RETAIN® FOR WALNUT PISTILLATE FLOWER ABORTION (PFA): AN EXTENSION SUCCESS STORY

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ABSTRACT

Pistillate flower abortion (PFA) in walnut is the loss of female flowers early in the season, typically 2 to 3 weeks after bloom. It was first noted in the Serr cultivar soon after the earliest plantings came into production in the early 1970's. Serr is an important early maturing, high edible yield variety, which extends the harvest period and initiates marketing conditions. PFA can reduce dry, in-shell walnut yield 75%. In the 1980's, field-based research by Catlin et al., confirmed from detailed tagging of flowers that PFA is always associated with high numbers of pollen grains present on the receptors (stigmas) of female flowers. Research by Polito showed that live or dead pollen grains in excess of 85 per flower produced a large ethylene peak 24 hours after inundation and that this was the most likely cause for abortion. Polito also tested two non-commercial compounds, which either promoted or inhibited ethylene production and observed corresponding increases and reductions in PFA. The first field tests with the commercial product, ReTain®, an AVG-based ethylene inhibitor, were performed by the lead author in 2003. A four-fold increase in fruit set was observed over untreated flowers. In 2004, commercial speed sprayer trials performed in Kings and San Joaquin Counties at 25 and 50 grams ai/ac resulted in significant increases in percent set and yield improvements in excess of 1000 dry in-shell pounds per acre compared to untreated trees. Treatment was at an estimated 40% pistillate bloom. In 2005, trials in Kings and Tulare Counties examined the effects of application timings from prebloom to 70% bloom, as well as concentration (25 and 50 grams ai/ac) and water volume (100 and 200 gal/ac). Yield carryover affects were also evaluated on the 2004 Kings County trial. The 20-30% and 60-70% bloom timings resulted in the greatest yield improvement (163 dry inshell lbs./ac) compared to untreated trees (76 lbs./ac). Half the recommended concentration (25 grams ai/ac) in 100 or 200 gal/ac provided a 30 lb./tree increase. Application of 50 grams ai/ac in 100 gal/ac resulted in a 53 lb./tree increase. No adverse carryover effect in the average two-year yield was observed in trees treated only in 2004. A vigorous letter campaign orchestrated by UC Cooperative Extension to the federal and state EPA agencies accelerated ReTain registration for 2006. In 2006, six demonstration and three replicated trials were performed in Kings and Tulare Counties to test the efficacy of aerial treatment on the Serr walnut cultivar and the responsiveness of two additional cultivars (Chandler and Tulare) to ReTain application at approximately 30% bloom. Results indicate that properly applied aerial treatment at 50 grams ai/ac is as effective as ground application. The Tulare cultivar showed yield increases similar to that of Serr. No benefit was recorded in the Chandler cultivar and there was no interaction from the presence of pollenizers.

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INTRODUCTION

For over thirty years, scientists with the University of California Pomology Department at Davis, in cooperation with their colleagues in Cooperative Extension, have researched the cause and solution for pistillate flower abortion (PFA) in walnut (Polito et al.). PFA is the loss of nut-producing pistillate flowers early in the season, typically 2 to 3 weeks after bloom. This was first noted in the Serr cultivar soon after the earliest plantings came into production in the early 1970's. Originally referred to as the Serr drop problem, flower loss due to this phenomenon sometimes exceeded 90 percent in certain

orchards and years. Determining the cause of the disorder proved extremely difficult. By the late 1980's the above researchers had eliminated mites, walnut blight, numerous nutritional deficiencies including nitrogen, calcium, and boron, tree age, shading, pruning practices, water stress, intra-tree competition for nutrients, incompatible pollen and lack of pollination. Cherry Leafroll virus, the cause of Blackline, was also studied as a possible cause and eliminated (Polito et al.). In the 1990's, field-based research lead by

UC Davis Pomology faculty confirmed from detailed tagging of flowers and yields from individual trees varying in distance from a pollen source that PFA is always associated with high numbers of pollen grains present on the receptors (stigmas) of female flowers. Reduction of the pollen load in test orchards by catkin removal decreased PFA and increased yield. Tests on cultivars other than Serr (Chandler, Vina and Chico) showed the presence of PFA but not at levels which typically resulted in economic loss. The discovery of excessive pollen affecting walnut flower abortion also lead to the UC recommendation that Serr growers remove the pollenizer trees from their orchards and shake the catkins from the remaining Serr trees during the early bloom period. Growers accomplish this with the mechanical shaker normally used for harvest.

Serr growers in northern California became so frustrated with the poor yields received from this potentially high-producing variety that most orchards were removed. This left the majority of the state Serr acreage in southern California where it enjoyed popularity as an early maturing, high edible yield variety which helped extend the harvest period and set marketing conditions. However, from 1998-2003, Serr has yielded very poorly in orchards which typically produced about two ton of in-shell walnuts per acre. Use of the catkin shaking recommendation has also been met with frustration because a single shake has been insufficient to adequately reduce the pollen load. Many Serr growers also do not own shakers and therefore find timely coordination of this practice difficult. Growers who have shaken also report mixed results depending upon their proximity to surrounding orchards with varieties adding to their pollen load.

Research by Dr. Polito (unpublished) showed that pollen grains in excess of 85 on the stigma of the female walnut flower creates a large peak of ethylene, a natural plant hormone associated with organ senescence. Elevated ethylene levels are likely the cause of flower abortion. Polito also field tested non-commercial compounds which either promoted or inhibited ethylene production and observed corresponding increases and reductions in PFA.

Retain®, a commercially available, AVG-based ethylene biosynthesis inhibitor developed by Valent BioSciences was tested in 2003 by the author on 100 individual walnut fruiting shoots. ReTain treatment resulted in a four-fold increase in fruit set compared to untreated flowers. These positive results led to the commercial sprayer application tests and registration on walnut reported in this paper.

MATERIALS AND METHODS

Two Serr walnut orchards in the southern San Joaquin Valley and one in the northern San Joaquin Valley were selected for the 2004 studies. One orchard was in Kings County, one in Tulare County, and one in San Joaquin County. The southern San Joaquin Valley sites were located approximately 35 miles south of Fresno, and the northern site 2 miles east of Ripon, California.

The Kings County site was an 11 year-old, mature canopied orchard 55 feet in height. Directly north of the Serrs was a Chandler walnut orchard. The pollen from Chandler catkins overlaps about 80 percent of the Serr pistillate bloom and is implicated in exacerbating Serr PFA. This hypothesis is supported by the grower who reported that the annual per acre production of the first 15 Serr rows used for this study averaged only 1000 pounds dry in-shell walnuts over the past four years.
The Tulare County site was similar in age but half the height and wider spaced. Hartley, a walnut cultivar whose male catkins overlap the latter half of Serr pistillate bloom, was northwest of the test site about 100 yards. Open ground was directly north of the test rows and Payne walnut, whose catkins dehisce during the first half of Serr pistillate bloom, was northeast of the test about 200 yards.

The San Joaquin County trial was located in a mature (planted 1973) 27-acre Serr orchard with a closed in canopy roughly 45 to 50 feet tall. The test orchard was bound on the west and east by a 30-acre block of nonbearing Hartleys and a 20-acre block of mature Paynes, respectively. The areas immediately north and south of the test orchard were open.

Southern San Joaquin Valley trials-2004

Four treatments were applied to four, six-tree plots using a Latin Square experimental design to measure the variability between replications and the effect of distance from the Chandlers. Retain was tested at 62.5 and 125 ppm in 200 gal/ac. and compared to a water and untreated control. Application was made at 70 percent bloom (3/24/04) to the Tulare site and at 40 percent bloom (3/25/04) to the Kings site. Both applications were performed between 7:30 am and 9:00 am when ambient temperatures ranged from 57^0 F. to 59^0F.

Immediately following application, 15 shoots possessing two pistillate flowers in a pre-receptive stage were tagged for future set evaluation on each of the two middle trees in each plot. This was repeated for 15 shoots in the stage of peak receptivity. Set counts were then performed three and nine weeks post-treatment.

Harvest was also performed at each site on individual plots. During harvest, a 40 pound random sample was collected from the elevator belt and used to calculate a dry, in-shell conversion factor following commercial hulling and drying. A five- pound subsample was then submitted to Diamond Walnut Cooperative of California for third party quality evaluation.

In addition to the speed sprayer trials, an experiment was conducted in the Kings County orchard to test the effect of pistillate flower bloom stage on Retain® efficacy. Retain® was applied to flowers in the non-refracted, partially refracted and fully refracted stages of stigma development and compared to untreated flowers in various stages of pollen receptivity. Each of the four treatments were applied to five shoots bearing two flowers and replicated on 15 individual trees randomly selected but adjacent to the Chandler orchard. Percent set was then recorded three and nine weeks after treatment.

Treatment separation for all the tests was determined using Duncan's multiple range test at p=0.05.

Northern San Joaquin Valley trial-2004

Three treatments were applied to four six-tree plots using a completely randomized design with blocks arranged north to south in two pairs of rows (rows 5 & 6 and 8 & 9) in the orchard. A single row of Tehama pollenizers was located between the paired test rows. ReTain at 62.5 and 125 ppm and a water control were applied at 200 gallons per acre using a commercial air blast sprayer. The ReTain and water applications were made at 80% pistillate bloom on March 28 between 11:00 pm and 1:30 am.

The day after treatments were applied, fifteen shoots possessing two open pistillate flowers were tagged for future set evaluation on two center trees of each plot. Set counts were performed on April 16 and May 11.

Harvest was performed twice (September 13 and October 2) on each plot. Sampling methods for dry in-shell conversion calculations and quality evaluations by Diamond Walnut Growers were similar to those used at the southern San Joaquin Valley sites.

Treatment separation for all the San Joaquin County data was determined using Fisher's Protected LSD test at p=0.05.

Southern San Joaquin Valley trials- 2005

An application timing trial was performed in a mature Serr orchard (40 ft. x 40 ft., 27 trees/ac) in Visalia, California, with a history of severe PFA. Nine, single-tree plots were established for each of the five treatments as a randomized complete block experiment. The treatments included ReTain applied at prebloom, 2-5%, 20-30%, and 60-70% bloom. They were compared to untreated trees. Each plot had thirty, two-flower shoots tagged for PFA evaluation three and eight weeks post treatment. In September, two harvests

were performed to collect individual tree yield data. Sampling methods for dry in-shell yield conversion and quality evaluation was the same as 2004.

A trial to test the effect of ReTain concentration and volume was also performed in mature, PFA-affected Serr orchard in Hanford, California. Five treatments were applied to six, single tree plots using a randomized complete block experimental design. In addition to untreated plots, ReTain was applied at two concentrations (25 and 50 grams ai/ac) and two spray volumes (100 and 200 GPA). Thirty, two-flower shoots were tagged in each plot shortly after treatment for PFA evaluation three and eight weeks post treatment. Two harvests were also performed in September. The same sampling procedure used in the timing trial was followed to derive dry in-shell yields per tree.

In addition to the speed sprayer trials, two hand-applied, single shoot studies were preformed on the Chandler cultivar. One site had Franquette pollenizer trees in the row directly north of the Chandler test row. The other site had no pollenizers. Twenty, single-trees were employed at each site. Three stages of bloom (prebloom, early receptivity, and late bloom) were treated to run-off with ReTain at 125 ppm and compared to untreated flowers . Each of the 20 trees had five, two-flower shoots per treatment. The tagged shoots were evaluated three and eight weeks after treatment and reported as percent set.

Southern San Joaquin Valley trials- 2006

Six demonstration and three replicated trials were performed during this first full registration season. The demonstration trials compared ReTain treatment at 50 grams active ingredient in 100gpa to untreated plots approximately one-half acre in size. Six to 10 trees in each plot had thirty, two-flower shoots tagged for PFA evaluation three and eight weeks after treatment. Four of the trials involved the Serr Cultivar. Two tested the effect of ReTain on the Tulare cultivar. One of the Serr trials compared aerial treatment at 30% bloom to ground at 80%, since access to the orchard was limited by wet spring conditions. All the other demonstration trials were treated at approximately 30% bloom.

Using a randomized complete block experimental design, two replicated trials were performed in the Chandler orchards tested for PFA in 2005. The site with Franquette pollenizers had five, four-tree plots comparing ReTain at 50 grams active ingredient in 100gpa to untreated trees. The site without pollenizers had seven, four-tree plots for the same treatments. One tree within each plot had thirty shoots tagged in the same manner as previously described and evaluated. Harvest data was collected in October using the same procedure previously described.

The third replicated trial compared aerial versus ground ReTain treatment to untreated trees in a mature Serr orchard (30 ft. x 30 ft., 48 trees/ac). Eight, four-tree plots were established for each of the three treatments in a randomized complete block design. Each row of data trees was positioned directly south of a Tehama pollinator row to provide similar pollen density conditions. The ground treatment was applied at approximately 30% bloom using a ReTain rate of 50 grams ai/ac in 100gpa and 1.5 mph. The aerial treatment was applied the following day by helicopter using the same ReTain rate in 20gpa. The inside two trees of each plot were used for flower tagging (fifteen shoots per

tree) one day following the air treatment and harvest in September. Field weights were converted to dry in-shell weights using the previously described method.

RESULTS AND DISCUSSION

Southern San Joaquin Valley trials-2004

Table 1 shows the effect of Retain® on percent fruit set at the Kings County site when treatment was performed at 40% pistillate bloom. After nine weeks, there was a significant increase in fruit set with both concentrations of Retain® compared to the untreated and water controls. The high rate of Retain® increased fruit set by 60%. The application of water at 200 GPA had no effect on fruit set. Table 2 shows the resulting effect of improved fruit set on dry inshell walnut yield per acre. Both rates of Retain® significantly increased yield by about 1000 pounds per acre over the untreated trees. Trees treated with water were not significantly different from untreated trees. Although there was no differences in plot yields averaged down the field (row), plot yields increased significantly with greater distance from the Chandler orchard on the northern edge of the trial. This suggests that pollen density still affected yield even with the application of Retain®.

Table 3 shows the effect of pistillate flower bloom stage on Retain® efficacy. Flowers in the pre-receptive and early stages of stigma reflection had significantly higher percent set than flowers at peak receptivity. In contrast to flowers treated at full bloom, which were eight percent higher than those untreated, flowers treated at the pre-receptive stage set almost 24% more flowers than the untreated. This data suggests Retain® has greater efficacy when applied early in the bloom period. Its residual must also be sufficient to inhibit ethylene production from excessive pollination during the 5-7 day receptivity period.

Table 4 shows the effect of Retain® on percent fruit set at the Tulare County site when application was made at 70% bloom. Initially thought to be optimal timing, the lack of significant improvement after nine weeks supports the findings obtained in the bloom stage timing trial. In addition to the late application, pistillate flower abortion was not as great in this orchard as the Kings County site. The Tulare site also was not adjacent to a walnut cultivar whose pollen release period overlapped with Serr pistillate bloom.

The yields recorded from the Tulare site correlate with the fruit set data by showing no statistical differences (Table 5). The low rate of Retain® was very similar in yield to the water and untreated trees. The high rate of Retain® produced 433 dry inshell pounds more than the untreated and suggests a concentration effect may exist between the two rates tested.

Northern San Joaquin Valley trial-2004

Observations of staminate (catkins) and pistillate (female flowers) bloom in the Serr and Tehama pollenizer trees in the test orchard indicated that Serr was shedding pollen throughout the first 25-30% of Serr pistillate bloom. By March 24, when Serr pistillate

bloom had reached 80%, Tehama pollenizers were at roughly 60% staminate bloom. These observations suggest that there was considerable Serr and Tehama pollen in the test orchard throughout most of the Serr pistillate bloom period.

The early set counts performed April 16 reflect loss of flowers due to lack of pollination. The later (May 11) set counts include flowers lost by lack of pollination and PFA. Non-pollination drop was not significantly different among treatments (Table 6). Both ReTain treatments reduced PFA significantly but there significant difference in set between the two experimental rates of ReTain used. Spraying with water did not significantly affect PFA or non-pollination drop.

Treating with ReTain significantly increased first shake and total yields (Table 7). There was no statistically significant difference in yield between the 62.5 and 125 ppm ReTain treatments.

There were some differences in nut size among treatments but the differences were not consistent enough to attribute them to the spray treatments Table 8). A tendency toward slightly smaller nut size among ReTain treated trees may be a result of the greater crop load on those trees.

Southern San Joaquin Valley trials-2005

Results from the timing trial indicate ReTain application during the early stages of bloom is not as effective in reducing PFA and increasing yield as treating later. Data collected from this single trial showed treatment at 20-30% and 60-70% both had about 16% drop compared to 69% for the untreated. In contrast, the prebloom and 2-5% bloom timing averaged about 40% drop. Individual tree yield data correlated well the bloom data. The two later timings produced 163 dry in-shell pounds per tree compared to the two early timings of 122 pounds. Both were significantly better than the untreated trees at 76 pounds. These results differ from the 2004 hand application data (table 3) and may be caused by significant differences in coverage and active ingredient applied per flower.

The volume and concentration study showed no significant differences in percent flower drop or yield between the four ReTain treatments. Percent flower drop averaged 16% for the ReTain treatments compared to 41% for the untreated. Per tree yield for the untreated was 107 dry in-shell pounds per tree compared to 136 pounds for the 25 grams ai/ac rate in 100 and 200gpa and the 50 grams ai/ac rate in 200 GPA. Although not significant at P=0.05, the highest concentration (50 grams ai/ac in 100gpa) yielded the most at 160 pounds.

Yield data collected in 2005 from the Serr trial treated with 25 or 50 grams ai/ac ReTain in 2004 shows no adverse carryover effects. Although trees treated with ReTain the previous year produced significantly less than the untreated or water control in 2005, the average yield of the four treatments was essentially identical. Thus, the yield depression recorded in 2005 for trees treated with ReTain in 2004 reflects the alternate bearing character of walnut.

Results from treating different stages of bloom in the two Chandler orchards showed a significant reduction in percent drop (14%) in flowers treated during their early bloom stage. The presence of pollenizers at one of the sites did not affect the percent drop in the untreated flowers. Both sites had about 20% drop in the control treatment. The prebloom timing was not as effective.

Southern San Joaquin Valley trials-2006

Improvements in fruit set from ReTain application in the five Serr trials ranged from 77% to 184%, depending upon location and severity of PFA. Compared to the untreated trees identical in plot size to those treated with ReTain, all trials showed a positive yield increase from 17% to 183%. The degree of improvement appears correlated with PFA severity. Tagging of pre-receptive flowers in treated and untreated Serr blocks showed no difference in percent set after eight weeks.

Data collected from the replicated and demonstration aerial studies in Serr showed the greatest yield increase from air application. In the replicated trial, tree height (55+ feet) and lower fruit wood loss appear to have been the primary cause for these results. In this orchard, most of the flowers were in the upper 20 feet of the canopy, where air treatment is most effective. Ground treatment increased yield 17% above the untreated compared to 23% for the air treatment. Similar data was also observed in the demonstration aerial trial, where the ground treatment improved yield by 65% versus 131% for the air application. In this case, the differences are attributed to the delay in gaining ground access due to wet weather. The aerial treatment occurred five days sooner when bloom was rated at 30%. Young orchard age (seven years) also provided a much easier target for thorough coverage by air.

Both orchards of the Tulare cultivar responded positively to ReTain treatment. Yield increases of 17% and 23% were recorded over their corresponding untreated plot.

The two Chandler orchards, which had significant reductions in percent flower drop during last year's timing study, experienced no increases in fruit set or yield in the 2006 replicated speed sprayer experiments. This may be partly due to the erratic leaf out and bloom pattern this cultivar exhibited in 2006, which was caused by lack of winter chilling. Further testing is warranted.

CONCLUSIONS

Results from three years of field tests show ReTain plant growth regulator to be an effective tool for improving fruit set and walnut yield in orchards suffering from PFA. This research indicates that application timing is somewhat critical, and that sufficient number of female walnut flowers in the early stages of pollen receptivity must be present to maximize the benefit of application. Data provided by the manufacturer and these studies stress the importance of hitting the target flower with the product. Although residual of ReTain is reportedly as long as 14 days, insufficient amounts may contact flowers in the pre-receptive bloom stage due to their concealment within the emerging

terminal shoots. Good results have been attained between an estimated 30% to 60% bloom.

Research on ReTain concentration and spray volume for application suggests equivalent product performance with 25 or 50 grams ai/ac in 100-200 gallons of spray solution. However, the highest yield was received with 50 grams ai/ac in 100 GPA.

Yield improvements have been highly significant and vary with degree of PFA, flower load, application timing, and the duration of female bloom. In addition to the Serr cultivar, yield improvements were also recorded in the Tulare cultivar. No improvement was observed in replicated trials with Chandler. These results may have been affected by protracted bloom and leaf out from insufficient winter chilling in 2005-06.

Data is also presented to suggest that ReTain has no adverse carryover effect on subsequent year's yield. High yields produced from ReTain treatment one year may result in lower yields the following year due to the natural alternate bearing character of walnut.

Results from a single season of testing suggest aerial application, properly performed, can provide yield improvements equal to that of ground treatment.

LITERATURE CITED

Polito, Vito S., et al. 1998. Pistillate flower abortion and pollination management. In: Walnut production manual, chapter 17: pp133-138. Publication 3373. D.E. Ramos (ed.). Univ. of Calif. Div. of Ag. and Nat. Sci.

Table 1. Effect of speed sprayer application of Retain® on percent fruit set of Serr walnut, Kings County. Applied to four, six-tree replications at 40% bloom. Evaluated at three and nine weeks post application. P=0.05

Treatment	Percent Set	
	3 Weeks	9 Weeks
Untreated	52.4 b	52.9 b
Water	50.8 b	48.9 b
Retain @ 62.5 ppm	81.7a	78.9 a
Retain @ 125 ppm	89.7 a	84.7 a
Lsd	17.8	17.9
Treat X Bloom	NS	NS

Table 2. Effect of speed sprayer application of Retain® on the yield of Serr walnut, Kings County. Applied to four, six-tree replications at 40% bloom. Fifty-four trees/ac. Row data represents yields equidistant from the adjacent Chandler orchard. Column data represents yields P=0.05

Treatment	Yield per acre (lbs)	Row Yield	Column Yield
Untreated	5063 b	1. 5593	1. 4771 d
Water	4726 c	2. 5116	2. 5288 c
Retain® @ 62.5 ppm	6056 a	3. 5675	3. 5630 b
Retain® @ 125 ppm	6094 a	4. 5555	4. 6249 a
LSD	159.8	NS	159.8

Table 3. Effect of Retain® applied by handgun at 125 ppm on percent set of Serr pistillate walnut flowers at different receptivity stages. Applied to five, two-flower shoots per tree and 15 trees. Kings County. P=0.05

Treatment	Percent Set	
	3 Weeks	9 Weeks
Pre-Bloom	96.7 b	96.0 a
Early Bloom	95.3 b	91.8 ab
Full Bloom	83.3 a	80.7 bc
Untreated–various bloom stages	75.2 a	72.5 c
Lsd	11.1	12.3
Treat X Bloom	NS	NS

Table 4. Effect of speed sprayer application of Retain® on percent fruit set of Serr walnut, Tulare County. Applied to four, six-tree replications at 70% bloom. Evaluated at three and nine weeks post application. P=0.05

Treatment	Percent Set	
	3 Weeks	9 Weeks
Untreated	76.2 b	71.7 a
Water	78.9 ab	72.4 a
Retain @ 62.5 ppm	83.3 ab	78.3 a
Retain @ 125 ppm	86.6 a	76.9 a
Lsd	8.7	
Treat X Bloom	**	NS

Table 5. Effect of speed sprayer application of Retain® on the yield of Serr walnut, Tulare County. Applied to four, six-tree replications at 70% bloom. Fifty trees/ac. P=0.05

Treatment	Yield per acre (lbs)
Untreated	3298
Water	3293
Retain® @ 62.5 ppm	3278
Retain® @ 125 ppm	3731
	NS
Lsd	514.5

Table 6. Effect of bloom ReTain and water treatments on post bloom flower drop, San Joaquin County.

Treatment	% Non-pollination drop	% Pistillate flower abortion
ReTain 125	4.8	18.8 b
ReTain 62.5	3.1	26.9 b
Water	5.4	46.9 a
Untreated	3.1	56.7 a

Numbers within columns followed by different letters are significantly different, Fisher's Protected LSD ($P \leq 0.05$)

Table 7. Effect of bloom ReTain and water treatments on yield (8% wet basis moisture), San Joaquin County.

Treatment	1st shake, 9/13, lbs/acre	2nd shake,10/2, lbs/acre	Total lbs/acre
ReTain 125	4614 a	2017	6631 ab *A*
ReTain 62.5	5034 a	2210	7244 a *A*
Water	3428 b	1783	5211 c *B*
Untreated	3509 b	1904	5413 bc *B*

Numbers within columns followed by different letters are significantly different, Fisher's Protected LSD: abc, ($P \leq 0.05$); *AB*, Fisher's Protected LSD ($P \leq 0.10$).

Table 8. Diamond Walnut Growers quality evaluation of nuts from ReTain and water treated trees, San Joaquin County.

Treatment	Avg. nut wt. (g)	% Large sound	% Edible yield	% Offgrade	RLI
1st shake					
ReTain 125	12.5 a	88.6 a	55.0	3.8	51.2
ReTain 62.5	11.8 b	81.3 b	54.5	2.7	51.4
Water	12.6 a	89.1 a	53.6	3.2	52.0
Untreated	12.3 a	82.8 b	54.0	2.6	51.8
2nd shake					
ReTain 125	13.7 b	91.6	56.3 a	1.7	50.1
ReTain 62.5	13.7 b	91.3	55.8 a	1.7	51.0
Water	14.1 ab	92.4	54.6 b	2.9	49.7
Untreated	14.3 a	93.4	55.3 ab	1.5	50.0

Numbers within columns followed by different letters are significantly different, Fisher's Protected LSD ($P \leq ,0.05$)

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