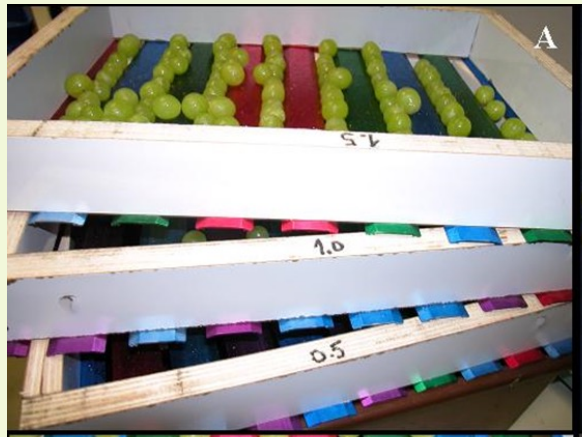
grapevine= Geffen

Uniformity within the cluster:

towards understanding of the central players, regulators, and potential means of manipulation

Dr. Etti Or, The Volcani center



Cluster appearance has a major importance for its marketing.

Two of the critical parameters are:

- degree of berry density
- uniformity of berry size.

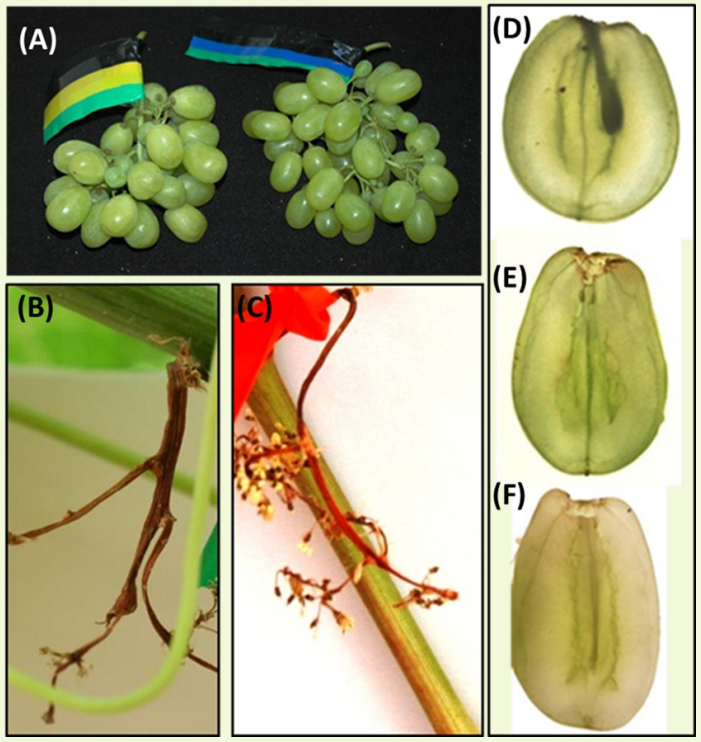
Both are affected by the degree of:

- fruit set
- flower/fruitlet abscission

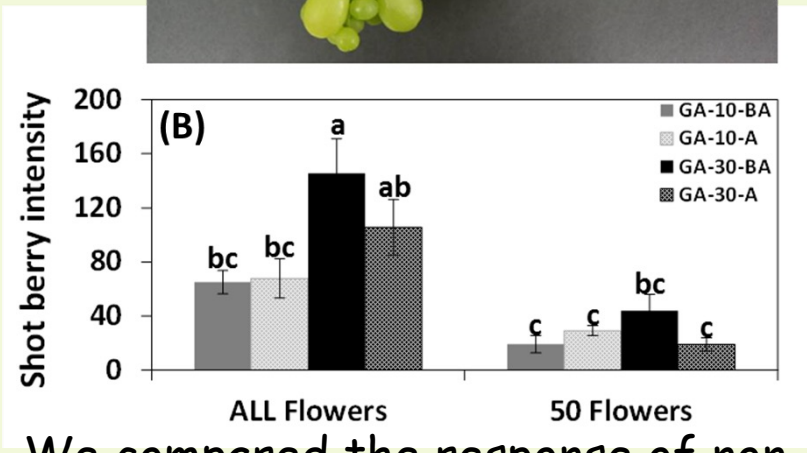
Further understanding of the regulation of uniformity and abscission by horticultural, environmental and genetic factors is critical to develop means to better control cluster appearance

GA induce parthenocarpic fruit set of emasculated flowers

GA lead to a significant increase in the percentage of small berries in a cluster, depending on initial flower load

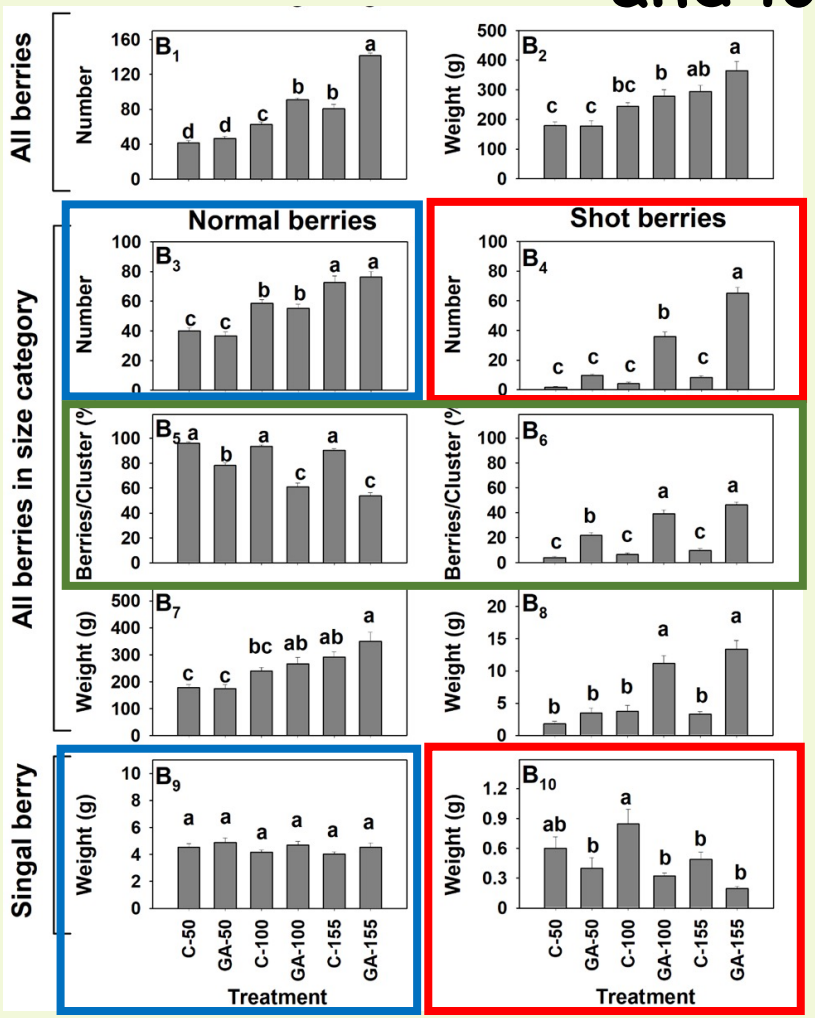


- GA treatment of emasculated flowers resulted in normal-sized, parthenocarpic berries (A, D-F)
- GA is indispensable for inflorescence survival, as untreated emasculated inflorescences, as well as PAC-treated non-emasculated inflorescences wilted and dried a few days after treatment (B-C)



- We compared the response of non-manipulated inflorescences to that of inflorescences manipulated to carry 50 flowers and to GA.
- We recorded a significant decrease in size variability and number of shot berries in the manipulated inflorescences when compared with the non-manipulated inflorescences

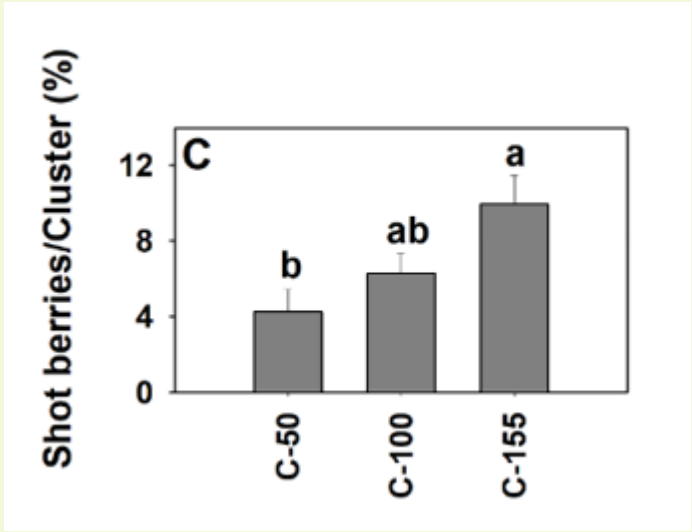
High initial flower load results in greater shot berry percentage and lower uniformity in the cluster



In a given load, GA treatment has no significant effect on the total number (Fig. $4B_3$) and weight (Fig. $4B_7$) of normal berries

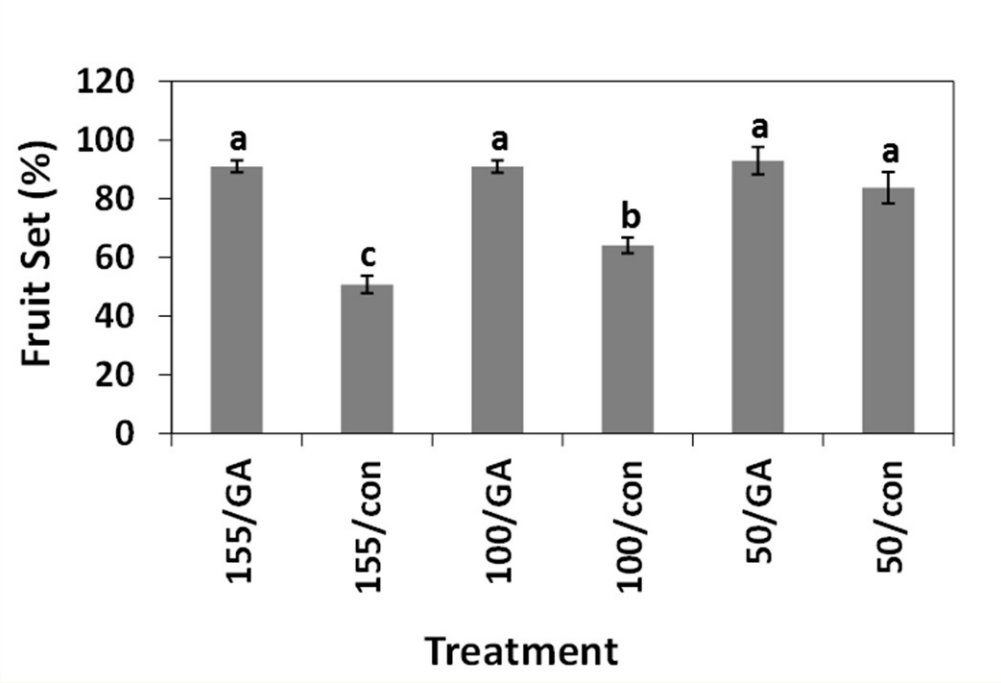
However, GA-treated clusters carrying 100 and 155 flowers presented considerable increase in number of shot berries (B_4), and a decrease in the weight of a single shot berry (B_{10}). Much milder difference was recorded for clusters carrying 50

GA- induced increase in the percentage of shot berries (B_6) and decrease in percentage of normal berries (B_5) is correlated with initial flower load



Higher initial load led to a significantly higher percentage of shot berries in untreated clusters as well

Fruit set is regulated by the initial flower load, and *GA* bypass such regulation



Irrespective of flower load, *GA* treatment resulted in a 90% fruit set.

The percentage of fruit set within control inflorescences was significantly lower than that of the *GA*-treated inflorescences when initial load was 100 and 150 flowers.

The percentage of fruit set within control inflorescences was not significantly different for a cluster with an initial load of 50 flowers.

These results suggest that:

(1) Higher initial flower load resulted in lower percent of fruit set

(2) There is an inherent mechanism that regulates flower load and ensures optimal cluster size

(3) This mechanism may be disrupted by *GA*

(4) When fruit set rate is beyond the cluster "capacity", competition among sinks is developed which lead to decreased size uniformity

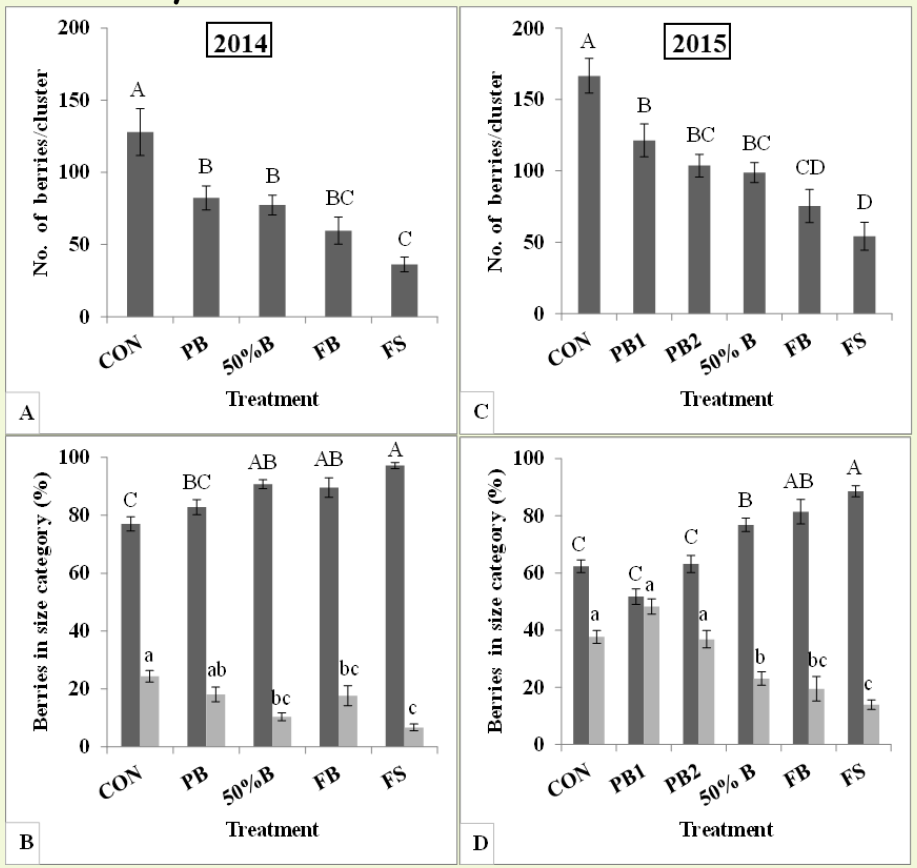
ABA application results in flower abscission

Control

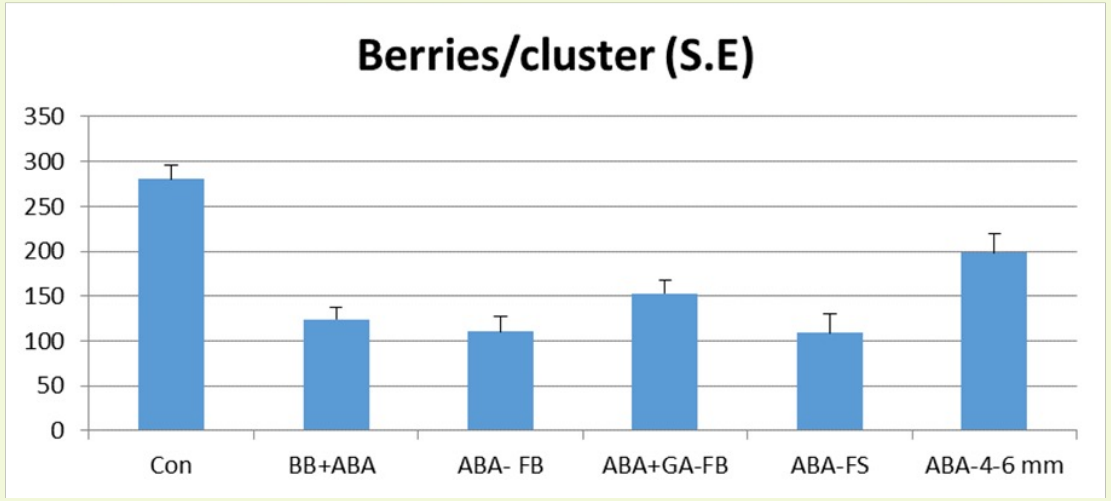
ABA

ABA application during flowering and fruit set reduces berry number and improves cluster uniformity

cv. Early Sweet



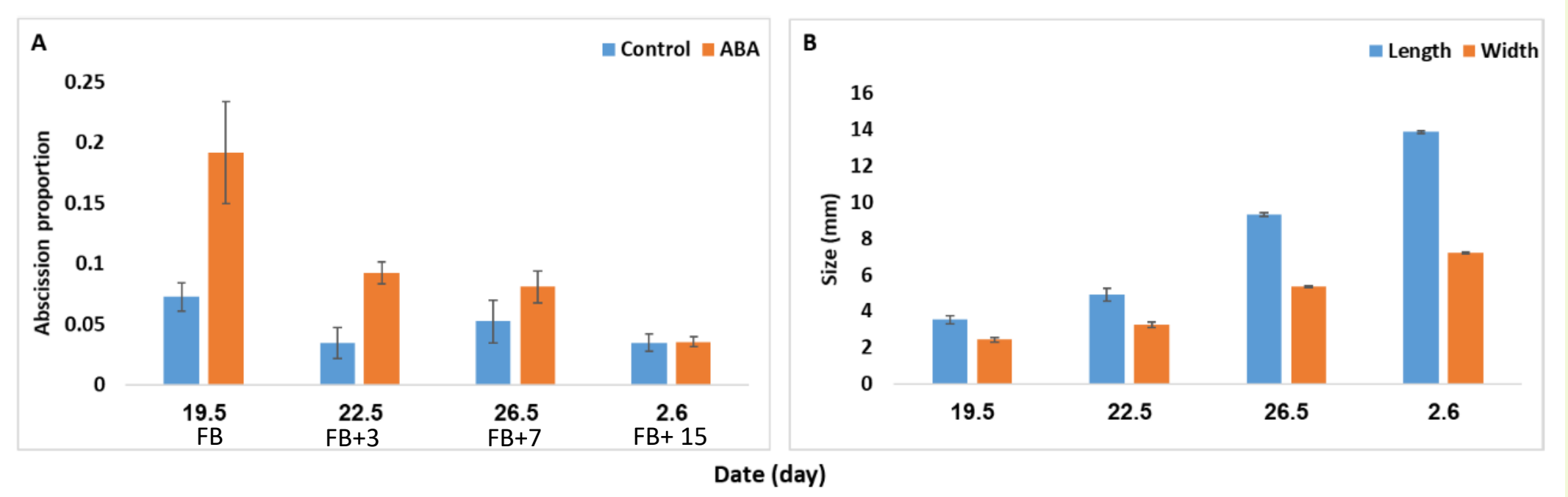
cv. Thompson



Commercial ABA application to cvs. Early sweet, Thompson, Superior, Crimson, Roki, and Scarlotta resulted in:

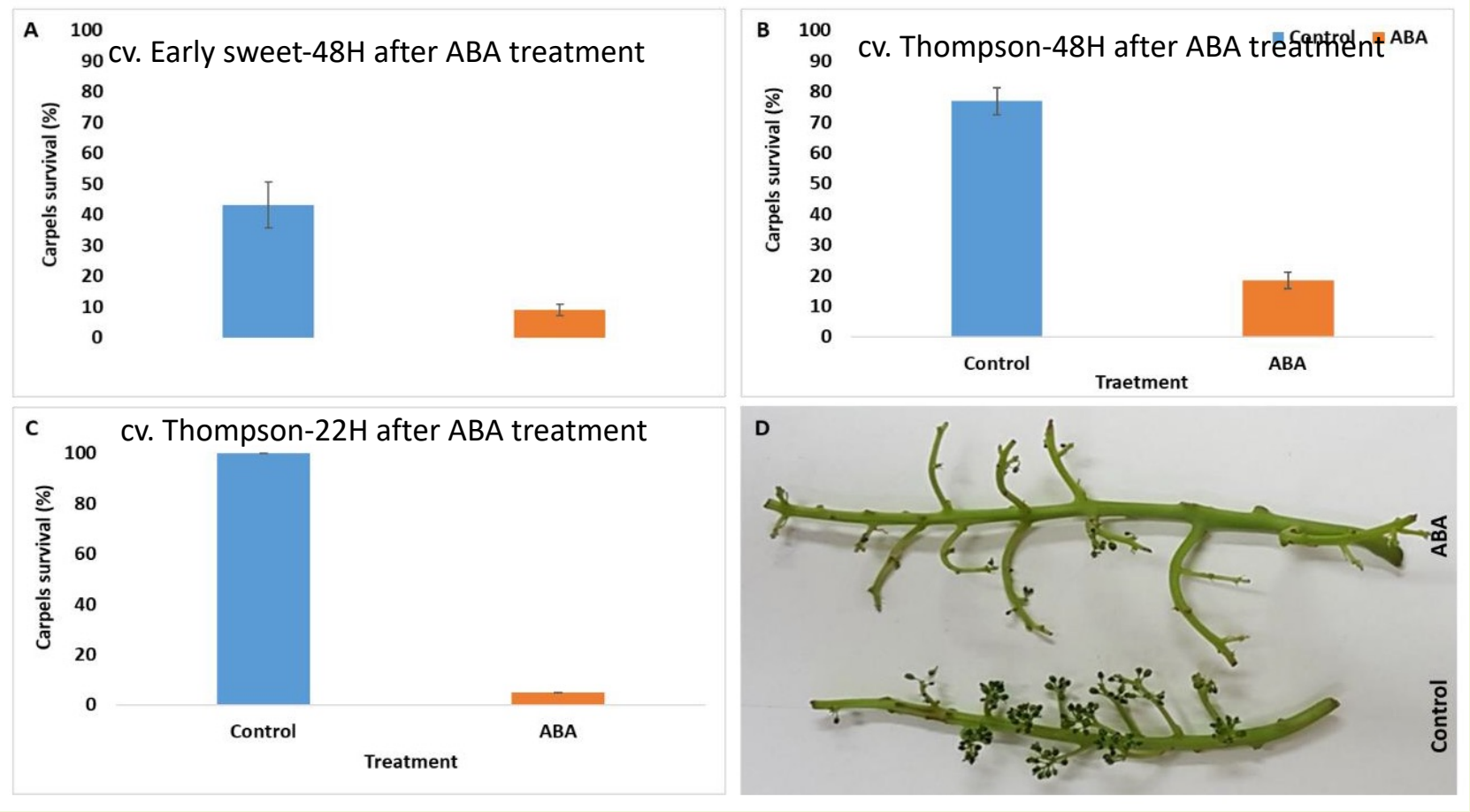
- Significant reduction in berry number/cluster
- Improvement in uniformity of berry size and reduction in fraction of shot berry
- Thinning is optimal between full bloom to "fruit set" (=after loss of anthers) and less effective at later stage of fruitlet development

ABA-mediated abscission proportion is decreased as fruitlet grows

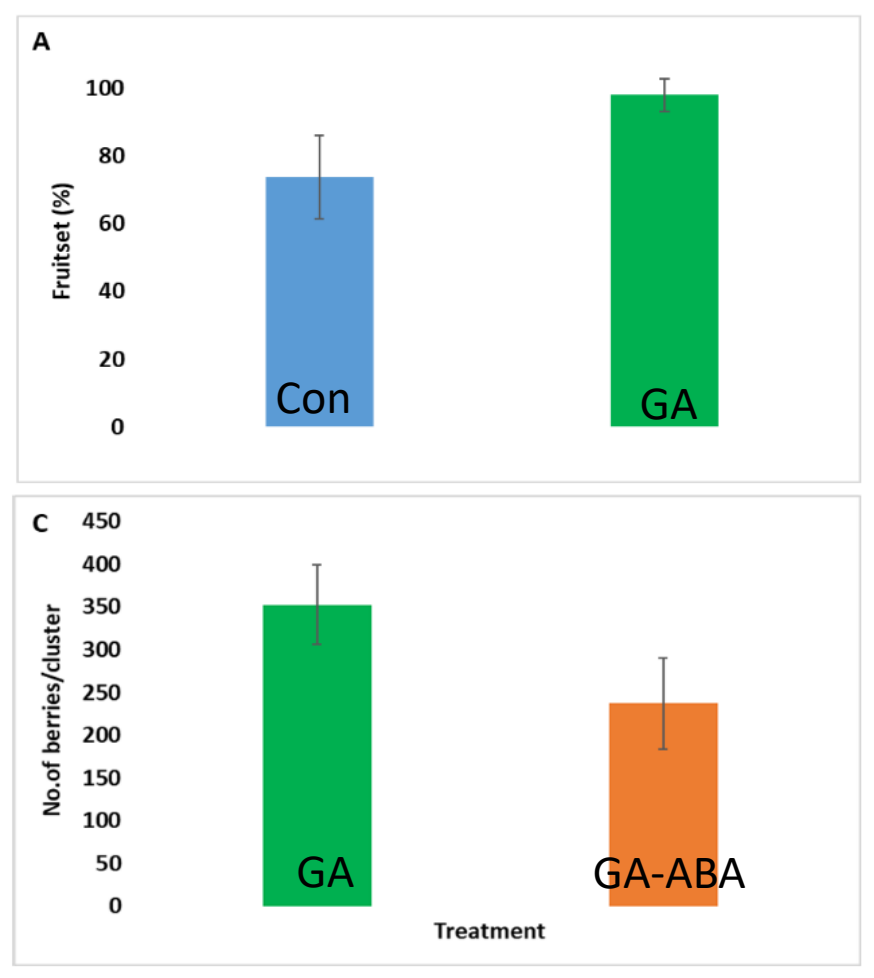


What is the target of ABA?

- The response to ABA is effective after removal of calyptra and anthers, suggesting that the target is the carple
- ABA treatment (250 ppm) enhanced thinning of emasculated carpels within less than two days, suggesting that unfertilized ovary is sensitive to the treatment



Does ABA treatment also induce thinning after fruit set?

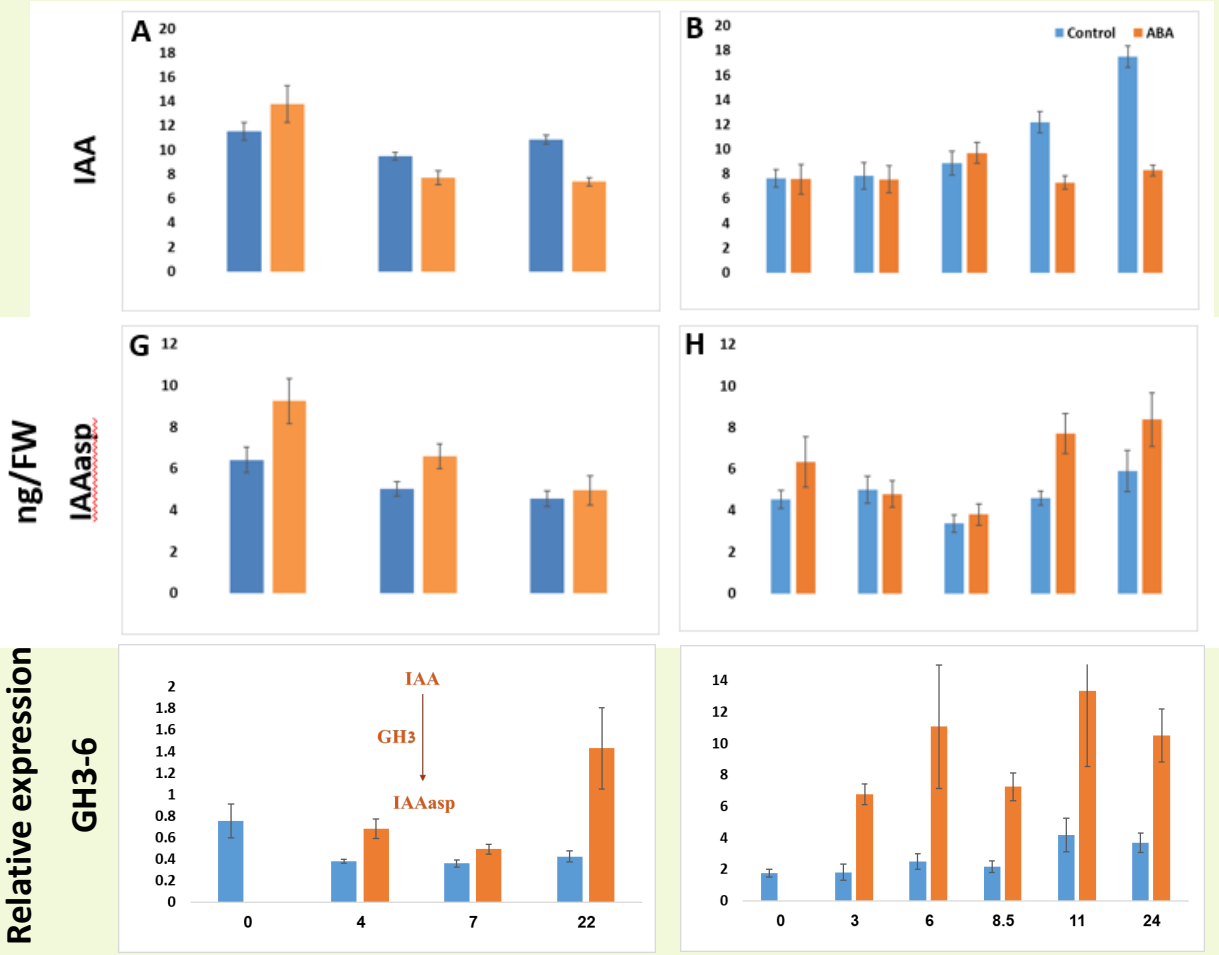


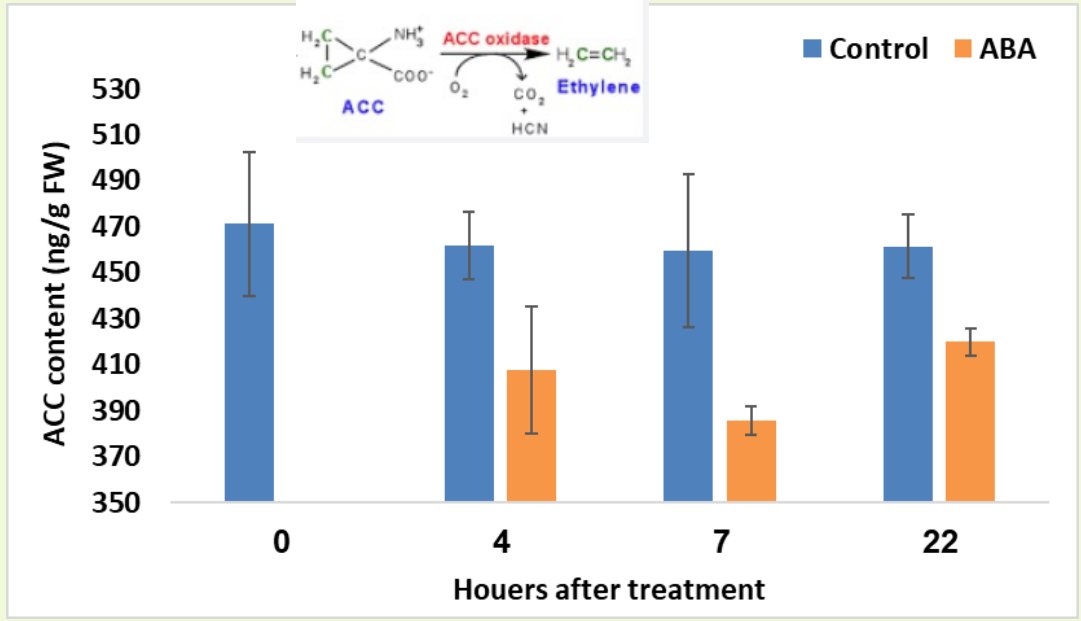
GA application 2 weeks before anthesis enhance fruit set

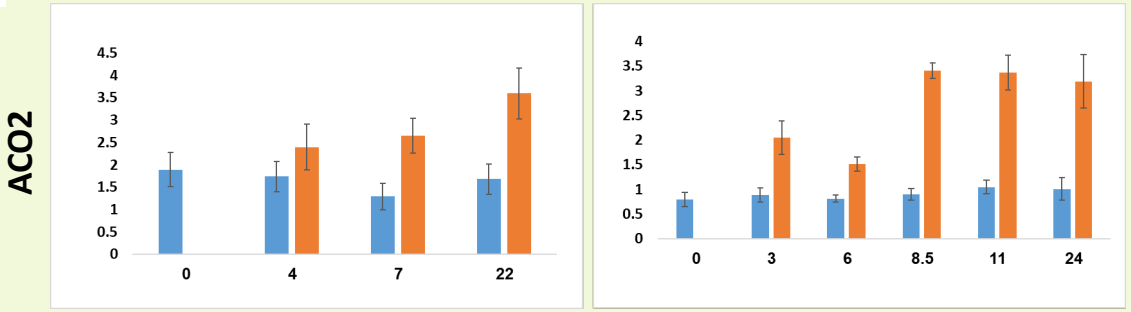
ABA application (250 ppm) at anthesis to GA treated infloresence reduced number of berries/cluster at harvest

So far the data suggests that ABA can induce abscission of both unfertilized carpels and very young fruitlets, hinting that fruitset itself may not be the main factor for abscission

It is well known that abcission zone development is mediated by parallel reduction in auxin and induction of Ethylene
In agreement, ABA enhance inactivation of auxin and ethylene biosynthesis







GH3 mediate binding of IAA (auxin) to ASP (amino acid)

In response to ABA, active auxin (IAA) level was decreased and the level of inactive conjugate (IAAasp) increased, supported by increased transcript level of the GH, coding for the relevant conjugating enzyme;

ACO transform ACC to Ethylene

ABA treatment induced decrease in ACC level and an increase in the transcript level of ACC oxidase genes, which together suggests activation of ethylene biosynthesis within the day after ABA application;

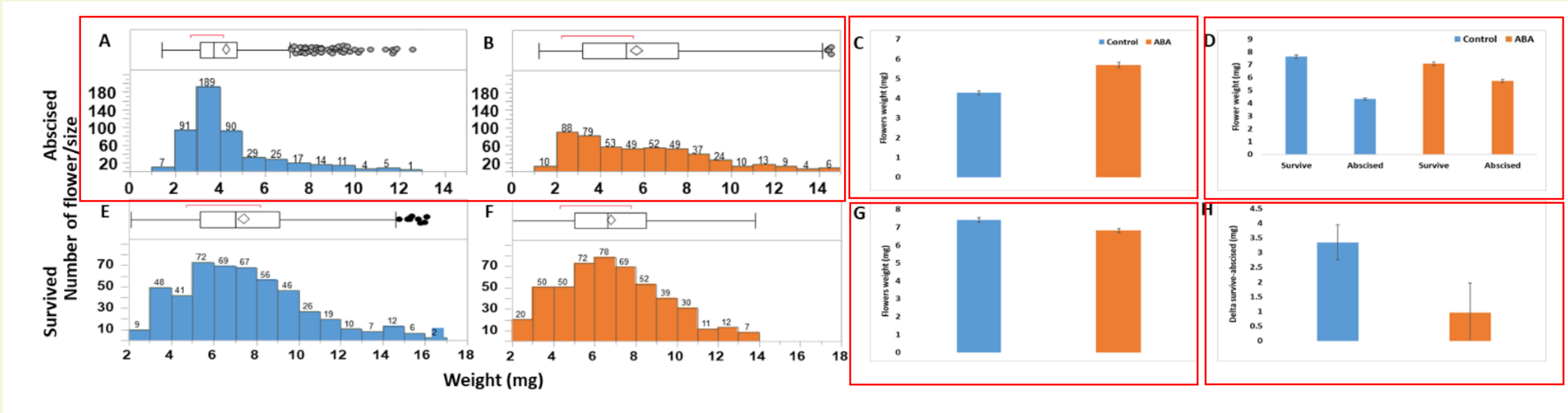
So far, the data suggests that:

ABA induce abscission through an effect on the carpel (before fruit set and for a limited period after fruit set)
This effect modulate balance between auxin and ethylene levels, known for its critical role in development of abscission layer

The central question is **what is the basis for the differential behavior of flowers carried on the same inflorescence in response to the same trigger/treatment?**

Variability in flower size within the flower population on a cluster may affect the differential response to ABA
Competition that is expected in light of such variation, due to variable sink ability, may affect the fitness of the individual flower survival.

We therefor tested potential relevance of variability in flower size

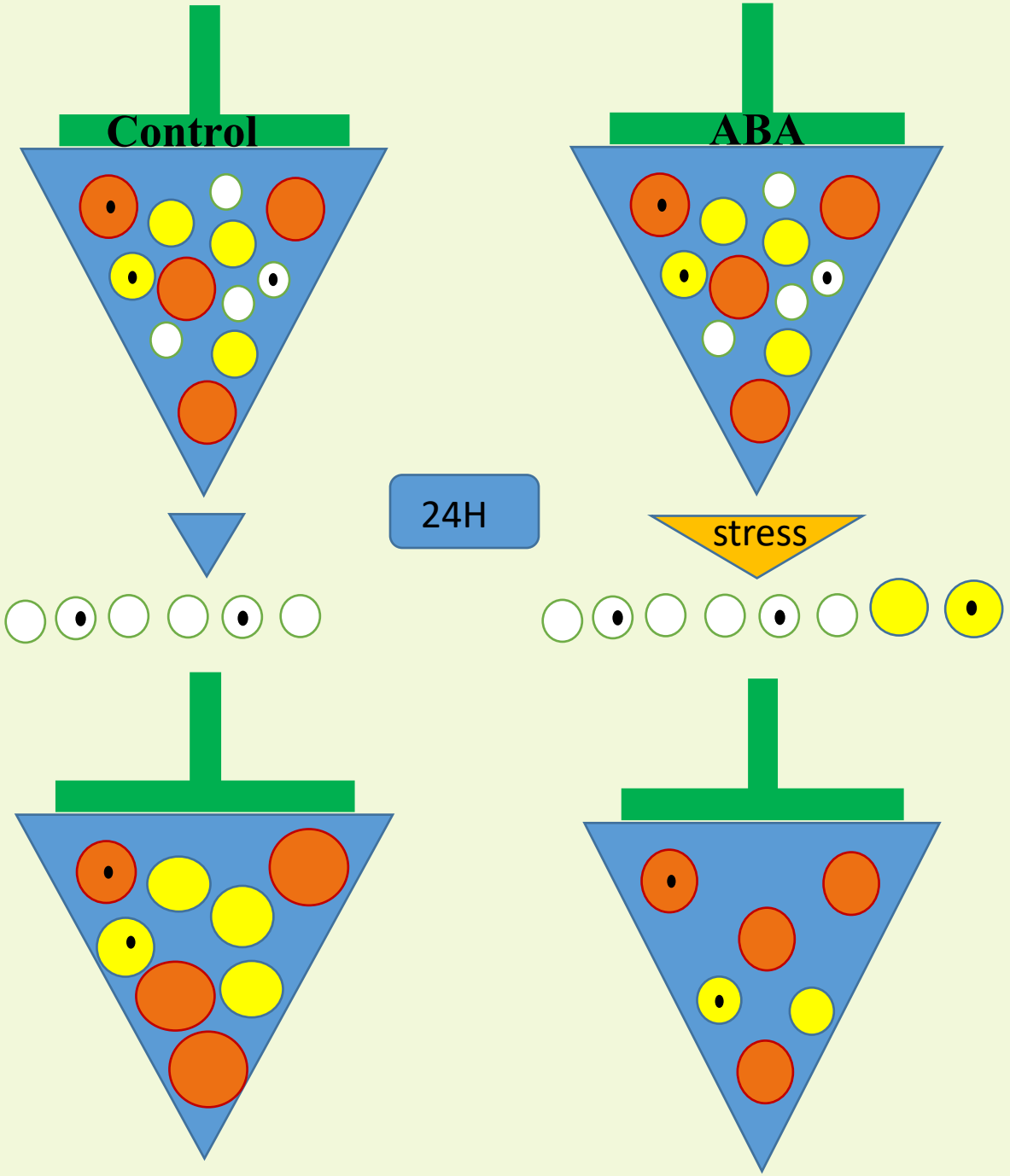


Single flower size was examined in surviving and abscised flowers after FB (50 flowersX10 clusters=500 flowers per category)

- Wight of surviving flower is higer then that of abscised flower in both ABA and Con treatments (D)
- Wight of abscised flower in control is smaller then that of abscised flower in the ABA treatment (C)
- Wight of survived flower in Control is bigger then that of survived flower in the ABA treatment (G)
- The distribution of the weights among abscised flowers in the ABA treatment (B)is wider than that in control). No noticeable difference in distribution between treatment and control in surviving flowers E-F)
- Difference in average weight between abscising and surviving flower was 3.5 times greater in the control inflorescences (H).

The data suggests that:

- abscised flowers are smaller than surviving flowers
- The range of sizes following ABA-induced abscission is wider and suggests abscission of bigger fruitlet, compared with control



The carpel serve as the primary target, whose response to ABA induce signal that activate development of abscission zone between the pedicel and the fruitlet/carple.

The differential response within the flower population on a given inflorescence, which is reflected by partial abscission, is driven by initial variability in flower size

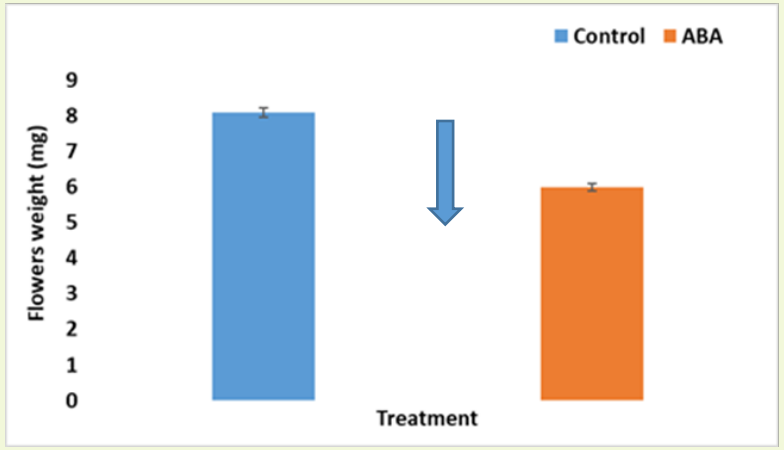
Such variability in flower response imply competition between sinks of variable strength.

ABA induce a currently unidentified stress situation that intensify competition among flowers of difference size within the inflorescence.

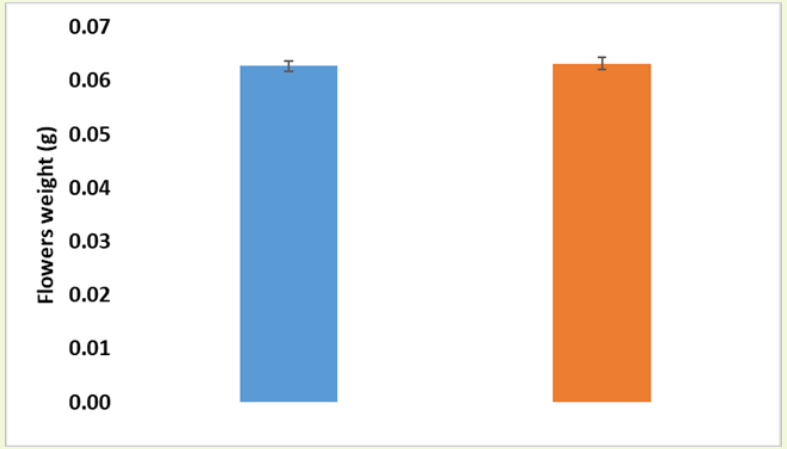
"medium-size" fruitlets which survive natural competition, are the main pool of flowers which are abscising due to enhanced competition that is enhanced by ABA .

The decrease in berry weight following ABA treatment is temporary

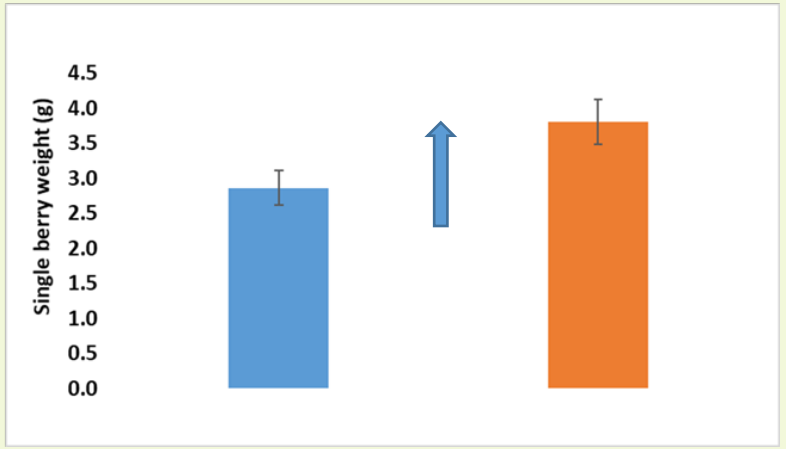
36h after ABA treatment



6d after ABA treatment



harvest



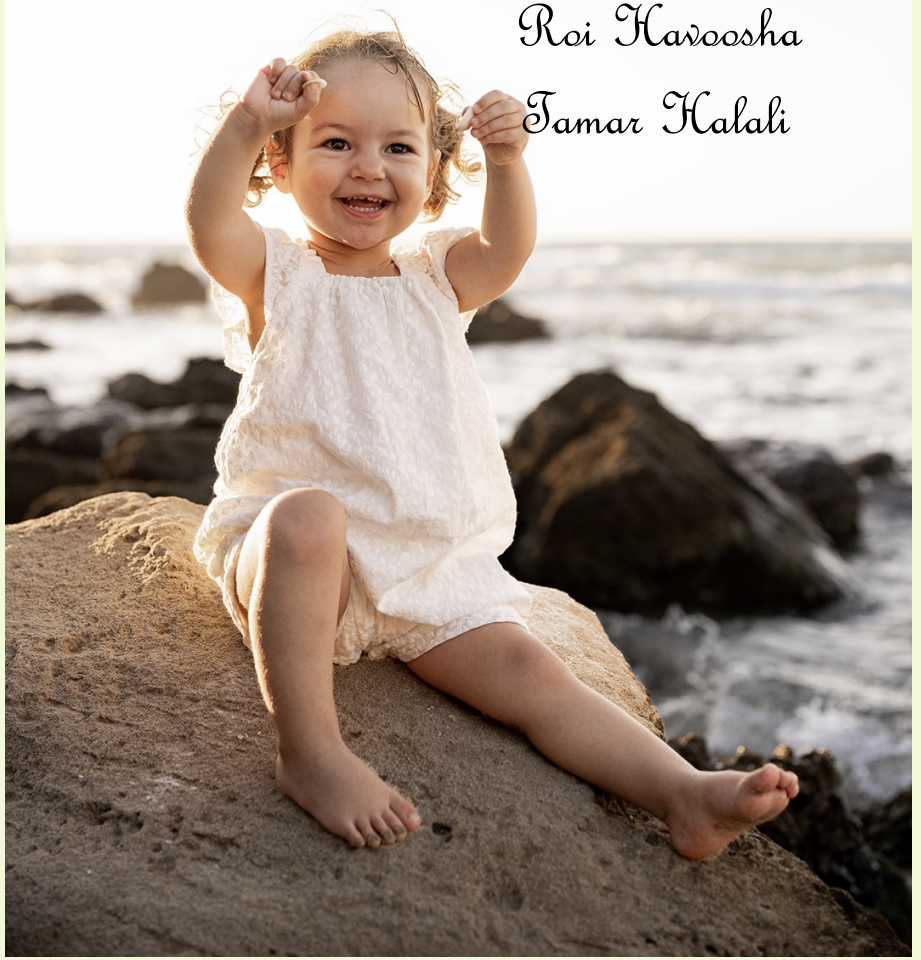
Decreased competition in light of enhanced abscission is a rational explanation for final increase of average berry size, compared with the control

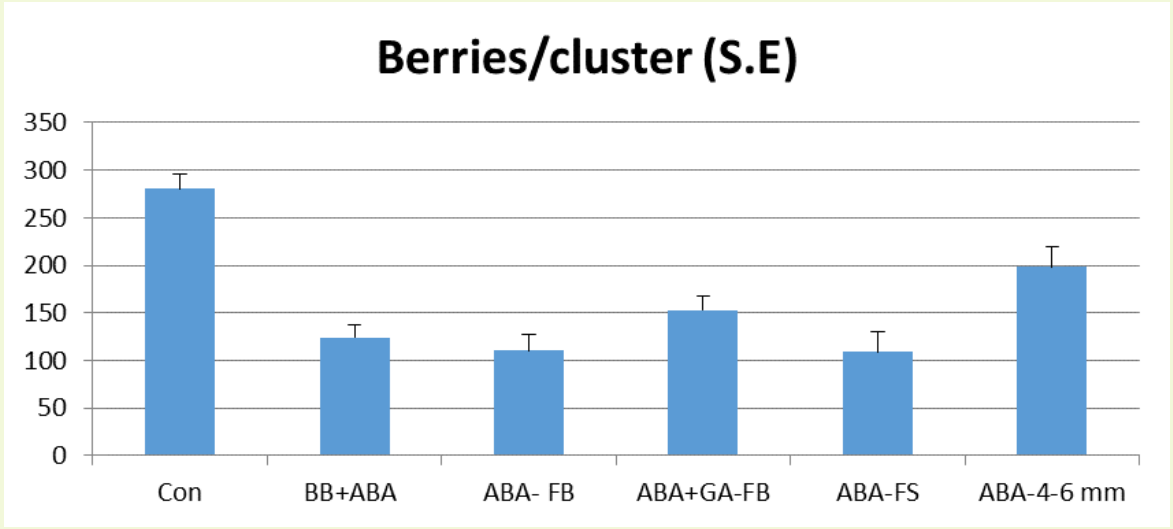
Thanks for your attention
Lets Hope for a better future

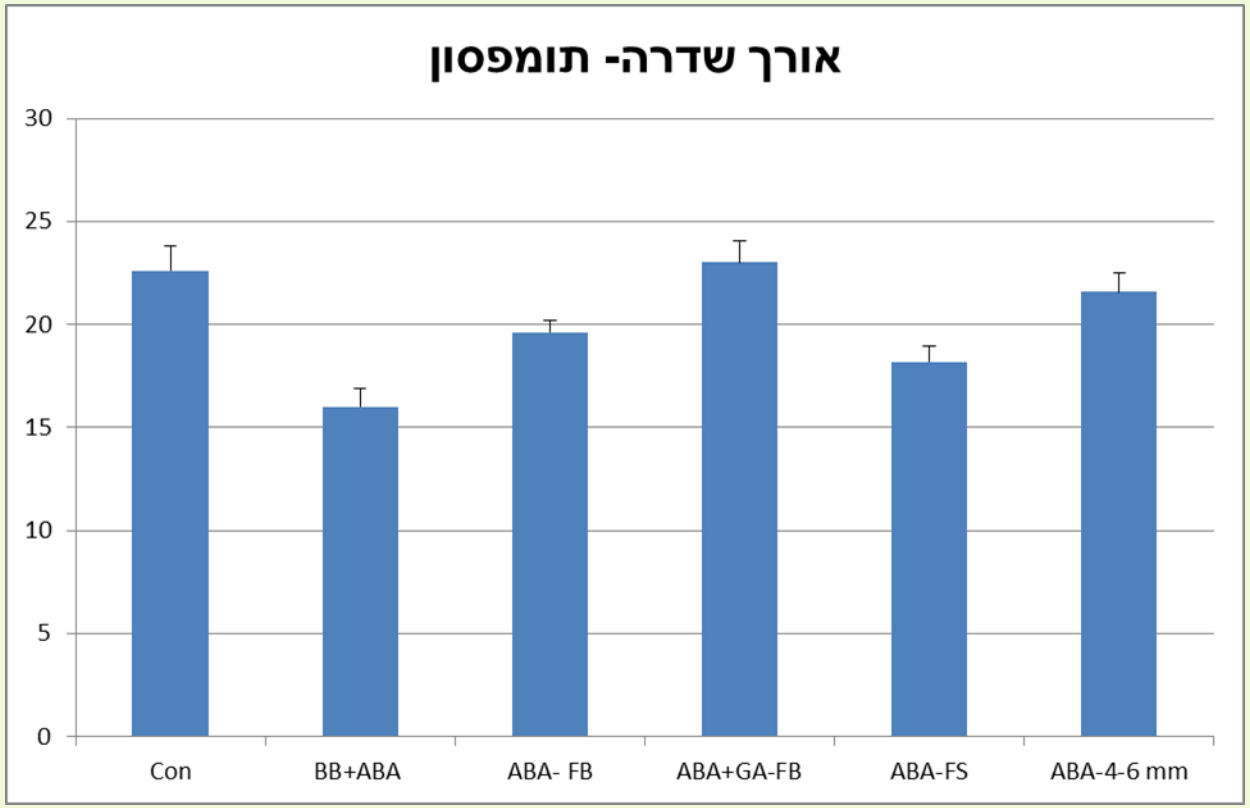
Etti and Geffen Or

Roi Havoosha

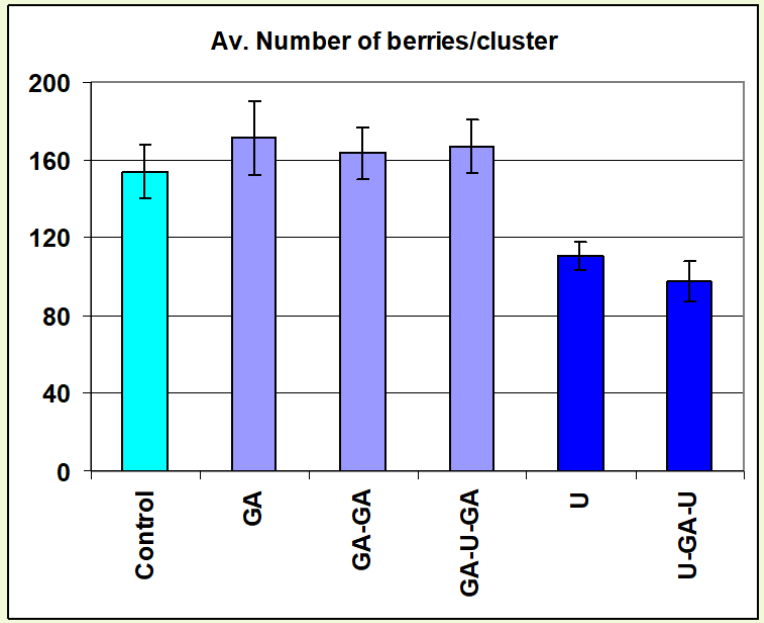
Tamar Halali

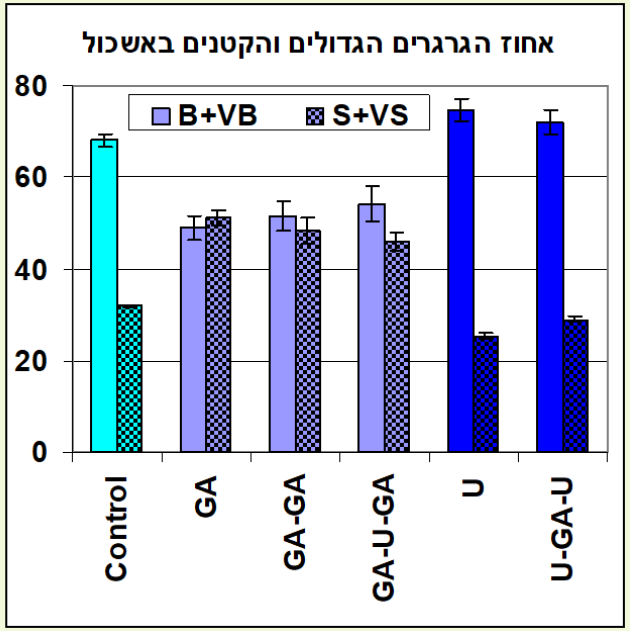


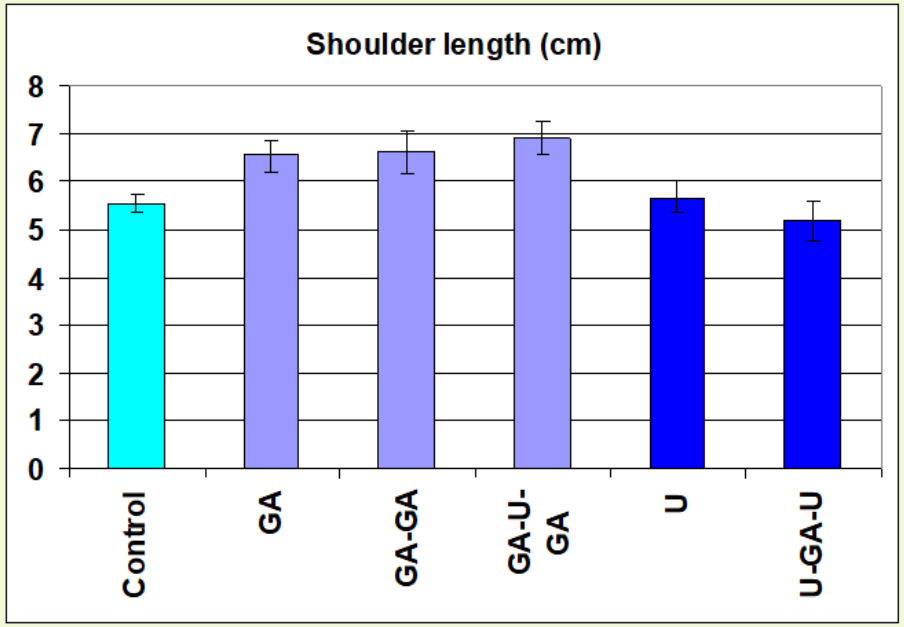

Berries/cluster (S.E)
350
300
250
200
150
100
50
0
Con
BB+ABA
ABA- FB
ABA+GA-FB
ABA-FS
ABA-4-6 mm


אורך שדרה- תומפסון
30
25
20
15
10
5
0
Con
BB+ABA
ABA- FB
ABA+GA-FB
ABA-FS
ABA-4-6 mm

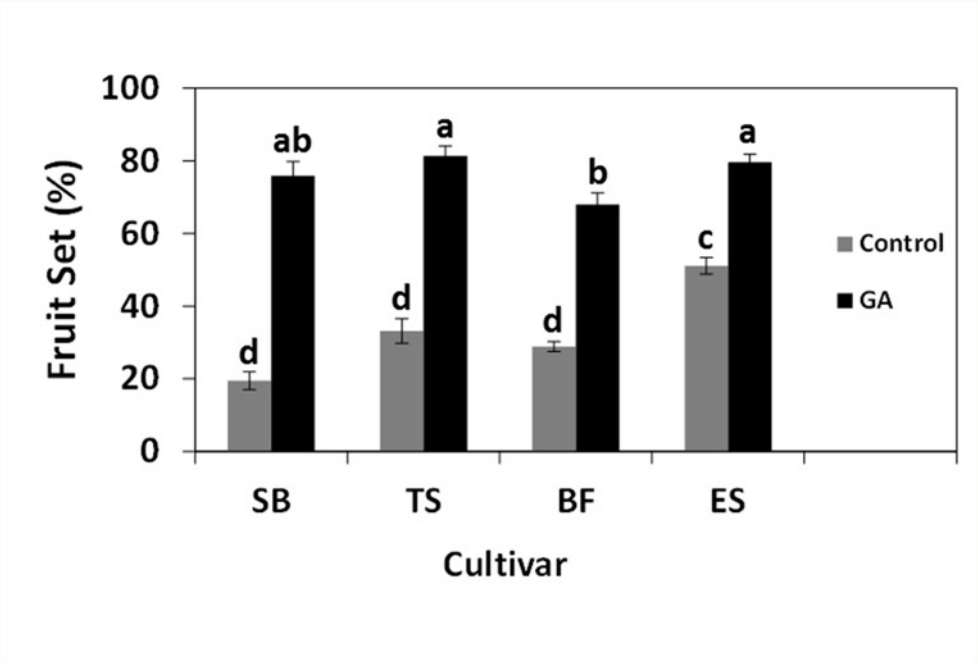
GA application does not decrease berry number and reduce compactness by in creasing % shotberry and rachis length but reduce







Cluster compactness visual assesment						
control	White	A				1.97
U	Green	A	B			1.84
GA-U-GA	Red	A	B	C		1.71
GA	Brown		B	C	D	1.50
U-GA-U	Black		B	C	D	1.49
GA-GA	Orange			C	D	1.44


100
80
60
40
20
0
Fruit Set (%)
ab
a
b
a
d
d
d
c
Control
GA
SB
TS
BF
ES
Cultivar