Use of plant growth regulators to improve fruit size and quality in pineapples

The success of any fruit exporter is based on obtaining a high number of export boxes of the highest quality per unit of planted area while maintaining a low production cost. Pineapple does not escape this rule and it is vital to produce fruits of good size and excellent external and internal appearance at a reasonable cost.

To achieve good results in quantity and quality, a very good management of the plantation is needed. Even when all the correct agronomic practices are applied, the unpredictable climatic variations can affect, in a remarkable way, the expected results.

Climate plays a preponderant role in the formation and development of fruits; this impact is negative in many cases and affects the natural synthesis of plant growth regulators produced by the plant. The impact is exacerbated in ratoon crops where the root system is almost always poorer and this is where the regulators that ensure the correct formation of fruits are synthesized.

The formation process of all plant organs is governed, in the first instance, by growth regulators, which promote cell division, differentiation and elongation; its balanced presence guarantees the correct formation of roots, stems, leaves and fruits.

It is known that plants produce five main growth regulators: auxins, cytokinins, gibberellins, ethylene and abscisic acid, which have different functions, but normally act in combination interacting with each other. The production of these growth regulators by the plant depends mainly on the phenological state, climate and, finally, nutrition. Therefore, not necessarily a well-nourished plant produces enough growth regulators to support a high production, it needs the appropriate climatic conditions to achieve it.

In the formation and development of a plant or any of its organs, for example, the fruit, the five growth hormones participate. As we can see in Figure 1, it starts with an accelerated cell division led by cytokinins. Then, there is a greater expression of auxins, which, in addition to helping in cell division, induce specialization of the cells and, towards the end of fruit formation, the quantities of gibberellins are increased in order to stimulate the cell elongation and therefore increase the size of the fruit. Finally, the other two regulators appear, which are ethylene and abscisic acid; these regulators have the function of stopping the activity of the first three and orienting the fruit towards the maturation and the end of its cycle.

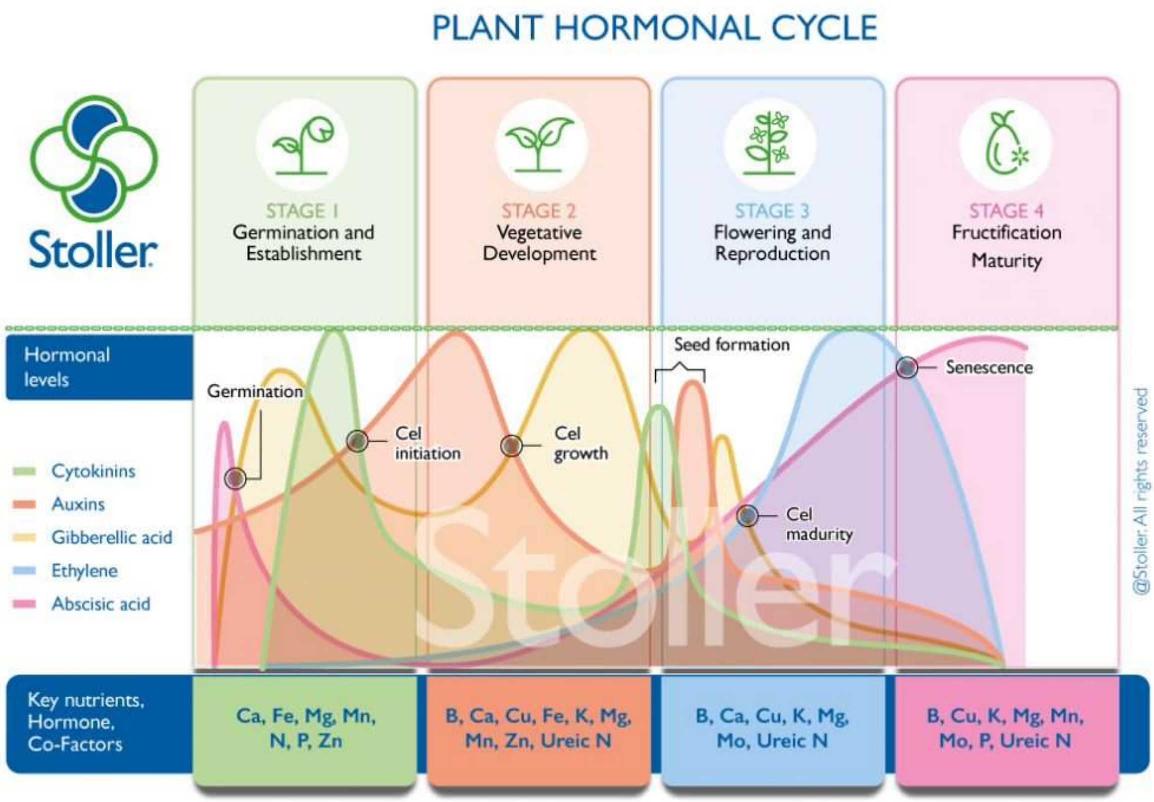

Figure 1. Plant Hormonal Cycle.

In the case of pineapple, the formation of the fruit starts from the moment of the floral induction. In the first days of fruit formation, cell division intensifies, so that in this period

the final size and shape of the fruit is defined. Once the formation process ends, the fruit filling process begins thanks to the cell elongation. In order to better understand the role of regulators in the process of fruit development, we will divide it into two stages: cell division, dominated by cytokinins, and cell elongation, mainly influenced by gibberellins. It is understood that one process is not exclusive of the other, but that there is greater activity of each one depending on the state of development of the fruit.
To ensure good plant performance during these processes, Stoller Enterprises Inc. of Houston, Texas, has designed a growth regulator therapy, which ensures maximum cell division in the first 60 days after floral induction and an adequate cell expansion or elongation between 70 and 110 days.
The therapy consists of making two applications of kinetin in doses of 200 to 300 ppb, using water volumes between 1500 and 2000 liters per hectare. Given the interaction of growth regulators with some nutrients, it is considered appropriate to accompany the application with a source of calcium and boron at 15 and 45 days after floral induction. For economy and ease, these applications can be made in mixtures with other products such as potassium chloride, urea or insecticides. This treatment will cause a greater cell division and thus produce better formed fruits which are able to achieve a good size even if they come from plants induced with low weight. Also, the percentage of fruits rejected due to malformations or internal damages is reduced, as shown in Figure 2.

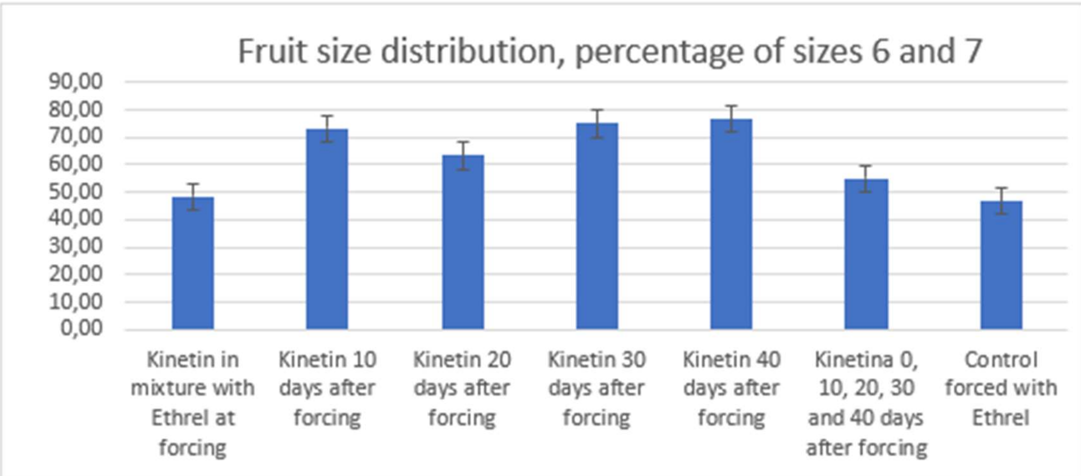

Figure 2: Results in the fruit size distribution in plots applied with kinetin in field trials in the Atlantic zone of Costa Rica under normal growing conditions. (2018)

The combination of the growth regulators with the elements calcium and boron ensure the good formation of the cell walls during the process of cell division, which reduces the risk of internal problems of the fruit such as translucency or water blow at the time of harvest.
The therapy is completed with the application of gibberellic acid in the form of GA3 in doses of 96 to 144 ppm in volumes of 2000 liters of water/Ha at 14 weeks (98 days) after floral induction. This application will promote cell expansion and stimulate the effect of the fruit

sink by transferring more sugars from the plant to the fruit to obtain larger and more uniform fruits (results in Table 1) with sufficient sweetness without losing its much-desired acid flavor.

Location	Treatment	Fruit weight average in kg	Yield kg/Ha	Yield boxes/Ha
# 1	GA3 96 ppm	1.712	85600	6585
	Control	1.586	79300	6100
# 2	GA 96 ppm	1.914	95700	7361
	Control	1.675	83750	6442
# 3	GA 96 ppm	1.716	102960	8580
	Control	1.628	97680	8140

Table 1: Effect of the application of GA3 at 96 ppm on the size and weight of the fruit in three different plantations in Costa Rica. (2014)

Table 2 summarizes the recommended applications as part of the therapy to achieve the largest and best pineapple harvest per hectare.

APPLICATION MOMENT	PRODUCT	DOSIS / Ha
15 TO 30 DAF	Kinetin CaB	200 to 300 ppb 5 L
30 TO 45 DAF	Kinetin CaB	200 to 300 ppb 5 L
98 DAF	GA3	96 a 144 ppm

Table 2: Recommendations to improve fruit yield and quality.

DAF: days after floral induction

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