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Early topping: an alternative to standard topping increases yield in cannabis production

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ABSTRACT

In commercial settings, cannabis is generally propagated through cuttings, a process referred in the industry as cloning. Some producers perform either topping or fimming to trigger the production of axillary shoots, which will enhance the number of flowers per plants and thus increase the yield of the cannabis plants. Topping or fimming is generally performed after the cuttings have been transferred to rooting media for two weeks. We have tested a new method to increase the shoot number per plant. The modification of the standard topping method consist of performing the topping on mother plants, prior to taking the cuttings for cloning, and the cuttings are taken one week after the topping is performed. The resulting plantlets develop axillary shoots much faster and the time of production from cuttings to harvesting is decreased by 7-10 days. The method proposed herein requires minimal adjustment to the existing workflow and the plants produce as much as when standard topping is performed. Moreover, this method cuts backs on the production time and nearly two weeks are saved compared to the standard topping procedure since the plantlets do not need to recover after topping. Application of this new procedure results in faster production time and ultimately enhanced productivity.

In nature, cannabis propagates through seed dispersal. Since cannabis is generally dioecious and a strong outcrosser, its progenies have segregating phenotypes. In commercial settings, it is required that all plants have identical properties (phenotype, chemotype, flowering time, ...) to ensure reproducibility, quality control and profitability. Thus, seed dispersal reproduction strategy is undesirable. For this reason, commercial cannabis installations usually propagate their plants through cuttings, a process that this industry usually calls cloning (1) and is now ubiquitous in the cannabis industry. In this process, a branch is cut from a mother plant and placed in a rooting media. All the resulting plants will have identical properties to their mother plant, hence they will be clones. Topping or fimming, which consist of removal or destruction of the apical meristem, will trigger the production of axillary shoots, which will enhance the number of flowers per plants and thus increase the yield of the cannabis plants. Topping or fimming is generally performed after the cuttings have been transferred to rooting media for two weeks.

Typically, each cutting will produce one main stem which will support the main inflorescence. To enhance the inflorescence productivity per plant, it is common to perform topping or fimming. In these processes, the upper apex of the stem is removed or damaged to break the apical dominance of the main stem. Apical dominance is the phenomenon by which the growth of the shoot apex (generally the central stem) inhibits the outgrowth of axillary inflorescences or branches, a process highly dependent on phytohormones (2, 3). However, even though apical dominance has been studied for nearly one hundred years, its molecular mechanism is still not fully understood (4). It has been determined that the axillary inflorescences are maintained in a dormant state by the hormones, such as auxins, produced by

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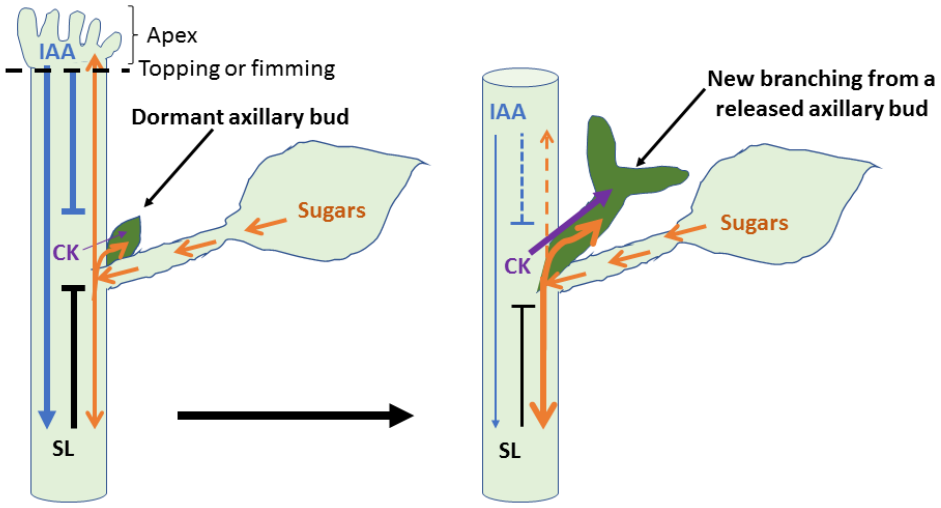

Fig. 1. Schematic distribution of auxins, cytokinins, strigolactones and sugars before and after topping or fimming.

Left: the apex is intact and exerts an apical dominance on the axillary inflorescence via a reduced sugar flux into the inflorescence or the inhibition of cytokinins by auxins and strigolactones. Right: After topping, a new shoot branching is initiated from the axillary inflorescence as a consequence of an intensification of the sugar flux into the axillary inflorescence and a drop of the inhibitory effect of auxins on cytokinins. IAA: auxins; CK: cytokinins; SL: strigolactones. Filled and flatten arrowheads indicates an activation and an inhibition, respectively. Open arrows indicates the flux of sugars. Thick arrows denote a strong hormonal effect or an intense sugar flux; thin arrows indicate the opposite. Discontinued arrows indicate the absence of inhibition by IAA and a reduced sugar flux toward the apical region.

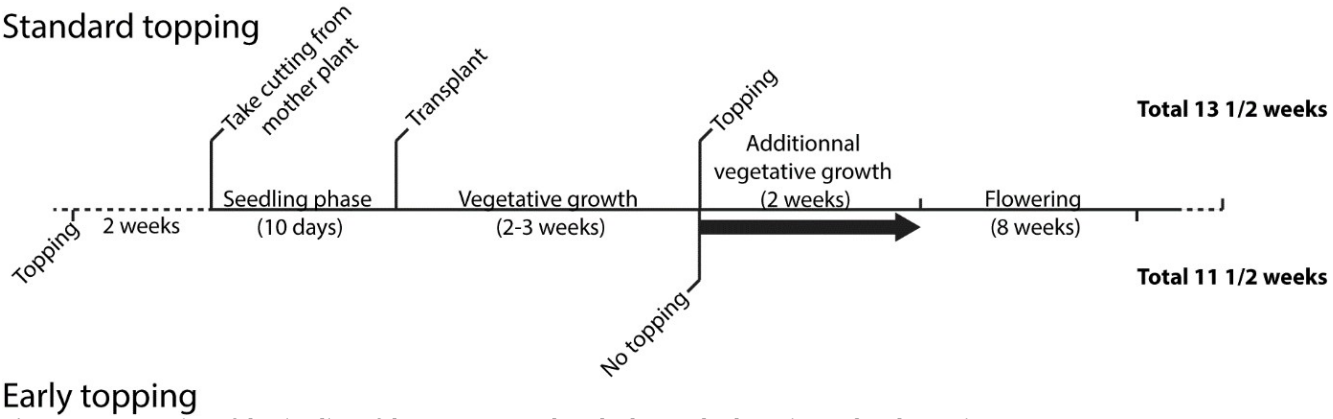

Fig. 2. Representation of the timeline of the two compared methods, standard topping and early topping.

In standard topping (above the horizontal line) a cutting is taken and transferred to rooting media for 10 days, then transplanted for vegetative growth, topped, vegetative growth is maintained to allow the plant to recover, and flowering is initiated. In early topping (below the horizontal line), topping is done on the mother plant which quickly initiates the production of axillary shoots, the cutting is taken exactly as is done for standard topping, seedling is initiated as well as vegetative growth. The additional vegetative growth which normally takes place after topping is not necessary and plants are allowed to go directly into flowering stage.

the main inflorescence (5), but when the apex is damaged, the plant enters a survival mode by breaking the dormancy of the axillary inflorescences and start to develop, resulting in a plant with several side branches that will each produce flowers (demonstrated in Fig. 1). Usually, the resulting cannabis plants will develop from 4 to 7 side branches and each one will produce an inflorescence. Although, topping or fimming represent an important additional step in the cannabis production workflow, because it can strongly enhances the yield per plant which is particularly relevant when the producers are limited to a fix number of plants (i.e. the designated grower system in Canada).

In the technique we described herein, the topping procedure is performed on the mother plant prior to cutting. Since the mother plant has a well-established root and aerial system, it promptly launches the development of axillary shoots, which emerge rapidly since the plant can draw nutrients from the media and perform photosynthesis efficiently. However, when typical topping (6) is performed on the plantlets regenerated from the

cuttings (1), since the plantlets do not yet have strong roots and have few leaves, a 7-10 days recovery period after topping is required (Fig. 2). Therefore, performing the topping on the mother plant will shorten the plant cycle by 7-10 days (Fig. 2) and the detailed procedure is shown in Fig. 3. We have produced hundreds of plants using this modified procedure and in all cases the production time was faster with early toping compared to the standard topping in all the cannabis varieties tested (White Cookie, Blue Cookie, Durban Poison, Sour Jack, Purple Kush, Hash Plant, Super Silver Haze and White Banner).

The reported observation, though unexpected at first, fully matches the early decapitation experiments that established the shoot apical dominance on the growth of axillary inflorescences. The molecular studies undertaken in different plant species converge to two major mechanisms controlling this phenomenon (5). In one scenario, the phytohormones auxins, cytokinins and strigolactones play a major role (7) where auxins are synthesized in the shoot apex and move toward the roots whereas strigolactones are synthesized in the roots and move in the opposite direction. Auxins inhibit the growth of axillary inflorescences by repressing the synthesis of cytokinins and this effect is reinforced by strigolactones (5, 8). Upon decapitation of the apex, the auxin flux from the apex ceases, relieving the inhibition of the axillary inflorescence growth. Concomitantly, cytokinins accumulate and activate cell division within the dormant inflorescence and the onset of the branching (3). A second possible regulation mechanism of shoot branching was more recently demonstrated. In a study, it was revealed that shoot branching is primarily limited by the amount of sugars going into the axillary inflorescence (9). In normal plants, most sugars derived from photosynthesis in leaves are used to drive the growth of the shoot tip. After decapitation of the shoot apex, the sugars rapidly accumulate in the axillary inflorescences, crossing a threshold that triggers cellular growth within the inflorescence. Both mechanisms likely interact to control the release of the axillary inflorescences from the shoot apical dominance (5).

With these mechanisms in mind, it seems likely that the early topping on the cannabis mother plant triggered the activation of the dormant axillary inflorescences and that the subsequent cuttings result in clones with pre-released inflorescences and equipped with enough sugars and nutrient reserves to quickly resume growth (Figs. 1 & 3). In contrast, when the topping is done later in the vegetative growth phase, the release of the axillary inflorescences can only occurs after the recovery period, delaying the overall growth of the plant. As shown in Figs. 1 & 2, this new method is faster than the regular topping procedure and only simple adjustments to the workflow are required. This new topping procedure provides a practical approach on how to increase cannabis yield by reducing the overall vegetative growth period by two weeks. Although, we tested the method on 8 cultivars and it is unclear how well this approach will work with other genotypes of cannabis, thus we recommend that growers first test the performance of this method on their genotypes in a pilot trial. Due to the space, time and plant number constraints faced by cannabis growers, this new cultivation method can represent a more profitable approach to plant propagation.

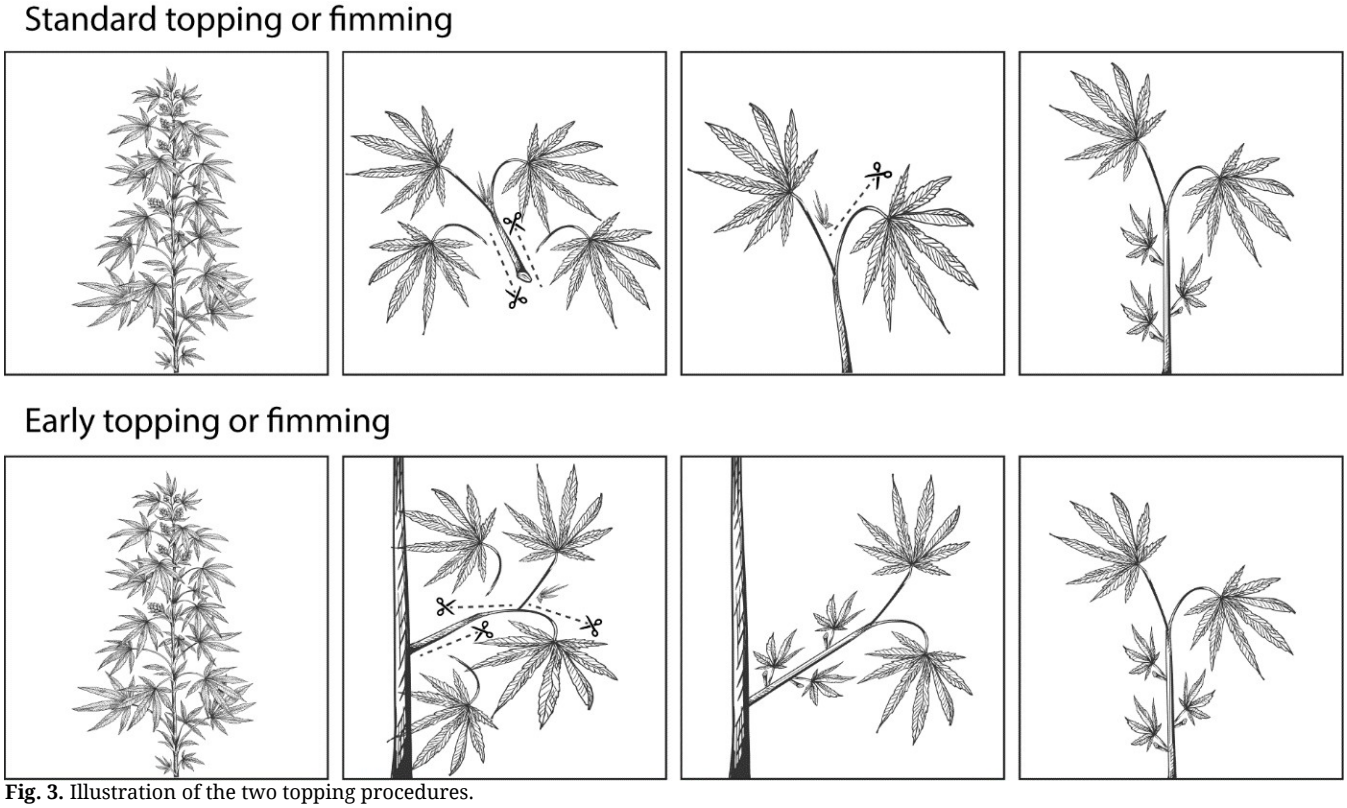

Fig. 3. Illustration of the two topping procedures.

Standard topping is presented in the upper panels, early topping is depicted in the lower panels.

Authors' contributions

SG, performed the measurements; TM and HG, drafted the manuscript; all authors read and approved the final manuscript.

Conflict of interests

Authors do not have any conflict of interests to declare.

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