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# ANTITRANSPIRANTS AND THEIR IMPORTANCE IN RAINFED AGRICULTURE

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Global food security is at risk due to the predicted climate change, making it imperative for agronomists to provide adaptive technologies that will sustain and improve food production. Rainfed agriculture, prone to drought, covers an estimated 80% of global cropland. Almost every part of the world evidenced its impact at different level and affected either positively or negatively. India being subtropical country is also sighting various changes in weather pattern and temperature rise that have effect on agriculture production. Water is necessary component for plant's growth and development (Rijsberman, 2008). Rainfall and irrigation are the two main sources of water in agriculture. Rain-fed crops contribute to 65% of world food production and the remaining 35% of food is produced from irrigation agriculture. Only 17% of total cultivated areas are irrigated (Rosegrant, 2002 and Hanjra, 2010). Thus, most of the land under cultivation depends on natural precipitation. Thus, shifting in global rain pattern and increase in local temperature is leading to unprecedented drought in many crop production areas of the world (FAO, 2011). One of the adaptive technologies is the use of antitranspirants – products that are applied on plants to reduce transpirational water loss and increase crop performance under drought conditions. The benefits of improving antitranspirant adoption in drought mitigation are expected to be high, especially in many drought-prone low-income countries where crop production is almost wholly dependent on rainfall. Antitranspirants are the chemical compound which results in declining the rate of transpiration from the leaves of the plants by reducing the number and size of the stomata and eventually hardening them to stress (Ahmed et al., 2014; El Khawaga, 2013).

In the field crops, the practical use of antitranspirants involves decreasing the water loss from the leaves by reducing the size and number of stomatal opening and therefore decreasing the rate of diffusion of moisture vapour. It is very important to control the loss of the water from the plant because only a very small amount of water taken up by the roots, out of which 98% is lost to the atmosphere through transpiration. Antitranspirants helps in minimising these losses to some extent. The role of antitranspirants increases in dryland agriculture where availability of water is very less and the temperature is very high which promotes the rate of transpiration. Based on the mode of their action, they are categorised into: stomatal closing type (Phenyl mercuric acetate and ABA), film forming type (Mobileaf, hexadeconol and silicon), reflectant type (Kaolin, calcium bicarbonate and China clay) and growth retardants (cycocel).

## The Scope of Using Antitranspirants Includes

1. Under dryland area, to reduce water losses through transpiration
2. In costly irrigation, for extending the irrigation interval
3. In areas having poor quality of soil-water or irrigation water, to reduce the uptake of salts
4. For reducing transplanting shock of nursery plants.

## There are Four Principles of Transpiration Control

1. By increasing leaf resistance to water vapour transfer by application of materials, which tend to close or cover stomata (e.g. both stomatal closing and film forming type of antitranspirants)
2. By reducing amount of energy absorbed by leaf surface (e.g. leaf reflectants).
3. By reducing top growth of plants (e.g. growth retardants)
4. By increasing air resistance to water vapour transfer by shelter belts/windbreaks

## Stomata Closing Type

Most of the transpiration occurs through the stomata the leaf surface. Some fungicides like Phenyl mercuric acetate (PMA) and herbicides like atrazine in low concentration serve as antitranspirants by inducing the stomatal closing. PMA was found to decrease transpiration to greater degree than the photosynthesis in a number of plants. Stomatal opening is regulated by various sensors like, water, CO, light and hormones. The opening is strongly controlled by hydroactive mechanism, while other sensors are hydro-passive and is mediated through relative water content (RWC) of guard cell chloroplast.

## Film-forming Type

Foliar spray of waxy or plastic emulsions such as mobileaf. hexadeconol and silicone produce an external physical barrier outside the stomatal opening to retard the escape of water vapour through stomatal opening. The film so formed should have more resistance to the passage of water than to that of carbon dioxide. Film type antitranspirants, which provide selective type of permeability barriers to water vapours and carbon dioxide diffusion in the required directions, have not yet been found so far.

**Disadvantages**

- Affects only at low temperature but not at high temperature
- Comes in the way of gas exchange.
- From the mechanical barrier for stomatal movement

## Leaf Reflectance Type

White reflecting materials such as whitewash or kaolinite % spray form a coating on the leaves and increase the leaf reflectance (albedo). Reflecting compounds do not cause blockage of stomatal pores when they are applied to the upper surfaces of leaves with stomata exclusively on the lower surfaces. Coating of reflectance type of chemical reduce the leaf temperature. Application of 5 per cent kaolin spray has been found to reduce transpiration losses markedly. Reflects radiation falling on the leaf and reduced heat load on leaf. When heat load is reduced amount of water to maintain temperature is also reduced. Therefore, water conservation occurs. Kaolinite does not come in the way of any metabolic activity.

## Growth Retardants

The chemical like Cycocel (CCC), Uniconazole and Mepiquat chloride reduce shoot growth which increase root growth. The reduced shoot growth decreases transpiration loss whereas increased root enables the plant to tolerate drought by increasing water absorption from deeper layers of the soil. Other than this anti-ozone chemical like Ethylene diurea (EDU) is also becoming popular in the dryland agriculture to suppress the effects of toxic levels of ambient ozone on the several fields and forage crops.


**Fig.1:** Different commercial products of some antitranspirants

## Good Feature of Antitranspirants

- Non-toxicity
- Non-permanent damage to stomatal mechanism.
- Specific effects on guard cells and not to other cells.
- Effect on stomata should persist at least for one week.
- Chemical or material should be cheap and readily available.

## Limitations of Antitranspirants

- May reduce the rate of photosynthesis
- May increase the leaf temperature by reducing evaporative cooling
- Interaction of climatic factors with antitranspirants reduces their effectiveness for longer duration
- Marginal cost may be more than marginal returns
- May produce toxic effects on leaves.

## Effect of Antitranspirants on Crop Production

### 1. Suppression of Transpiration

Several experiments using antitranspirants on several crops have shown that they can be used economically on higher values crops, especially in dry land/rainfed areas and for increases survival of transplants under all situations. Use of PMA with 50, 100 and 150 ppm at tillering, jointing and flowering of wheat reduce the rate of transpiration by 23.8, 40.5 and 45.5 per cent, respectively. In dry soils, PMA significantly reduced the rate of both stomatal and cuticular transpiration from sunflower leaves.

### 2. Water Relations

The primary objective of using antitranpirants is to improve plant performance by increasing plant water potential. This is an important effect because plant growth depends not only on the accumulation of raw materials and mineral uptake, but also on maintaining higher plant water potential. Foliar application of PMA 50, 100 and 150 ppm at tillering, jointing and flowering stages of wheat plants increased relative water content of leaves by 2.1, 5.0 and 5.6%, respectively. On barley, PMA (Stomata closing), mobileaf (Film forming) and Kaolin (Reflectant) resulted in increased relative water content.

### 3. Water use Efficiency

Water use efficiency is increased by use of antitranspirants, especially under moisture stress conditions. PMA/kaolin increases WUE of wheat. Foliar application of 6% kaolin or 40 ppm Chlormequat chloride (CCC) each at 800 lit/ha applied at tillering on rain fed wheat increased grain yield by 9.6 and 17.0 per cent and WUE by 21 and 26 per cent, respectively.

### 4. Moisture Conservation

Kaolin sprayed wheat plants grown under dry land saved 36cm water. Six per cent kaolin spray at CRI, jointing, flowering and grain formation stages of wheat as substitute for irrigation and produced similar yield. Using antitranspirants, it is possible to economize the water use by reducing number of ineffective irrigations.

### 5. Ionic Balance

In many arid areas, the underground water is brackish, when such water is used for sprinkling "chloride burns" appears. This effect can be reduced by spraying film forming antitranspirants.

### 6. Increases Survival of Transplants and Cut Flowers

When seedlings are transfer from nursery for transplanting some injury to root is caused. Thus, the water uptake rate is reduced but transpiration loss of water continues and the seedling may wilt or even die. Uprooted seedlings are either sprayed or dipped in antitranspirat solution, which increases plant water balance and increases seedling survival rate. The use of anti transpirants reduce the photosynthesis rate and slow down growth.

## 7. Effects on Growth and Yield

Rate of photosynthesis is slightly reduced after the use of antitranpirants, the plants water economy is improved and wilting is avoided. Plants continue to grow at a lower rate than well irrigated plants, but at a higher rate than unsprayed plants. Thus, the growth and yield of antitranspirants sprayed plant improved under rainfed/dry land conditions.

Assured benefits of transpiration suppressants and plant growth regulator to the rainfed/ dryland crops

- Optimized yield levels
- Better crop growth
- Normal sized grains
- Improved seed quality
- Reducing number of irrigations
- Monitoring crop loss with limited inputs
- Minimizing irrigation frequency and saving water through drip irrigation (eg. Cetyl alcohol and / Hexadecanol)
- Monitoring / managing drought
- Arresting fast receding soil moisture for better growth and yield of rabi crops
- Very useful for farmers with minimum irrigation facilities
- Saving large nurseries when water is scarce in summer months

## Conclusion

Water stress is a relatively prevalent occurrence today and has a significant impact on production. Antitranspirants, in addition to conventionally effective irrigation technologies like drip irrigation and spray watering, reduce the rate of transpiration, preserve plant moisture, increase consumptive usage (CU) of water, improve growth and yield-attributing characteristics, and save water. Antitranspirants can be utilised in places with limited rainfall or in drought-prone areas when there is a moisture stress. By using antitranspirants, transpiration can be slowed down as needed, and comparable measures can be taken to improve soil water retention. To increase crop output, antitranspirants must be administered at the right time. As a result, antitranspirants can reduce the effects of water stress while increasing crop output in the face of global warming.

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