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Advances in mitigation of alternate bearing of olive: Vegetative growth response to plant growth regulators

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Alternate bearing (AB) is a phenomenon in olive where fruit production alternates between large crops consisting of smaller, lower value fruit during an '"ON' year and smaller crops consisting of larger, higher value fruit during an "OFF" year. The large swings in biennial olive production impact the overall industry, from growers to harvesters, to processors. In olive, the vegetative growth in one year produces the nodes bearing potential floral buds in the spring of the second year. Fruit suppress vegetative shoot growth resulting nvbvv in fewer nodes available to bear fruit the following year. Our phenological studies have helped characterize the relationship between fruit load and vegetative growth on 'Manzanillo' olives in Tulare County, California.

Investigation of vegetative growth response to plant growth regulators

One strategy proposed to mitigate AB is to stimulate summer vegetative shoot growth to increase the number of nodes with the potential to produce floral buds. To address this strategy, our research team designed and implemented a proof-of-concept study in which plant growth regulator (PGR) treatments were injected into individual scaffold branches on opposing sides of 'ON' and 'OFF' trees. Plant growth regulators utilized in the study included two cytokinins, 6-benzyladenine (6BA) and a proprietary cytokinin (PCK), as well as two auxin-transport inhibitors, tri-iodobenzoic acid (TIBA) and a natural auxin transport inhibitor (NATI). Eight PGR treatments were included, with each PGR tested alone, and each cytokinin tested in combination with each auxin-transport inhibitor. PGR treatments were implemented in Summer (July 2012), and Summer + Spring (July 2012 and February 2013). Vegetative shoot growth was recorded monthly throughout the year to determine the influence of PGR treatments and timings on node production. The study was completed at the Lindcove Research and Extension Center (Exeter, CA).

Node production in response to plant growth regulator treatments

Scaffold injection with numerous PGR treatments resulted in significant increase in vegetative shoot growth. For example, nonbearing shoots on 'ON' control trees, produced an average of one node between July 2012 and February 2013, whereas nonbearing shoots on PGR-treated scaffold branches exhibited almost 4 times the new growth of the control trees (Table 1, shaded). Importantly, the new growth in some cases was statistically equal to and numerically greater than the new vegetative shoot growth of nonbearing shoots on 'OFF' control trees. The PGR treatments also had a positive effect in increasing vegetative shoot growth on bearing shoots of 'ON' crop trees. Bearing shoots on 'ON' control trees produced an average of 0.8 nodes between July 2012 and February 2013, whereas bearing shoots on PGR-treated scaffold branches of 'ON' trees produced over three-fold more nodes during this period. Some PGR treatments increased the number of new nodes on bearing shoots on 'ON" trees to values equal to those of nonbearing shoots of 'OFF' crop control trees (Table 1, asterisk). Identify the better treatments. On average two additional nodes of growth were added to shoots in all treatments from February through April. Thus, in April shoots treated with some PGRS (Table 1, shaded)

remained longer than bearing or nonbearing shoots on 'ON' crop control trees and equal to nonbearing shoots on 'OFF' crop control trees. This result suggests that with regard to increasing vegetative shoot growth there was no advantage derived from supplementing the Summer PGR treatment with the second Spring PGR treatment. However, the effect of the Spring PGR treatments on floral bud break, return bloom and fruit set remains to be determined.

Table 1. The effect of scaffold branch injected plant growth regulator treatments on vegetative shoot growth, as number of new nodes produced.

		New Nodes	
Treatment	**Branch Status**	**July-February**	**July-April**
ON Control	**Fruit**	0.8 l	3.3 jkl
TIBA+6BA SUMMER	Fruit	2.3 hijk*	4.6 cdefghij
TIBA+PCK SUMMER	Fruit	2.5 ghij*	4.9 bcdefghij
NATI+6BA SUMMER	Fruit	2.7 fghij*	4.2 fghijkl
NATI+PCK SUMMER	Fruit	2.2 hijk*	3.9 hijkl
TIBA SUMMER	Fruit	2.4 hij*	4.9 bcdefghij
NATI SUMMER	Fruit	2.5 fghij*	4.3 efghijkl
6BA SUMMER	Fruit	2.2 ijkl	4.2 fghijkl
PCK SUMMER	Fruit	2.6 fghij*	4.7 cdefghij
TIBA+6BA SUMMER+SPRING	Fruit	2.4 hij*	4.5 defghijk
TIBA+PCK SUMMER+SPRING	Fruit	3.0 efghi*	4.5 defghij
NATI+6BA SUMMER+SPRING	Fruit	2.6 fghij*	5.0 abcdefghij
NATI+PCK SUMMER+SPRING	Fruit	2.2 ijk*	3.7 ijkl
TIBA SUMMER+SPRING	Fruit	2.0 ijkl	4.1 ghijkl
NATI SUMMER+SPRING	Fruit	3.1 defghi*	5.5 abcdefghi
6BA SUMMER+SPRING	Fruit	2.7 fghi*	4.9 bcdefghij
PCK SUMMER+SPRING	Fruit	1.3 jkl	2.5 l
OFF Control	No Fruit	3.6 abcdefgh	5.0 bcdefghij
ON Control	No Fruit	1.0 kl	2.7 kl
TIBA+6BA SUMMER	No Fruit	3.8 abcdefg	4.7 cdefghij
TIBA+PCK SUMMER	No Fruit	4.7 ab	5.9 abcdefg
NATI+6BA SUMMER	No Fruit	4.8 a	6.3 abcd
NATI+PCK SUMMER	No Fruit	4.5 abc	6.0 abcde
TIBA SUMMER	No Fruit	4.4 abcd	6.0 abcdef
NATI SUMMER	No Fruit	4.2 abcde	4.9 bcdefghij
6BA SUMMER	No Fruit	3.4 bcdefghi	4.0 hijkl
PCK SUMMER	No Fruit	4.3 abcde	5.5 abcdefghi
TIBA+6BA SUMMER+SPRING	No Fruit	4.2 abcde	5.2 abcdefghi
TIBA+PCK SUMMER+SPRING	No Fruit	4.8 a	5.7 abcdefgh
NATI+6BA SUMMER+SPRING	No Fruit	3.9 abcdef	5.1 abcdefghi
NATI+PCK SUMMER+SPRING	No Fruit	3.2 cdefghi	4.2 efghijkl
TIBA SUMMER+SPRING	No Fruit	4.8 a	6.5 ab
NATI SUMMER+SPRING	No Fruit	4.5 abc	6.8 a*
6BA SUMMER+SPRING	No Fruit	4.8 a	6.4 abc
PCK SUMMER+SPRING	No Fruit	3.6 abcdefgh	4.7 cdefghij

***P*-value**		**<0.0001**	**<0.0003**
Note: Shading denotes treatments significantly different than ON Control + Fruit treatment. Asterisk denotes treatments significantly different than OFF Control (- Fruit).			

Summary

These preliminary data demonstrate that PGRs increase shoot growth, which might result in more nodes with the potential to produce inflorescences the following spring. Future studies are anticipated to address the use of promising treatments in foliar applications. Naturally-occurring compounds, such as PCK and NATI, may be easier and less costly to register than PGRs, which are classified as pesticides. Therefore, significant growth response to the natural compounds tested may have commercial benefit even if proven less efficacious than the synthetic PGRs.

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