power requirement

Advanced sprayers for orchard application

Electrostatic sprayers: Smaller droplets of pesticide spray provide greater biological efficacy per unit mass of pesticide than do the larger droplets for achieving insect control but drift was the major problem. Thus, the recent concept of spraying is to spray the target pest more efficiently by selecting optimum droplet size and density for maximum retention and coverage. Electrostatic spraying would offer a possible solution to those environmental problems; by reducing spray drift and improving coverage of chemical to target plant. It provides a uniform deposition onto the directly exposed as well as obscured surface of the crops and reaches the hidden areas of target canopy. It provides a means for efficient use of agricultural chemicals and natural resources.

Table 2. Advantages and limitations of electrostatic sprayers

Advantages	Limitations
• Better coverage of difficult targets than conventional spraying • Higher bio-efficacy • Longer distance coverage • Reduction of pesticide use (25% less pesticide per acre) • Overall cost per acre is 20% less than higher volume dilute sprayers • Increase in deposition efficiency • Normal pressure requirement • Deposition behind the leaves • Water consumption of this kind of sprayers is up to 10 times less than conventional spraying • Lower fuel costs • Reduction of environmental pollution	• High cost of sprayer • Maintenance/repair was extremely difficult • Coverage in heavy, thick canopies is uncertain • More complicated, need training • Nozzles have to be at specific distance from the canopy

Variable rate technology-based sprayers: Variable rate application technology is viewed as pivotal for the precise application of inputs. In spray applications, variable flow rate can be achieved with real-time information on the spray target to control the actual spray application. Orchard canopy has great variation in shape, size, foliage density and spacing between the row. This variability requires sprayers to be flexible in their operation and spray

an amount of chemical that can match with each canopy structure. Spraying at an adequate volume application rate on a site-specific basis would help reduce the amount of agrochemicals. A number of systems for the adjustment of dose rate according to orchard structure have been developed. These systems use various types of sensors, viz. ultrasonic sensor, LiDAR sensor, photoelectric sensor, light absorption sensor, machine vision system, etc. for crop canopy characterization. The target tree parameters acquired using these sensors and data processing unit further processes this information to regulate the flow of agrochemicals through nozzle. These systems are more accurate and precise in application of predetermined quantity of chemicals, hence saves considerable input cost and are more eco-friendly. These technologies have good potential for implementation in orchard crop to increase application efficiency optimally with more economical savings and environmental protection.

Table 3. Advantages and limitations of advanced variable rate sprayers

Advantages	Limitations
• Applies precise quantity of chemicals hence, avoids over dose or under dose • Significant chemical saving • More environmental friendly • Effective control of pest and disease • Flexible in adjustment of chemical dose	• Costly sensors and electronic control required • Skilled personnel required for operation and maintenance • Reliability and robustness in varied crop and field conditions is to be ascertained • Uncertainty in availability of sensor and electronic components

CONCLUSION

Significant development and improvement took place over the years in spraying technologies for application in variety of areas. As a result, many versions of sprayer are available for pesticides application in orchard and plantation crops. However, general model of air blast sprayer is most widely accepted by farmers considering its advantages and suitability in Indian conditions. Nevertheless, more precise technologies such as Electrostatic spraying system (ESS) and Variable rate spraying have crucial role to play in future agriculture, from point of view of reduction of input cost, environmental concern and safety of human health. In this line, further modifications and innovation in crop protection equipment can be encouraged for efficient and effective use of chemicals in agricultural production system.

For further interaction, please write to:

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**Flowers always make people better, happier, and more helpful;
they are sunshine, food and medicine for the soul.**

– Luther Burbank