The Role of Photosynthesis in Ultraviolet Responses: Are UV Responses Different in Maize *Albino*Mutants That Have No Chloroplast?

By

Rebecca A. Burt

Departmental Honors Thesis

The University of Tennessee at Chattanooga

Department of Biological and Environmental Sciences

Project Director: Dr. Ann E. Stapleton

Examination Date: November 3rd, 2001

Dr. Ann Stapleton, Dr. Nicky Ozbek, Dr. Hill Craddock, Professor Linda Collins

Examining Committee Signatures:

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Chairperson, University Departmental Honors Committee

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I. ABSTRACT

It is the argument of the present study that photosynthesis damage is not linked to the reduced growth of UV exposed plants. To isolate the photosynthesis component, albino maize mutants were compared to wild type maize. Both the albino and wild type plants were exposed to UV radiation. The effects were compared to establish the role of photosynthesis. From this method, it was found that damage to photosynthesis does not play an active role in the hindered growth of plants exposed to elevated UV levels. From the results, it can be seen that flat/ rolled ratio is a more sensitive measurement of ultraviolet radiation stress than the measurements of dry weight or fluctuating asymmetry.

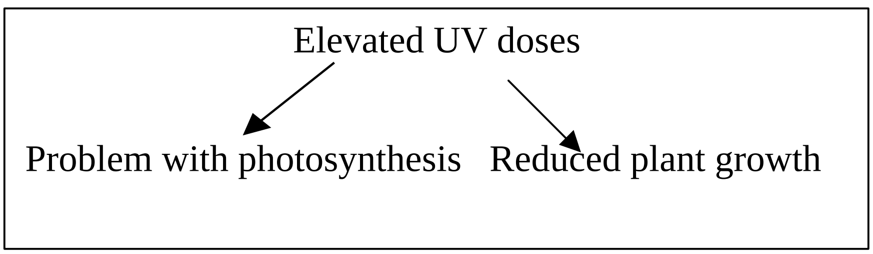
II. INTRODUCTION

A. OBSERVATIONS

Elevated UV radiation has been shown repeatedly to affect photosynthesis (Greenberg *et al.*, 1997; Caldwell *et al.*, 1989; Tevini and Teramura, 1989). In addition, it has been proven that plants exposed to elevated UV levels have reduced growth (Greenberg *et al.*, 1997; Ballare *et al.*, 1992; Tevini and Teramura, 1989). The relationship between the two however, has not been deciphered. Because photosynthesis is the process that drives growth, development and yield, physiological studies of UV-B effects have tended to concentrate in this area (Fiscus *et al*., 1995). The purpose of this study is to determine the relevance of photosynthetic elements to the well-being of the plant in an elevated UV radiation stress environment.

What we know:

Figure 1. Elevated UV effects both photosynthesis and plant growth

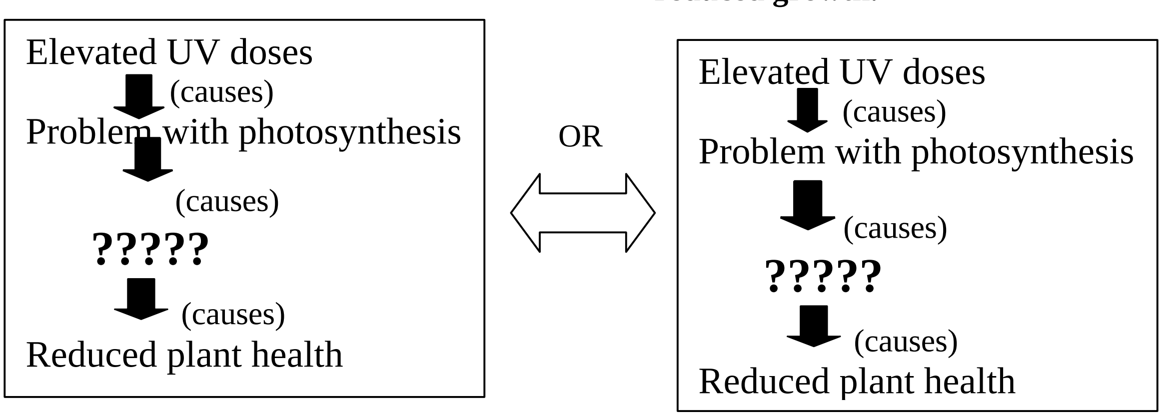


What we don't know:

Possible cause and effect chain reaction pathways:

Figure 2. Damage to photosynthesis causes seen reduced growth.

Figure 3. Damage to another component, besides photosynthesis causes seen reduced growth.



Is the reduction of plant growth a direct result of photosynthesis malfunction caused by UV damage (Fig. 2)? Or are there other possible causes of reduction of growth (such as DNA mutations) resulting from the elevated UV radiation (Fig. 3)?

1. UV RADIATION

Caldwell *et al.* (1989) state that there is compelling evidence that reduction of the global ozone layer is occurring. Since ozone in the stratosphere absorbs much of the short-wave solar ultraviolet radiation (UV-B), diminished ozone means that more UV-B (wavelengths between 280-315 nm) will be received at the earth's surface. Resent research suggests that within the ecosystem level there could be a great deal of damage to plants, morphologically and chemically (Caldwell *et al*., 1989).

2. WILDTYPE AND ALBINO MAIZE

Albino maize mutants have a mutation that inhibits photosynthesis by inhibiting the formation of chlorophyll or any of its precursors (Stapleton, personal communication). The plants are identical in every other way. Figure 4 demonstrates the differences in coloration of the wild type and albino plants.

Figure 4. Different phenotypes of albino and wild type plants are clearly evident after 7 days of growth.

3. DEVELOPMENTAL INSTABILITY

Homeostasis is a basic feature of living organisms that regulates the physiological processes maintaining growth, reproduction, and life itself. Stress disrupts this regulation. If organisms are undergoing development while suffering disruption, then development may be affected and compromised negatively, literally altering the way bodies grow and function (Tracy *et al*., 1995).

Tracy *et al*. (1995) defined developmental stability as "the ability of a given genotype to consistently produce a given phenotype in a particular environment." The phenotype may not accurately be produced under environmental stress, resulting in developmental instability. Developmental instability allows one to identify geographic areas in which ecosystems are stressed and to estimate the degrees of stress that an ecosystem contains (Tracy *et al.*, 1995).

Numerous researchers have shown that developmental instability increases because of changes in environmental conditions. The assessment of developmental instability is not based upon severe abnormalities but rather upon small changes in development, which become measurable at stress levels that are detrimental to the plant. Fluctuating asymmetry, the most common measure of developmental instability, "quantifies the absolute difference in the expression of a trait on the left and right hand sides of an organism" (Tracy *et al.*, 1995). This measuring approach, which is simple, inexpensive, and non- invasive, can be used for screening toxic effects or even identifying and monitoring threatened or endangered species (Tracy *et al.*, 1995).

It is not appropriate to compare variability of a trait among individuals in a population because of varying genotypes. Variability for a trait repeated within the individual implies developmental stress. Developmental invariants usually involve some sort of aspect of symmetry (Tracy *et al.*, 1995).

Deviation from symmetry is a response to stress in organisms, and conversely the return of symmetry implies the relaxation of stress. Therefore, developmental stability of specimens collected over time can reveal whether an environment is becoming more or less stressful and can be used to monitor the success or failure of remediation efforts. Measurements of morphological traits are inexpensive and can be taken from digitized photographs using automated methods in a minute or less. Obtaining these measurements requires little expertise and equipment (Tracy *et al*., 1995).

It is important to obtain several different measurements of developmental instability for several individuals. Specific measures of developmental instability are not uniform in their appearance under stress. While numerous studies have documented this effect, the biological mechanism responsible for the increase in developmental instability has yet to be found (Tracy *et al*., 1995).

4. DAMAGE BY UV

a. Damage to Photosynthesis

Photosynthesis has been shown to be partially inhibited when UV radiation is absorbed by the photo system II reaction center (Caldwell *et al*., 1989). Photo system II, which essential for photosynthesis, is one of the most vulnerable plant targets for increases in environmental UV-B irradiation. This system's sensitivity to UV stress is reflected by the negative impacts of both the oxidizing and reducing paths of photo system II (Greenber*g et al.*, 1997).

b. Damage to Growth of Plant

Another one of the most sensitive areas of a plant to UV-B radiation is the leaf surface. The total number of stomata has been found to diminish after exposure of plants to UV-B. Partial collapse of the epidermal layer in response to UV-B has been observed in several plant species. The epidermis is continuously and fully exposed to UV-B and subject to damage. Furthermore, cell division during leaf growth is inhibited by UV-B and may be the basis for changes in leaf shape. The cytoskeleton of plant cells, which carries out critical functions during cell division and expansion, is also disrupted by UV-B (Greenberg *et al*., 1997).

Midgley *et al* (1998) found that the symmetry of the plant's leaves (leaf fluctuating asymmetry) was altered by exposure to UV during the development of the plant. This significant effect of UV-B history on leaf fluctuating asymmetry strongly suggests a negative impact of this stress on plant developmental stability. The leaf fluctuating asymmetry was significantly increased by greater numbers of enhanced UV-B exposures in the parentage of the seed. The dose-response was found have a linear to exponential relationship with the number of UV- B exposures. This relationship suggests that damage to DNA caused by UV exposure during plant development may not be fully repaired and then be inherited by offspring and accumulated over successive generations. Thus, the data suggest that the activity of

UV-B induced DNA mutation caused the seen impaired growth of the plants in their study (Midgley *et al.*, 1998).

Midgley *et al.* (1998), also feel that their data imply that UV-B irradiation has been found to result in subtle alterations in growth of different plant organs. Examples of found changes include altered-internode-length of leaf and stem production. These morphological changes may allow one species to intercept more sunlight than others, and thus change the competitive interactions of various species (Caldwell *et al.*, 1989).

5. UV DAMAGE ASSESSMENT TECHNIQUES

a. Weight Measurements

Dry weight and fresh weight both were measured in this study for UV effects. Dry weight is the leaf mass when the water weight is evaporated. A substantial lower leaf mass implies a less healthy plant. In other studies, wild type maize that have been exposed to elevated UV doses have been found to have lower dry weight when compared to wild type control groups (Stapleton, personal communication).

The fresh weight takes into account the attained water weight of the leaf. A significant change in fresh weight (water weight) as a result of elevated UV exposure can be caused by many different things, such as the quantity of available water, the amount of heat present in the environment, or the degree to which stomata open.

b. Fluctuating Asymmetry

An inexpensive technique that indicates the health of the plant is the measurement of fluctuating asymmetry (FA). Fluctuating asymmetry is a measure used to analyze the phenotypic quality or fitness, and has been used widely in biological studies to reveal both direct and indirect effects of environmental stress on organism developmental stability. FA in a bilateral organ is a form of asymmetry. FA is calculated as the absolute difference between right and left hand sides, which shows a normal distribution around a mean of zero. Because FA in a bilateral organ is a form of asymmetry, zero represents optimal genetic expression. Degrees of deviation from this benchmark imply degrees of affecting stress. Leaf fluctuating asymmetry may constitute a relatively sensitive yet inexpensive means of quantifying UV-B damage to plants (Midgley *et al.*, 1998).

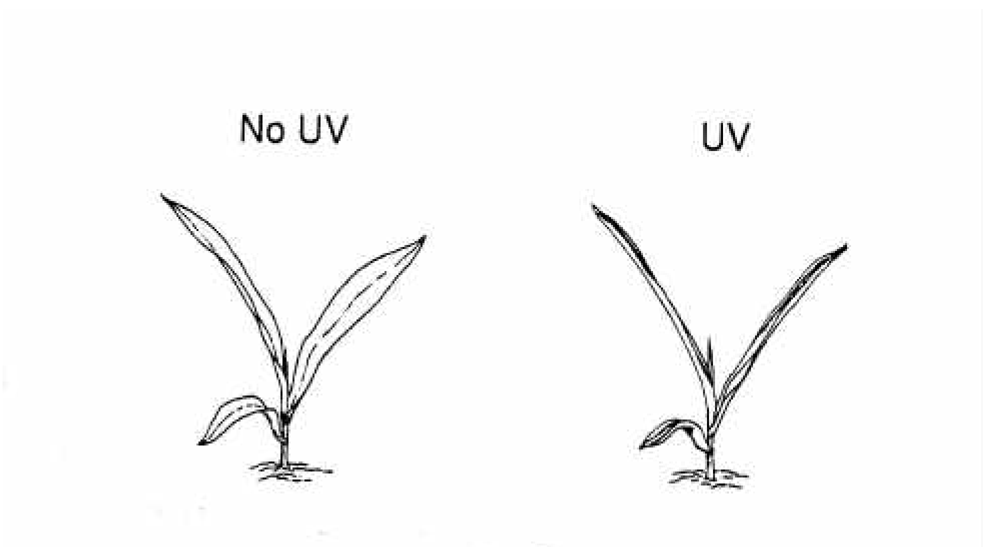
c. UV Induced Leaf Rolling

The leaves of maize have been seen to become rolled as a response to elevated UV dosages (Greenberg *et al.*, 1997). Refer to Figure 5 (p.11) for an illustration of leaf rolling. The flat/ rolled ratio is the measurement that quantifies the leaves' rolled response. This process was developed by previous studies in Dr. Ann Stapleton's lab at the University of Tennessee at Chattanooga. Flat/ rolled ratio is established by making imprints with ink of the rolled and flat length of a leaf, measuring the edge-to-edge distance of the imprints with a calibrator, and then creating a ratio of the values. Leaves that are curled inward are given a positive value of curl (usually UV exposed leaves) and leaves that are curled outward are considered to have a negative curl (usually control plants) (Stapleton, personal communication).

The leaf curling response to UV has been documented as having a threshold response. The UV induced leaf rolling has not been found to increase steadily with amount of dosage. On the contrary, the UV exposure must reach a threshold amount before any leaf curling is seen. Leaf curling is a response to UV damage in the plants and is easily and inexpensively measured by taking the flat/rolled ratio of the plant's leaves (Stapleton, personal communication).

Leaf curling could possibly be a protective mechanism to protect the plant from UV damage. The leaf curling provides less leaf face surface area to be exposed to the UV radiation, perhaps minimizing plant damage that other non-rolling leaves would obtain (Stapleton, personal communication).

Figure 5. Illustration of UV-induced rolled phenotype.



Non-Rolled Leaves (Normal) **Rolled Leaves (UV damaged)**

B. HYPOTHESIS DEVELOPMENT

There has been no direct study that links UV induced photosynthesis damage as causing UV induced morphological responses. The general assumption might be that UV induced damage to photosynthesis is linked to reduced growth. Past studies, such as Greenberg *et al.* (1997), have shown reduction in photosynthesis and reduction in plant growth in separate tests. Ballare *et al.* (1992) report that Tevini and Teramura (1989) have reviewed much of the literature on the effects of UV-B on plants. Tevini and Teramura (1989) confirm that in most controlled- environmental experiments with UV radiation, morphological responses are usually accompanied by reductions in photosynthesis and total growth (Ballare *et al.*, 1992). Because reductions in photosynthesis and reductions in growth are correlated, it has been assumed that they are related (Fiscus *et al.*, 1995).

Plant growth has been shown to be reduced by UV-B to a greater extent than would be expected simply from reduced photosynthesis rate. This growth reduction has been attributed to other by-products of the changed environment and leaf properties and/ or direct DNA damage (Caldwell *et al.*, 1989).

Another study reports that DNA damage in plants has not been eliminated as an important result of elevated UV-B also possibly causing many disruptions in growth. “Relatively low fluence rates [of UV-B radiation waves] may result in many disruptive effects at the molecular level, notably dimer formation in DNA” (Midgley *et al*., 1998).

Ballare *et al.* (1992) state “a number of effects of UV-B on morphology are difficult to interpret as mere by-products of photosynthetic inhibition.” It has been suggested that a number of UV-B effects cannot be attributed to photosynthesis. Leaf elongation and shoot length have been shown to be affected by UV-B radiation while not affecting photosynthesis. These morphological effects of UV-B may be the consequence of disturbing effects of UV-B on the cellular functions other than photosynthesis. In fact, the behavior of the morphological effects resembles those obtained for DNA damage and does not imply photosynthesis damage (Ballare *et al.*, 1992).

Fiscus *et al.* (1995) question the relevance of the focus on photosynthesis damage from UV radiation. “The effects of UV-B on photosynthetic processes seem to be less ambiguous than those on growth and yield.” Numerous studies have demonstrated that UV-B exposures of sufficient magnitude can have deleterious effects in almost every area of photosynthesis. There exists a question whether “these effects are relevant to the crop production environment expected to occur with projected stratospheric ozone depletions” (Fiscus *et al*., 1995).

The hypothesis of this study is that developmental instability, or other morphological changes seen in elevated UV exposure, is not induced from UV damage of photosynthetic apparatus. This study uses three different measures of UV stress: the dry weight of the leaves, fluctuating asymmetry of the individual leaves, and UV induced leaf rolling.

C. PREDICTION

If the albino mutant plants’ damage from the UV radiation is equivalent to the wild type plants’ damage, then the photosynthesis characteristic does not play a role in morphological defects seen in the plant. If photosynthesis of the plant contributes to the reduced growth of the plant, then elevated morphological differences will be seen in the wild type only.

III. MATERIALS & METHODS

a. Albino maize mutants and wild type maize

Albino maize mutants (*Zea mays* L.) were compared to wild type maize in order to isolate the photosynthesis component from possible other components of UV induced damage. Two inbred heterozygous lines were used (lines J-30 and J-31 were selfed by Dr. Stapleton). These seeds have an expected ratio of 3:1 of wild type to albino plants respectively. The seeds were planted approximately 1 cm deep in non-nutrient vermiculite and allowed continuous access to water. The seedlings were allowed to grow for approximately 5 days or until the first leaves were revealed. Then, these plants were subjected each day to a varying amount of UV radiation during their development. Their overall health was then assessed.

The maize were planted in sectional flat trays containing non-nutrient vermiculite. These flat trays contained 48 different units, housing one seed per unit. The plants were exposed to UV in the University of Tennessee at Chattanooga green house, using UV chambers containing Hubbell Lighting, Inc. lamps with Light Source UV-B bulbs. The exposure period was regulated with a Intermatic Heavy Duty timer. The control group also was placed in a chamber, but the UV lamps were shielded with Mylar plastic sheets. The UV-B radiation output of the lamps was measured by Solar Light Company Meter (PMA2100) and connecting UV-B probe (PMA2101).

The measurements of the leaves taken in this study (fluctuating asymmetry, dry weight, fresh weight, and flat/rolled ratio) also required equipment. To collect these measurements a calibrator, ruler, weight scale, incubator, ink, and a ink roller were used. Imprints of the leaves required the use of super glue, clear glass slides, and a microscope. The collected data was entered into the computer programs of STATVIEW, SPSS, and ORIGINS to conduct statistical analyses and make graphs.

b. Measurements taken

The study began by focusing on the measurement of fluctuating asymmetry to reveal UV damage. However as time proceeded, the fluctuating asymmetry measurements had not shown that it was affected by UV treatments at all. At elevated UV exposure periods, curling of the leaves was observed and incorporated into the UV stress assessment for the study. Dry weight and fresh weight measurement were also taken throughout the study to see if any noteworthy difference occurred. While the study began by focusing on one UV stress measurement, fluctuating asymmetry, another UV stress measurement, flat/rolled ratio, incorporated later, actually yielded results at the exposure periods being studied.

Each plant's second and third leaf was weighed right after it was cut from the plant for its fresh weight. After the fresh weight was measured, the leaves were put in a 65^{o} Celsius incubator for 3-5 days. The incubator dried the leaves to eliminate any water weight that was attained by the plants during growth. After they were dried, each leaf was measured for its dry weight, which indicates the true leaf mass

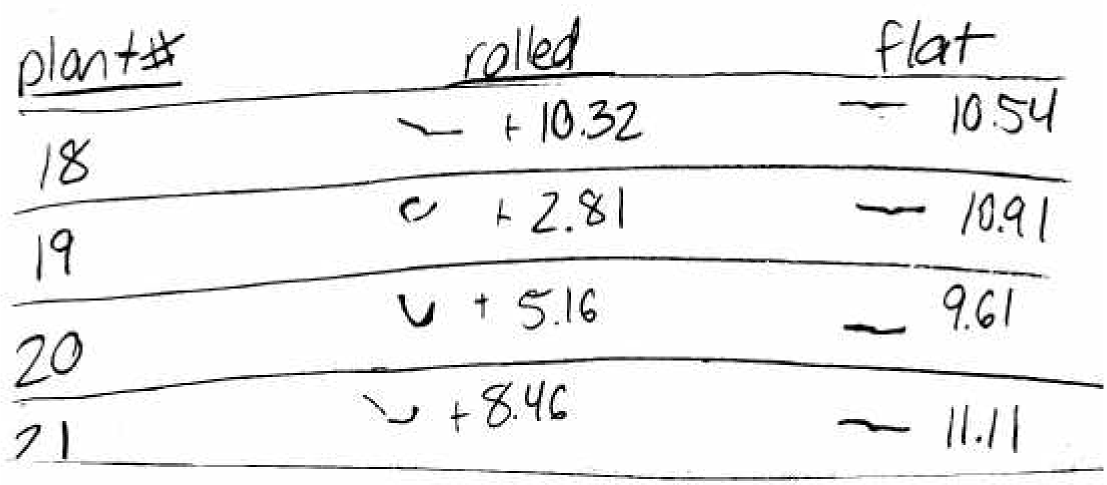
Fluctuating asymmetry was calculated for the second and third leaf of each plant. Each leaf's left width and right width were measured and then the leaf's FA was calculated by using the following equation:

FA= absolute value (left width- right width)/ (left width + right width)

The flat/rolled ratio measurement assessed leaf rolling as it was induced in maize exposed to elevated levels of UV. Leaf rolling was not observed until three hours of UV exposure. In these trials, the second or third leaf was cut mid-way, still preserving the original shape of the leaf. The cross-section was then dipped in ink and an imprint was made of the rolled shape. The leaf was then lengthened to its flat shape. For both rolled and flat imprints, the edge-to-edge distance of the cross-section was measured using calibrator. Figure 6 portrays an example of the flat/ rolled procedure. Then the flat/ rolled ratio was found by using the following equation:

Ratio= Flat length/ Rolled length

Figure 6. Original ink imprints of cross-section of leaves used for flat/rolled ratio method.



c. UV Intensity Used

Both the control and the experimental groups were placed under UV lamps, but a Mylar sheet of plastic that filtered out the UV-B radiation covered the control group's UV lamp. To ensure the UV dosages that were received by the plants the output of the UV lamps were measured. The UV lamp with covering UV-B filtering plastic emitted approximately 0.0 microwatts / cm^2 through to the control group. The UV lamp that was not covered with the plastic and housed the experimental groups emitted approximately 26.1 microwatts / cm^2. The green house shielded the plants from all the UV emitted by the sun. The UV emitted by the lamps was the only UV radiation endured by the plants.

d. UV Exposure Times

Each trial was subjected to a certain length of UV exposure for a certain amount of days. The normal exposure times for a trial continue from ½ hr to 3 hrs for 7 to 8 days. The length of exposure per day was multiplied by the number of days exposed to get the total number of hours exposed. Please refer to Figure 5, on page 15-16 for a detailed description of the UV treatments.

Figure 7. The description of UV treatment on each trial and date of treatment.

J-31	Exposure period/ day	Total # of days exposed	Total Hours of Exposure to UV	Date of first UV exposure	Appendix page number
Trial A	½ hr.	8 days	4 hours	8-14-00	I
Trial B	½ hr.	7 days	3 ½ hours	9-21-00	II
Trial C	1 hr.	8 days	8 hours	2-14-00	III
Trial 1	2 hrs.	8 days	16 hours	5-7-01	IV
Trial 2	2 hrs.	8 days	16 hours	5-23-01	V
Trial 3	2 hrs.	8 days	16 hours	5-31-01	VI
Trial 5	3 hrs.	8 days	24 hours	6-20-01	VIII
Trial 6	3 hrs.	8 days	24 hours	7-10-01	IX

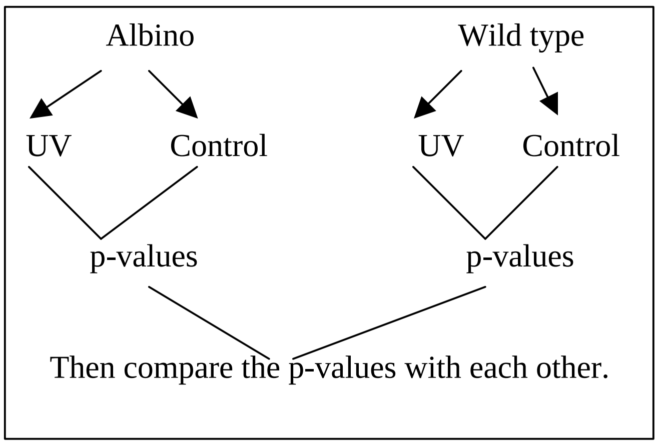
J-30	Exposure period/ day	Total # of days exposed	Total Hours of Exposure to UV	Date of first UV exposure	Appendix page number
Trial 3	2 hrs.	8 days	16 hours	5-31-01	VI
Trial 4	3 hrs.	7 days	21 hours	6-12-01	VII
Trial 7	3 hrs.	8 days	24 hours	7-11-01	X

It should be noted that Trial 3 contained both J-30 and J-31. For the J-31 line in this trial, there were not enough Albino plants (must be at least three plants) to do a statistical analysis. Because of the lack of albino J-31 subjects, the data collected for trial 3 was J-31 wild type data and J-30 albino and wild type data, without any J-31 albino data.

e. Statistical Analysis and Graphs

In this study, there are two different groups (albino and wild type) that contain two subgroups (UV and control). We cannot directly compare albino and wild type data because one uses photosynthesis and the other does not- producing different responses, but we can expose the groups to the same treatment and compare the differences. We can then look for differences in the significance data (p-values) to assess whether chlorophyll is playing a role in the UV reaction. We can deduce that chlorophyll is playing an active role when one p-value is significant and the other is not, because we know that the only difference between the two groups is the presence of chlorophyll.

Figure 8. Experimental technique and statistical comparisons.



The data for fluctuating asymmetry, fresh weight, dry weight, flat/rolled ratio as they were gathered for each trial were typed into STATVIEW. A means table for each group was computed along with the error for the data set. The data was then converted to SPSS to complete a Mann Whitney-U test, based on the presence or absence of chlorophyll (or albino vs. wild type), to retrieve p-values for the in-strain comparisons. The means table from STATVIEW was graphed in ORIGINS and labeled with the p-values from SPSS. The dose-response curves were also graphed in ORIGINS.

Utilizing the total hours of exposure, dose-response regression curves were made for each measurement (dry weight, fresh weight, fluctuating asymmetry, and flat/rolled ratio). The dose-response regression curve was graphed for each data point for both the J-30 and J-31 lines. The total length of exposure was graphed on the x-axis while the individual values for fresh weight; dry weight, FA, or flat/ rolled ratio was graphed on the y-axis. A best-fit curve was found for the data. Its function is presented on its graph.

IV. RESULTS

In the following graphs, the letters above the bars represent the mean of the set. If there is a significant difference between the two means, the bars will be given two different letters, both colored in blue. If there is no significant difference, the bars will be labeled with the same letter.

a. Dry Weight

The dry weight data contain no significant differences throughout the exposure periods, for either the J-31 and J-30 lines. Examples of this non-significant relationship can be seen in Graphs 12 (p.29), and 25 (p.36). No significant difference implies that there was no noteworthy differences in leaf mass between the UV exposed and control plants for either the wild type or the albino strains when exposed to UV in the manner of this study. No significant difference also suggests that the UV dosages used in this study were not strong enough to produce a significant change in the dry weight of the data.

b. Fresh Weight

The data show that there were significant differences in fresh weight. The fresh weight measurements are first seen to change significantly at the 3-½ hour level

(Graph 7, pg.27). The albino plants in trial C (J-31) had a significant difference between the groups that were and were not exposed to UV. Changes in fresh weight traditionally can be attributed to many different variables, however because the plants are in the same environment, all environmental conditions should be the same and any significant difference seen should be a result of the presence or absence of chlorophyll. The significant difference found would suggest that the chlorophyll is active in some role in stabilizing attained water weight when exposed to elevated UV. The significant difference seen in trial C albino data was not seen in any other exposure period. Because the result was not repeated, this result cannot be explained.

Also, a significant difference was seen in the fresh weight measurement of more extreme UV exposure. Trial 5 (J-31, 24 hours) and trial 4 (J-30, 21 hours) wild type groups both showed a significant decrease in fresh weight when exposed to UV as apposed to the albino data that contained no significant difference. These differences are demonstrated for J-31 and J-30 respectively in Graph 18 (p.32) and Graph 29 (p.38). This finding would imply that photosynthesis is actually attributing to the loss of water weight of the leaves. When the exposure period was repeated for both lines, trial 6 (J-31) and trial 7 (J-30) the significant differences observed in the first trials were not seen again. Because the result was not repeated, this effect of chlorophyll on fresh weight cannot be explained.

c. Fluctuating Asymmetry

The results also show that, throughout the UV exposure times, there was never a significant difference in fluctuating asymmetry. Examples of this non-significant relationship can be seen in Graphs 19 (pg.33), and 27 (pg.37). There were no significant differences in any of the groups, albino or wild type. From this absence of response, we can deduce that the UV exposure lengths used in this study must not have been long enough to cause an effect in fluctuating asymmetry.

d. Flat/ Rolled Ratio

At about 24 hours of exposure (trial 4 and 5, for J-30 and J-31 respectively), the leaves of the plants exposed to UV became rolled. Refer to Graphs 20 (pg. 33) and 24 (pg.35) for J-31 demonstration; Graphs 31 (pg. 39) and 35 (pg.41) for J-30. This exposure period was the first instance that leaf flat/ rolled ratio was measured- but also the first trial where leaf rolling was observed. In this time exposure for J-30 and J-31, the leaf flat/ rolled ratio was seen to significantly change in both the albino and wild type plants. When the exposure periods were repeated for both lines (trial 6 & 7, J-31 and J-30 respectively), the significant change was again seen. Because both the plants with chlorophyll and the plants without chlorophyll were affected in the same manner, it suggests that chlorophyll is not influencing the impaired health of the plant.

e. Effectiveness of Measurements Used

The effectiveness of the study's techniques at measuring UV stress can also be inferred from the results. In this study, dry weight and fluctuating asymmetry did not respond at all to the methods and duration of exposure. On the other hand, the measurement of leaf rolling, flat/ rolled ratio, did respond to the UV exposure levels used in the study. Flat/ rolled ratio detected a significant change in leaf growth when the other measurements did not. From the results, we can see that flat/ rolled ratio is a more sensitive measurement of ultraviolet radiation stress than the measurements of dry weight or fluctuating asymmetry.

f. Dose Response Curves

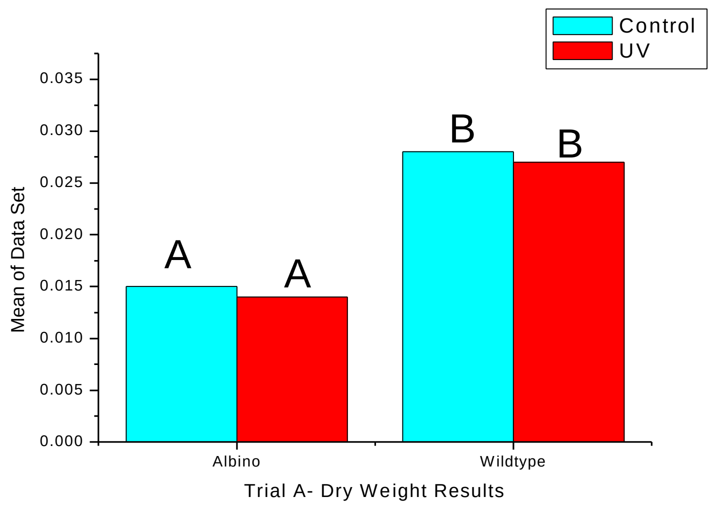
The dose response curves present a possible predictable relationship between UV exposure and the maize line's reaction. These curves are done for the overall purpose of attempting to predict the UV effect on maize of albino or wild type strains. If the direction or shape of the relationship is much different between the albino and wild type lines within the strain, then we possibly could contribute the difference to the presence or absence of chlorophyll. More data points need to be gathered and incorporated in the curve for it to have a possibly valid predictive ability.

A. Means Bar Graphs

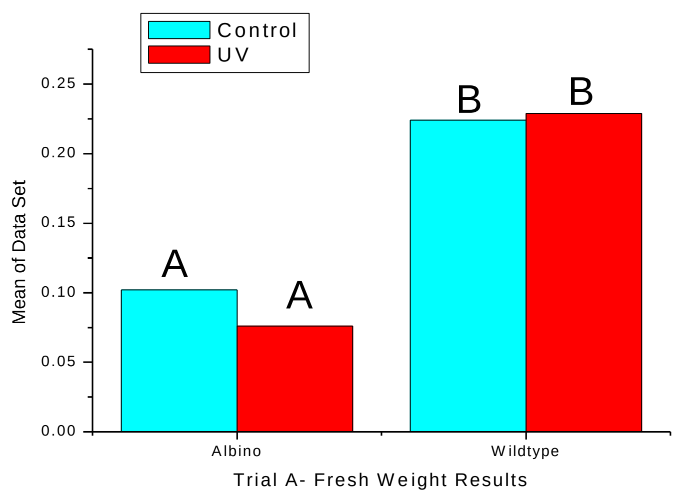
J-31 Results

TRIAL A RESULTS: J-31; 4 hrs UV (1/2 hrs/day for 8days)

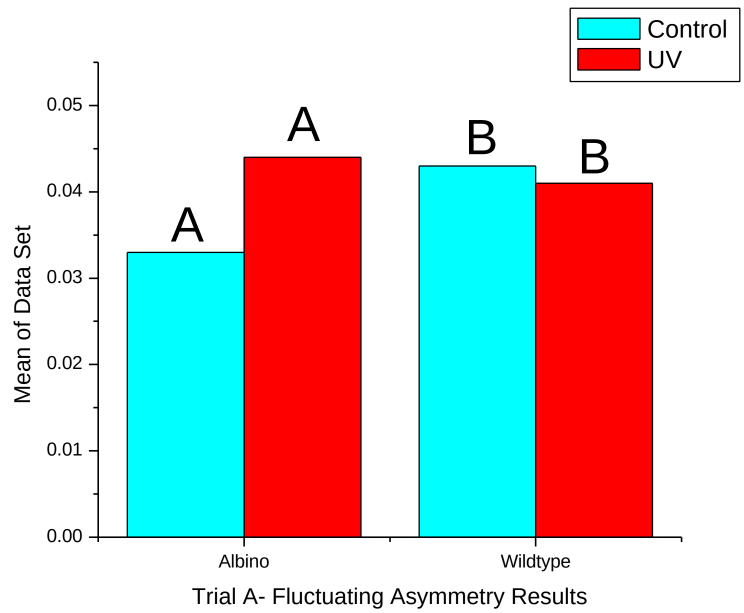
1. Dry Weight Graph



2. Fresh Weight Graph

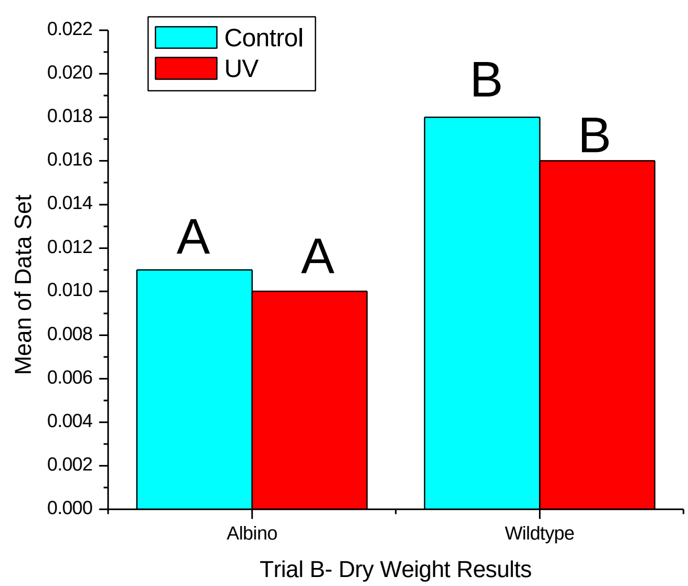


3. <u>Fluctuating Asymmetry Graph</u>

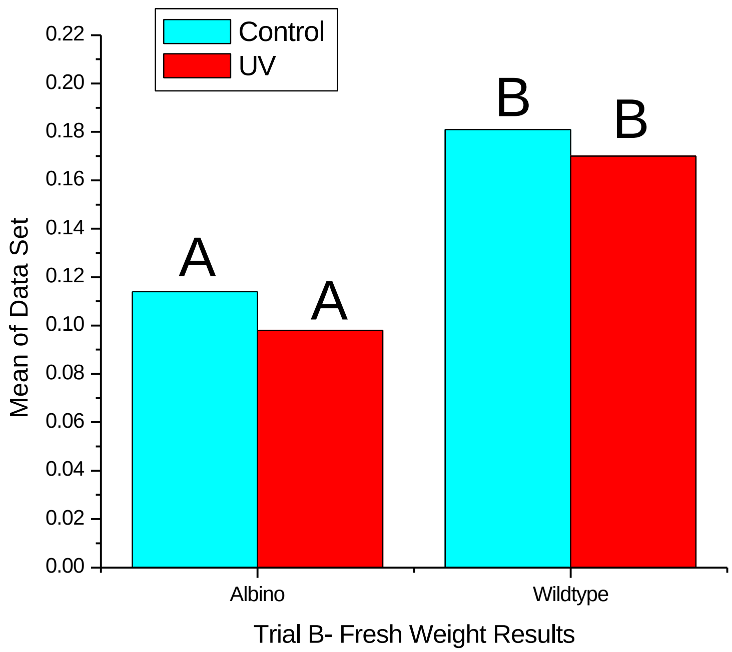


TRIAL B RESULTS: J-31; 3 1/2 hrs UV (1/2 hrs/day for 7days)

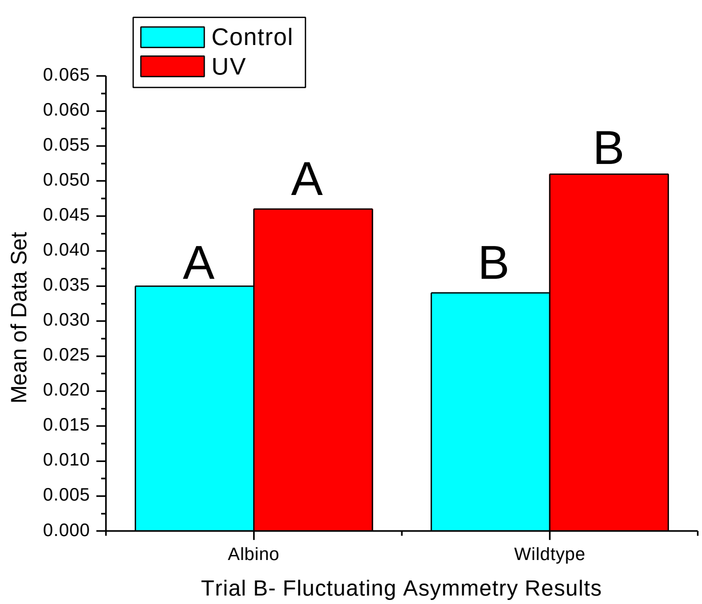
4. <u>Dry Weight Graph</u>



5. <u>Fresh Weight</u>



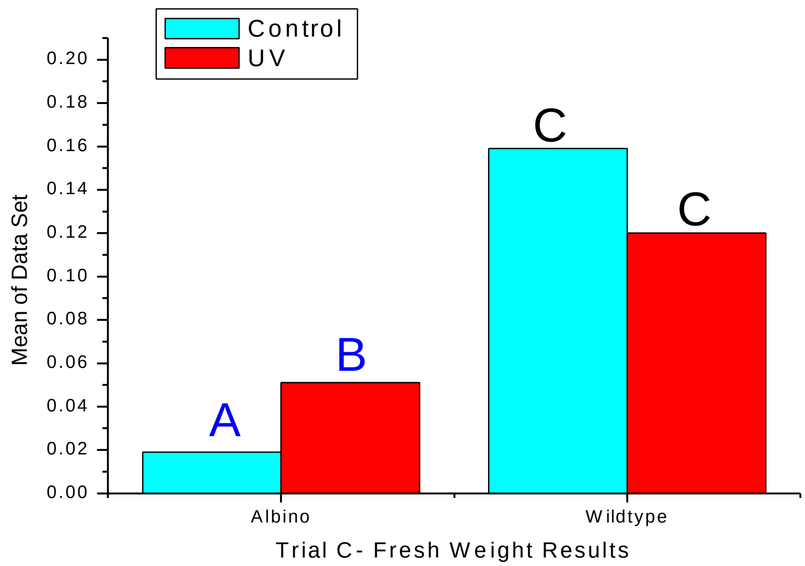
6. <u>Fluctuating Asymmetry</u>



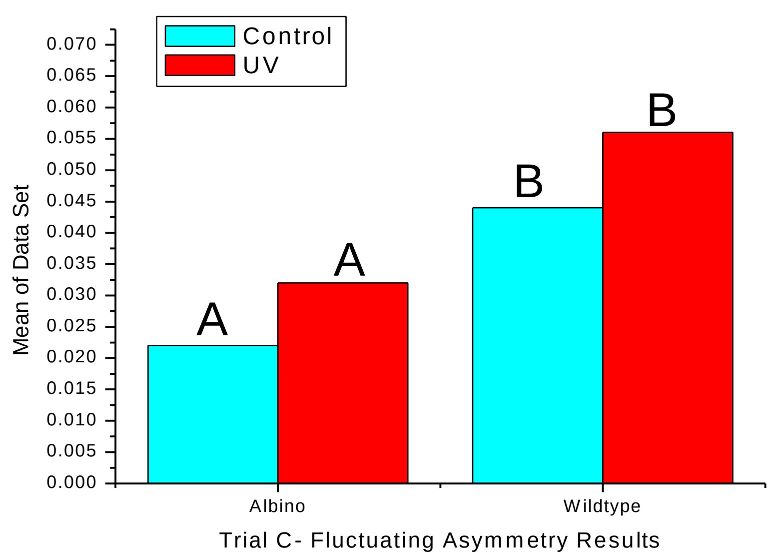
TRIAL C RESULTS: J-31; 8 hrs UV (1hr/day for 8days)

*Dry weight was not measured in this trial because of human error

7. Fresh Weight Graph

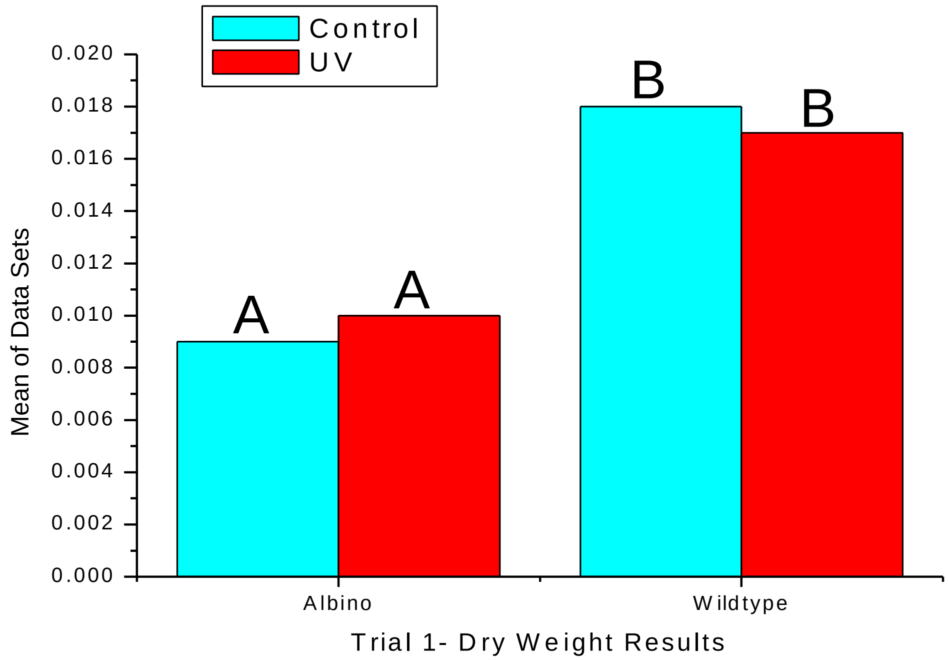


8. Fluctuating Asymmetry Graph

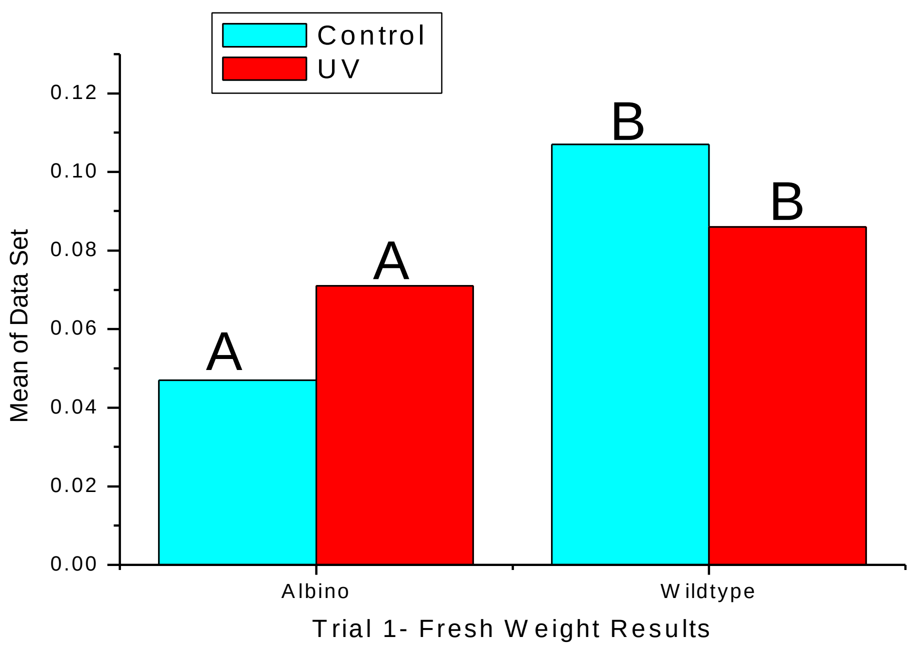


TRIAL 1 RESULTS: J-31; 16hrs UV (2hrs/day for 7days)

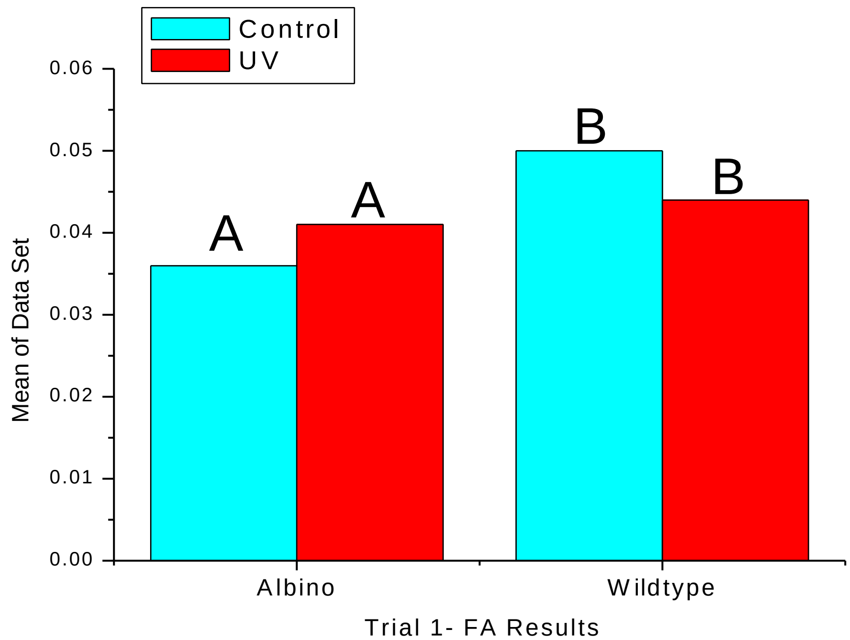
9. Dry Weight Graph



10. Fresh Weight Graph

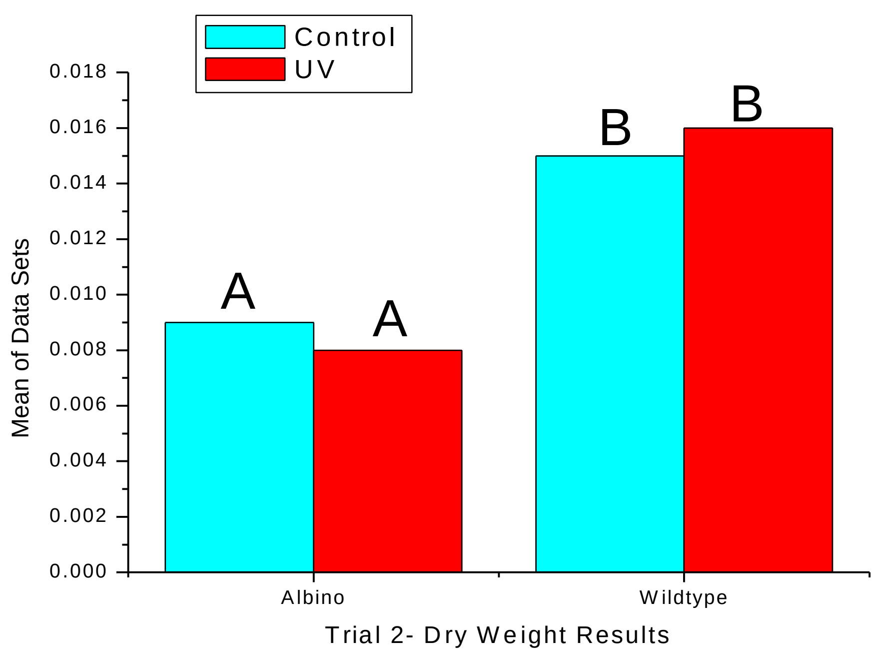


11. Fluctuating Asymmetry Graph

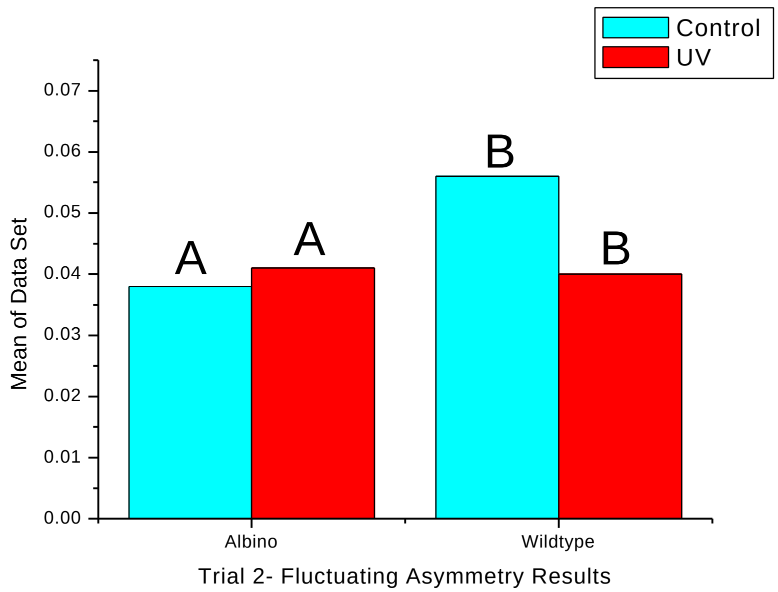


TRIAL 2 RESULTS: J-31; 16hrs (2hrs/day for 8days)

12. Dry Weight Graph



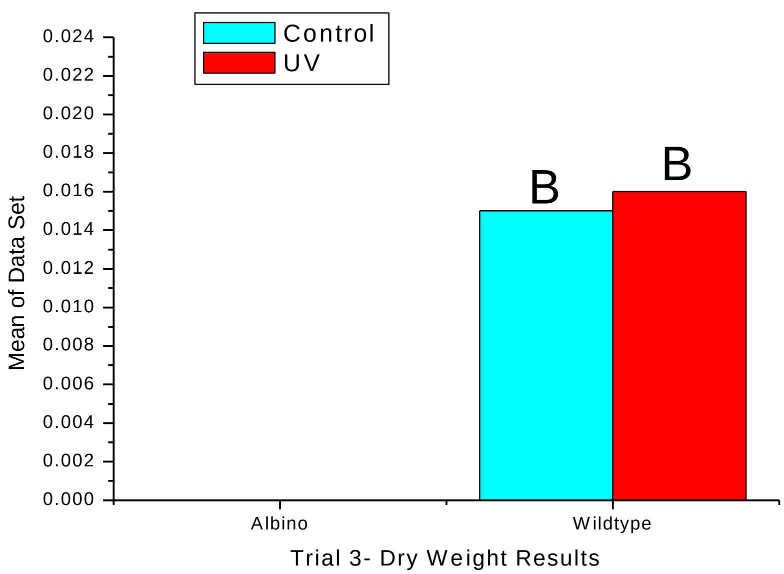
13. Fluctuating Asymmetry Graph



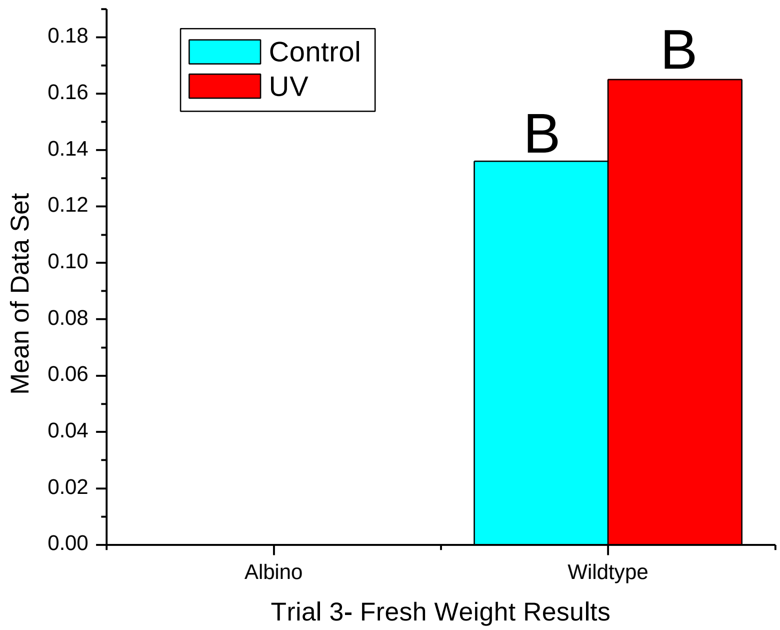
TRIAL 3 RESULTS: J-31, 16 hrs (2 hrs/day for 8 days)

*No albino data was measured for this trial because there were less than 3 albino J-31 individuals. There must be at least three individuals of every group for statistical analysis.

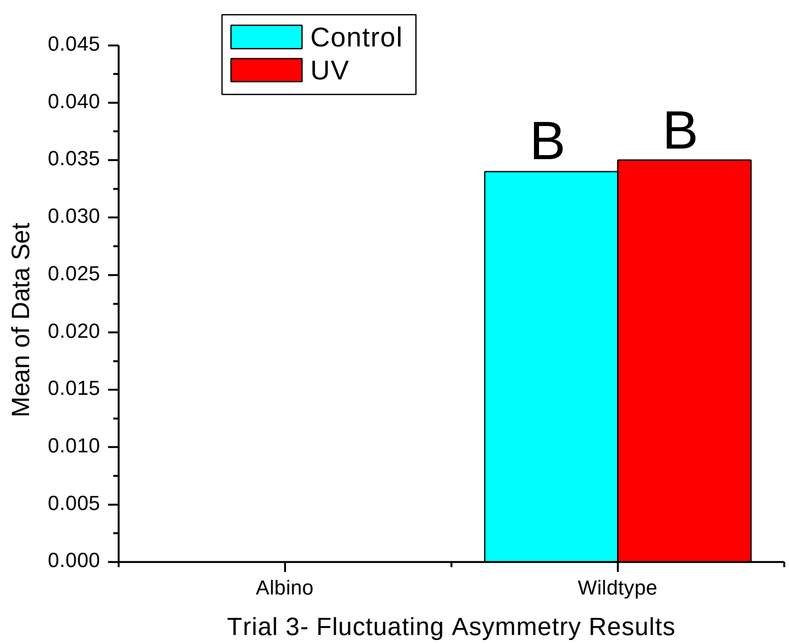
14. Dry Weight Graph



15. Fresh Weight Graph

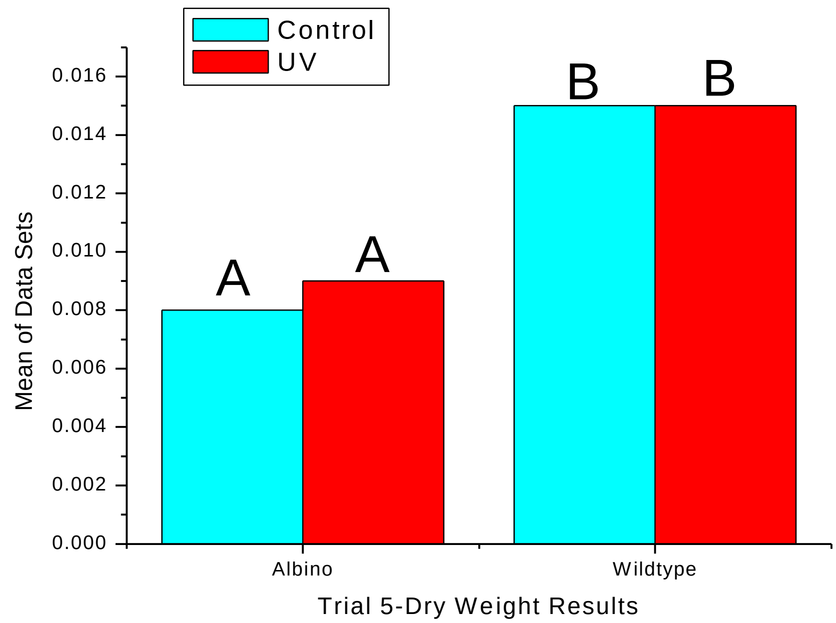


16. Fluctuating Asymmetry Graph

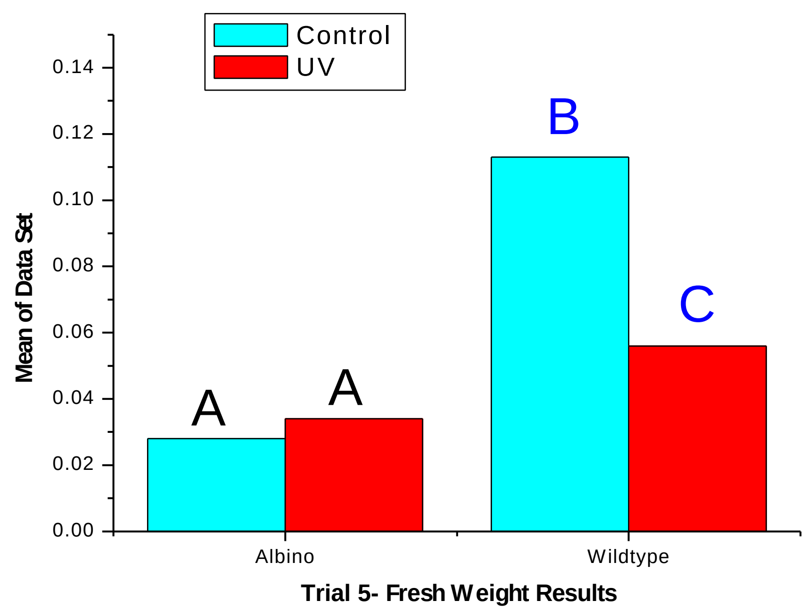


TRIAL 5 RESULTS: J-31, 24 hrs (3 hrs/day for 8 days)

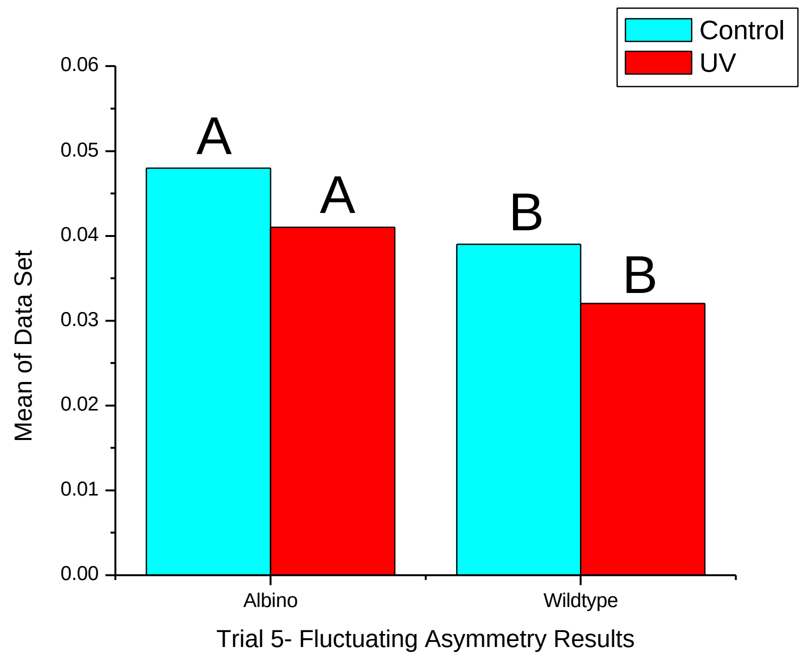
17. Dry Weight Graph



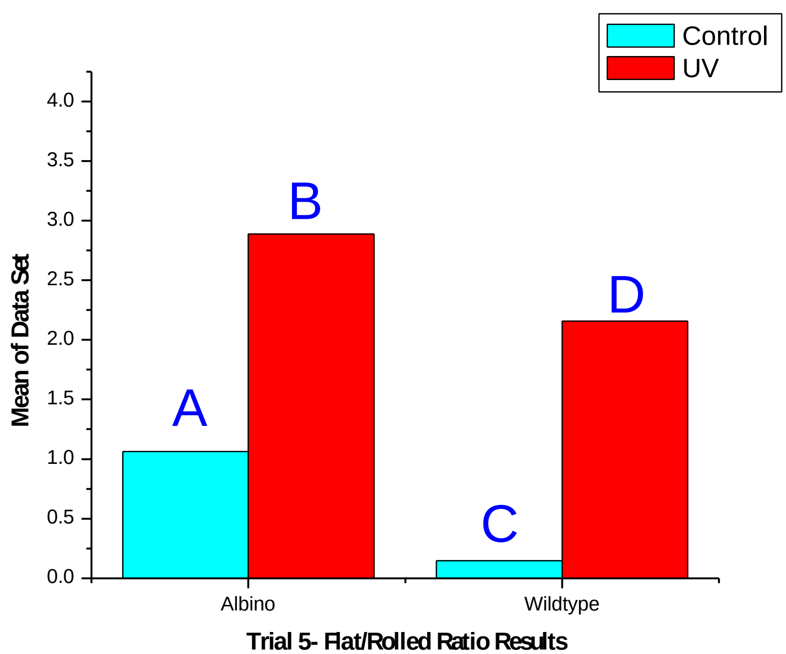
18. Fresh Weight Graph



19. Fluctuating Asymmetry Graph

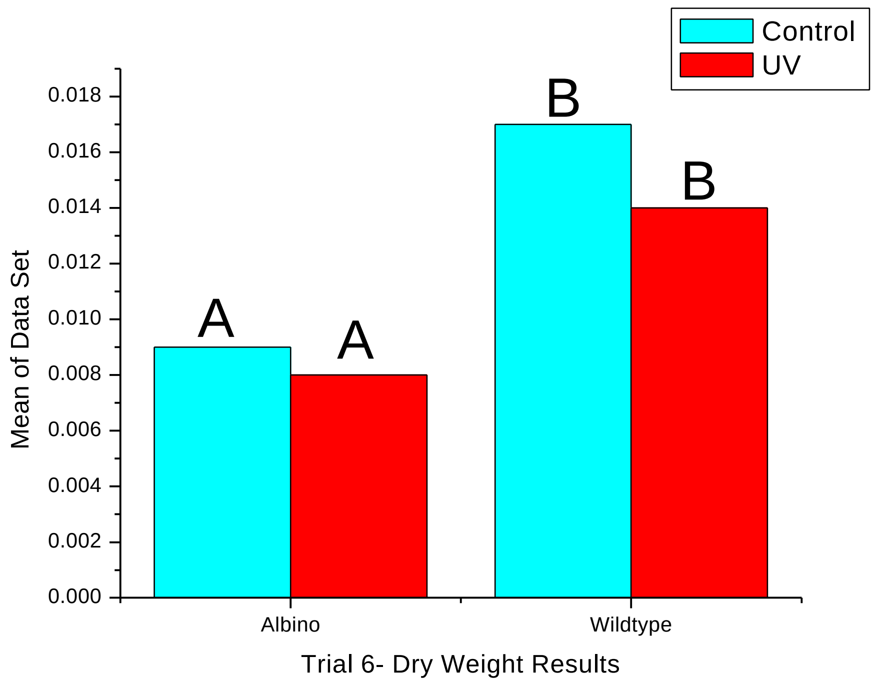


20. Flat/ Rolled Ratio Graph

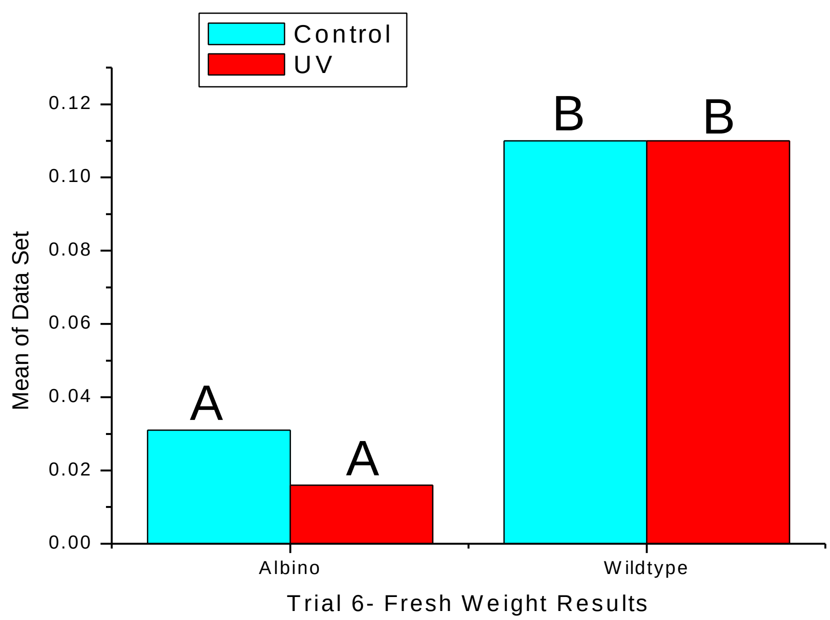


TRIAL 6 RESULTS: J-31, 24 hrs (3 hrs/day for 8 days)

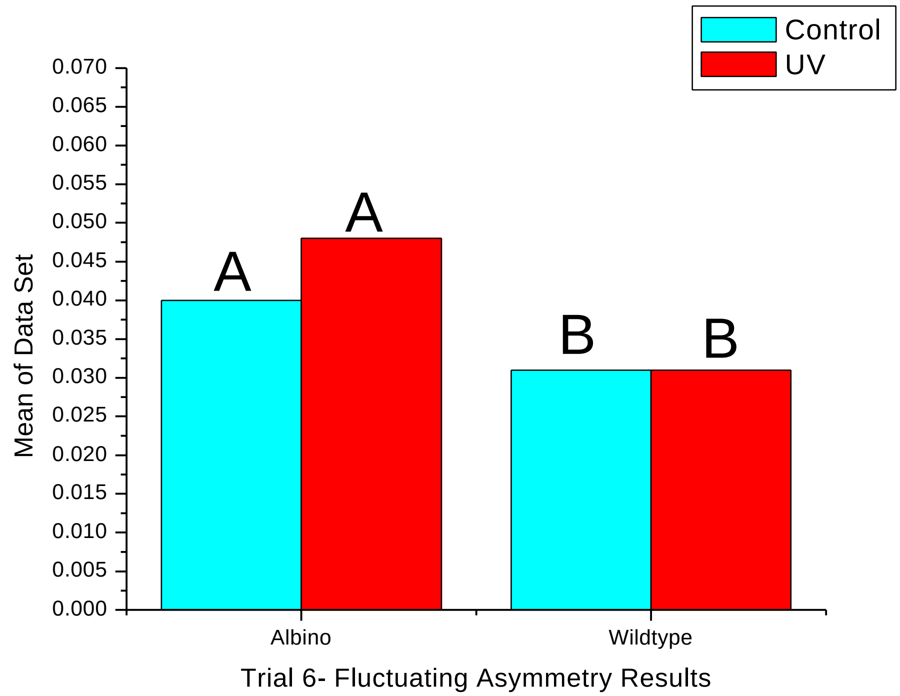
21. Dry Weight Graph



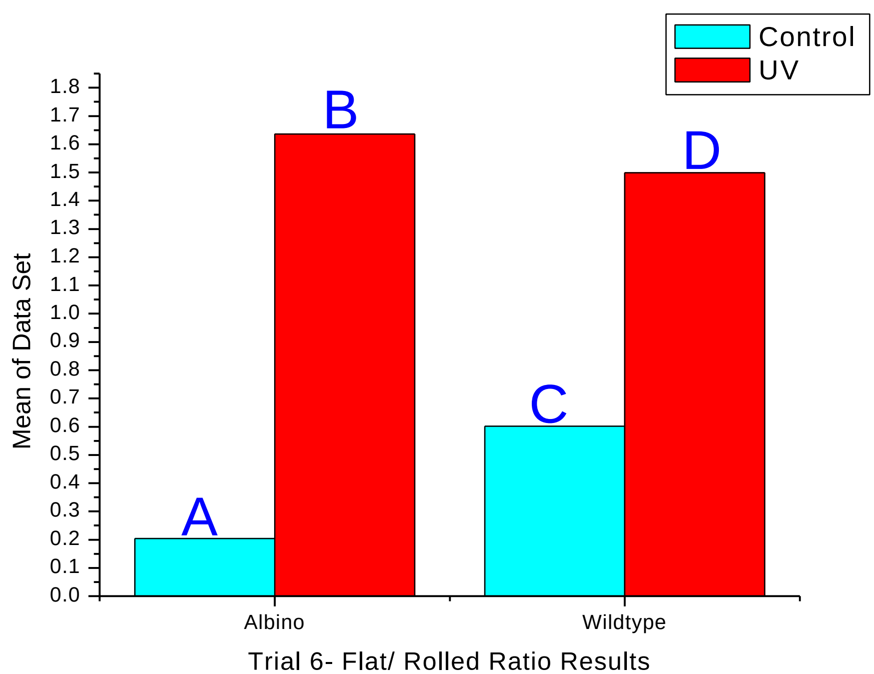
22. Fresh Weight Graph



23. <u>Fluctuating Asymmetry Graph</u>



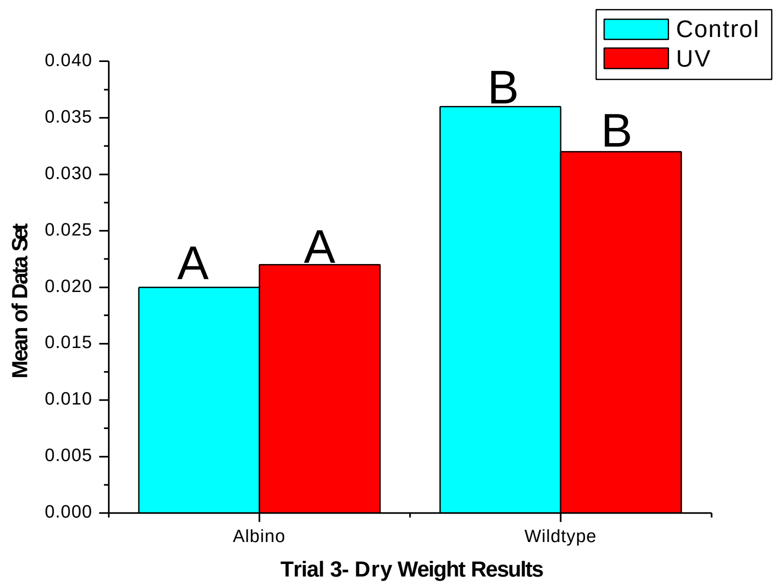
24. <u>Flat/ Rolled Ratio Graph</u>



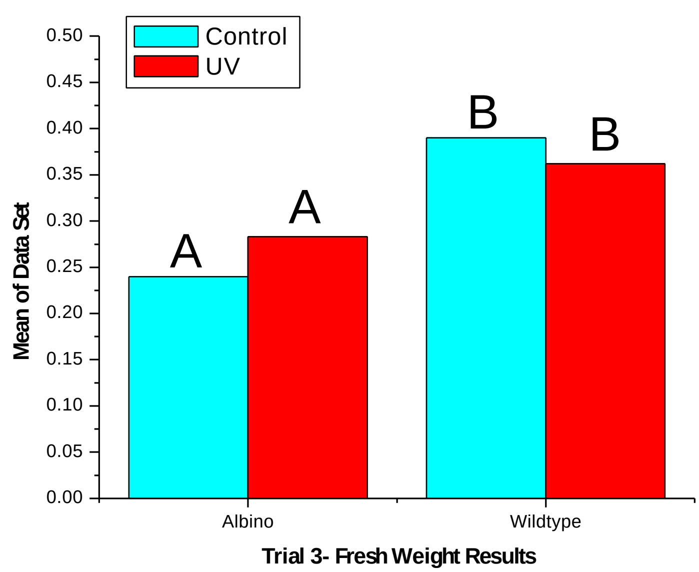
J-30 Results

TRIAL 3 RESULTS: J-30 16 hrs. (2hrs/ day for 8 days)

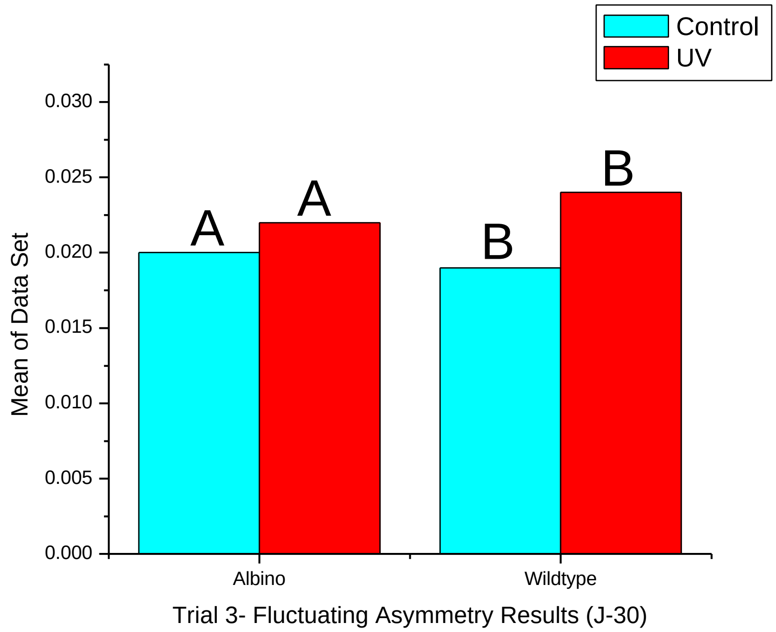
25. Dry Weight Graph



26. Fresh Weight Graph

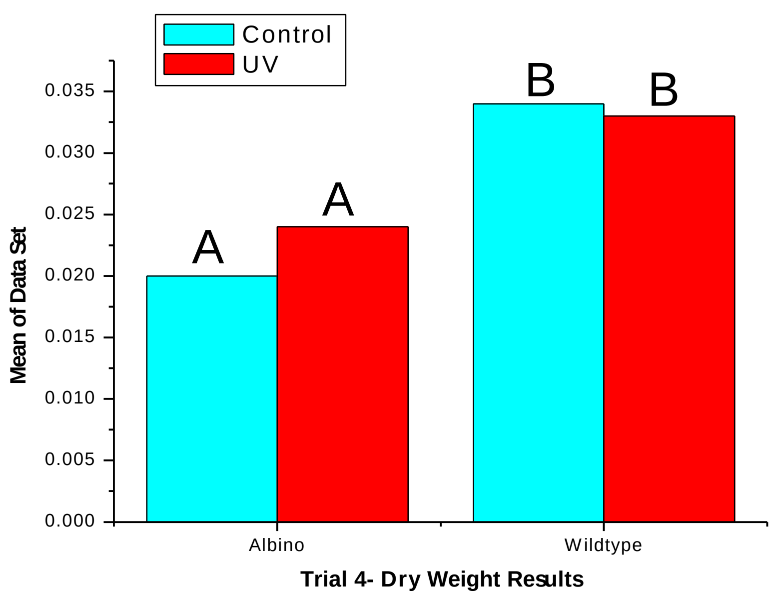


27. Fluctuating Asymmetry Graph

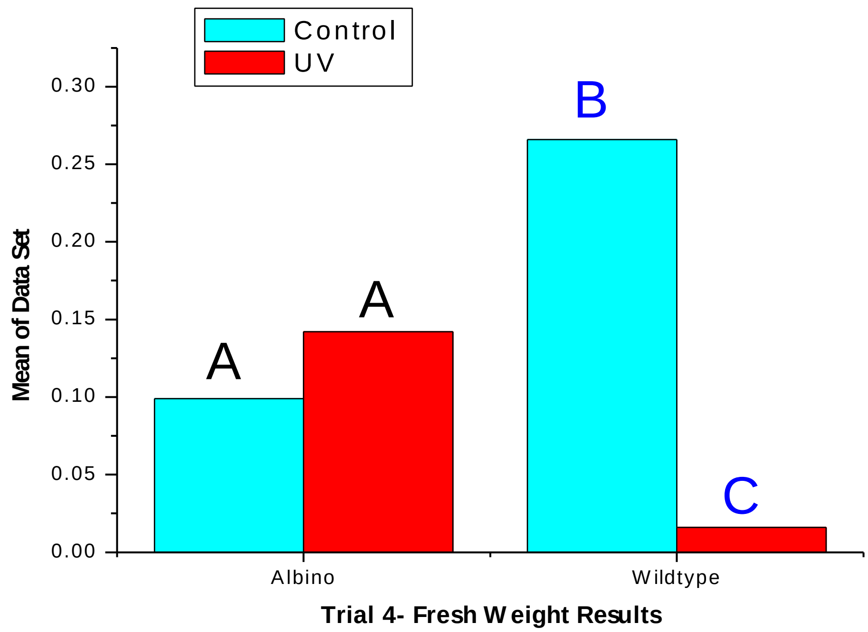


TRIAL 4 RESULTS: J-30; 21 hrs. (3 hrs/day for 7 days)

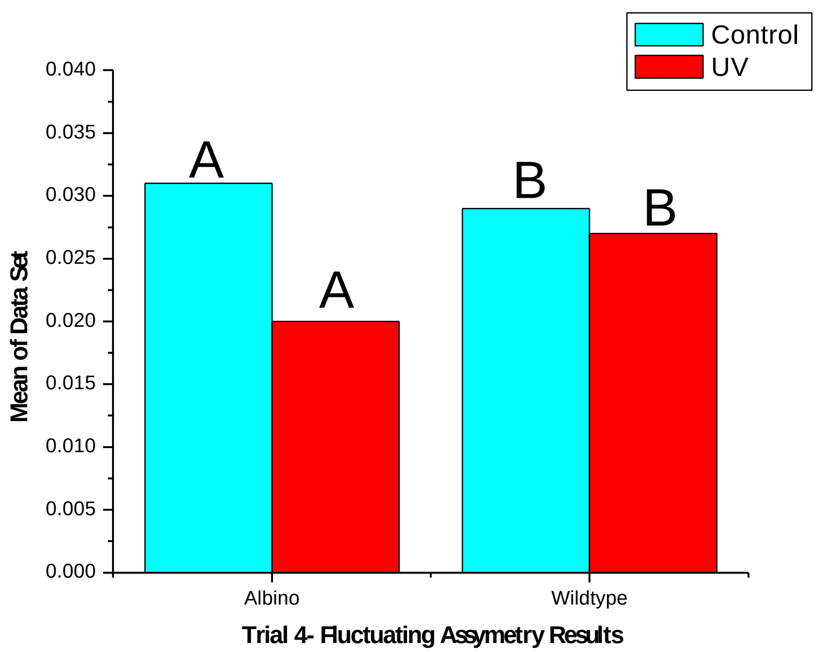
28. Dry Weight Graph



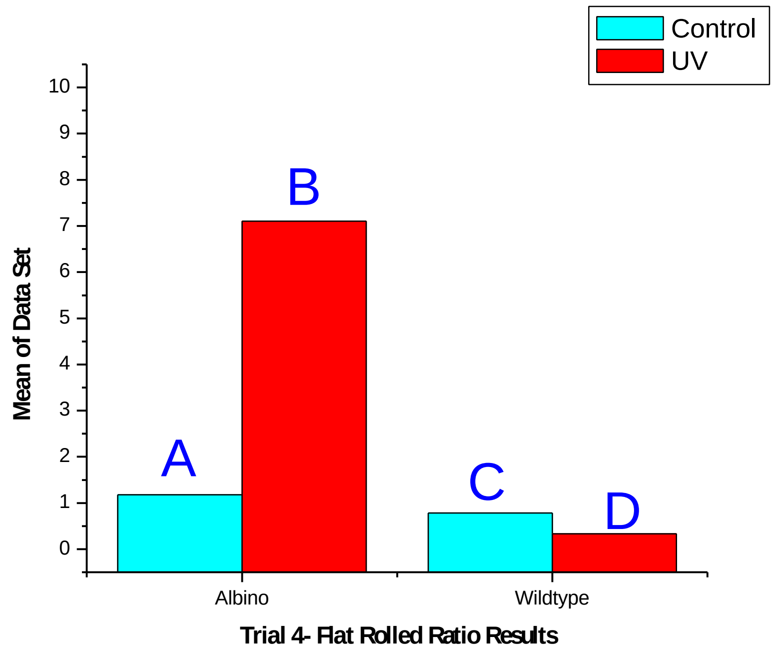
29. Fresh Weight Graph



30. Fluctuating Asymmetry Graph

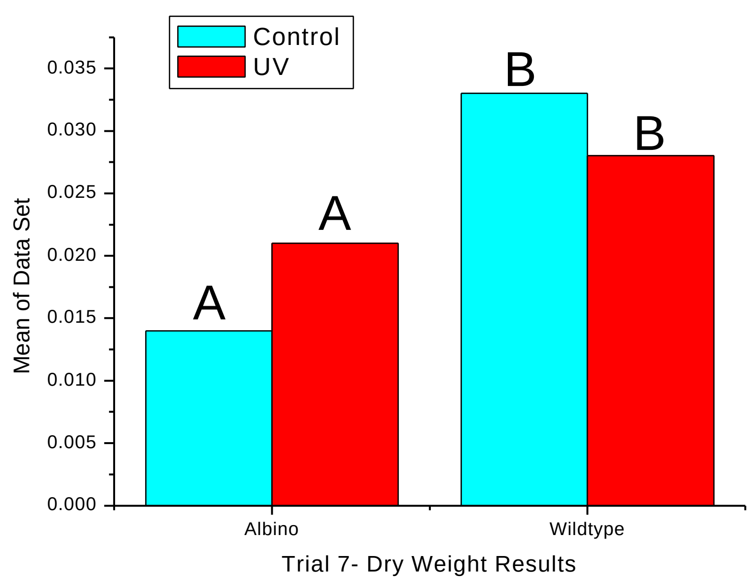


31. Flat/ Rolled Ratio Graph

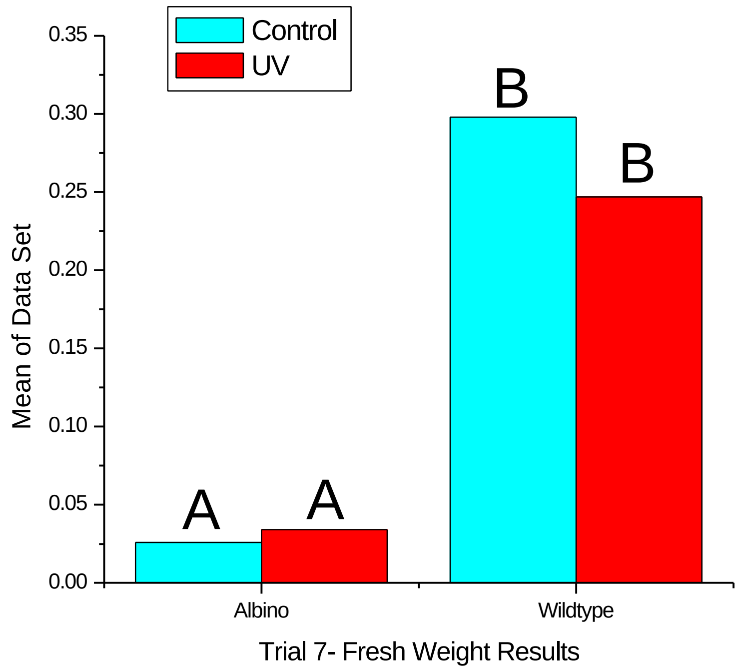


TRIAL 7 RESULTS: J-30; 24 hrs. (3 hrs/day for 8 days)

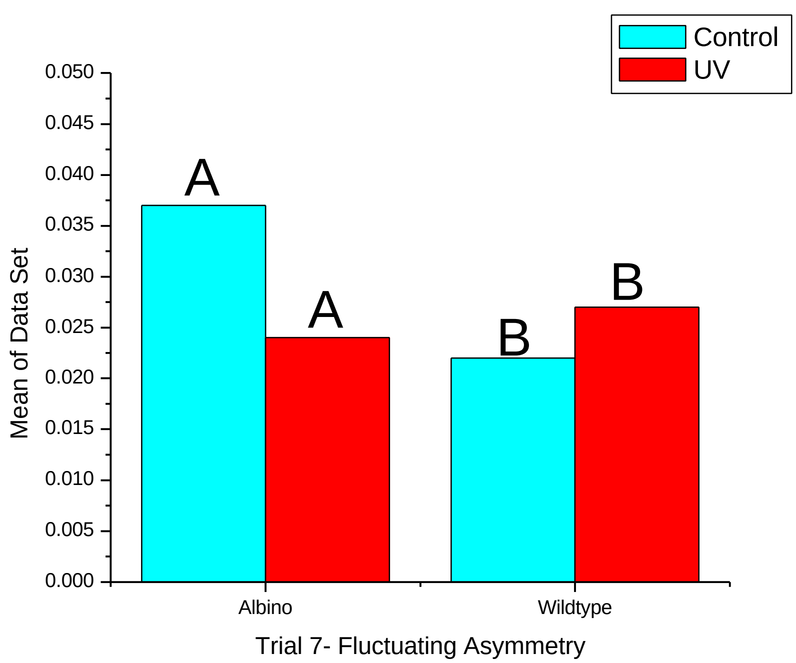
32. Dry Weight Graph



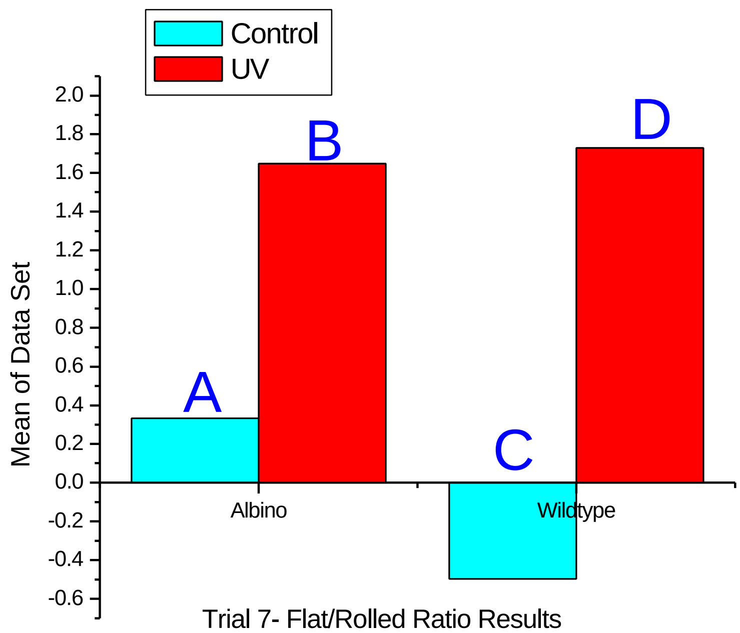
33. Fresh Weight Graph



34. Fluctuating Asymmetry Graph



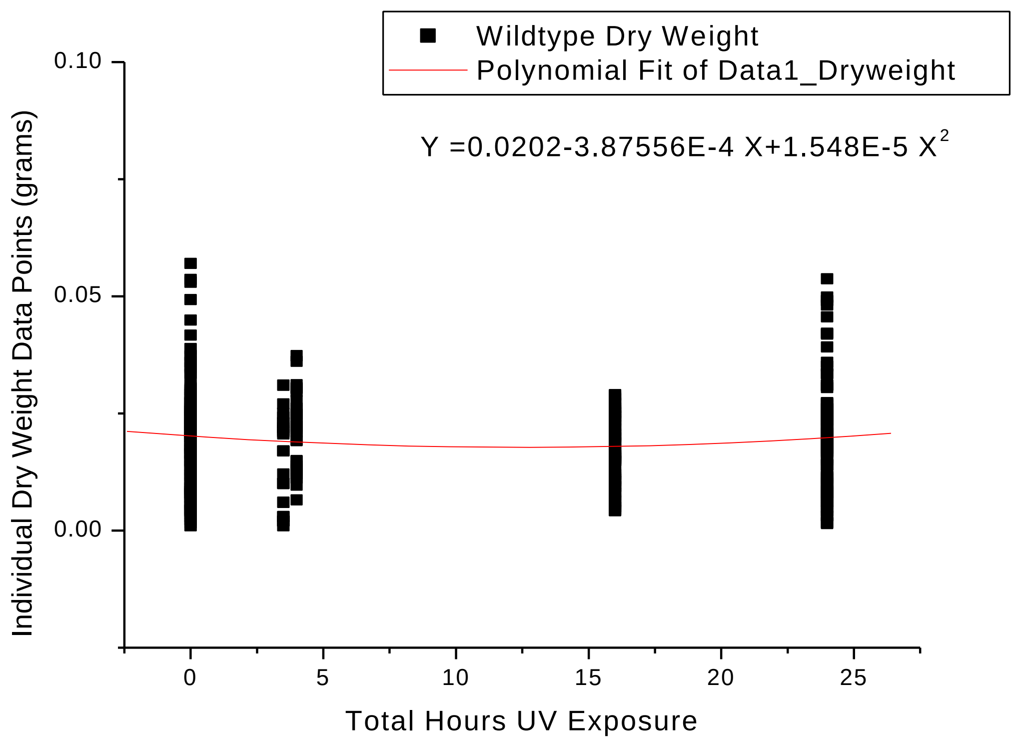
35. Flat/ Rolled Ratio Graph



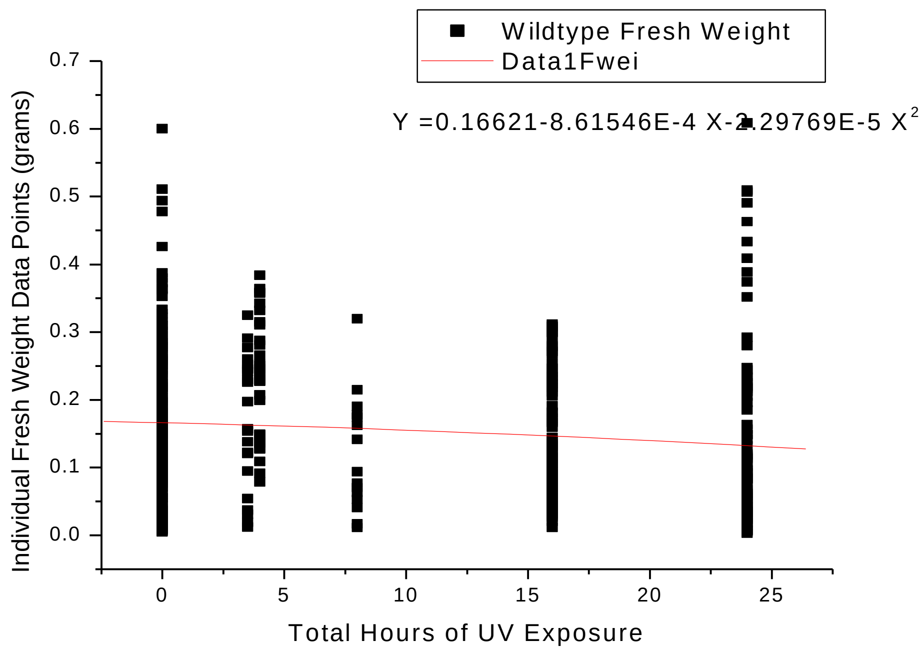
B. Dosage Response Curves

J-31 Wildtype UV Response Curves

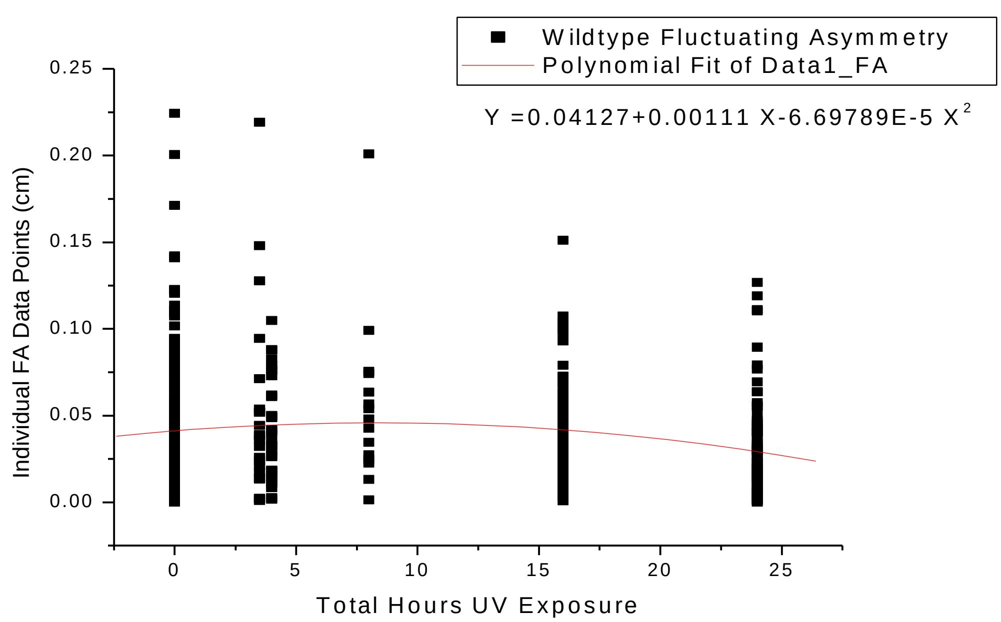
36. Dry Weight



37. Fresh Weight

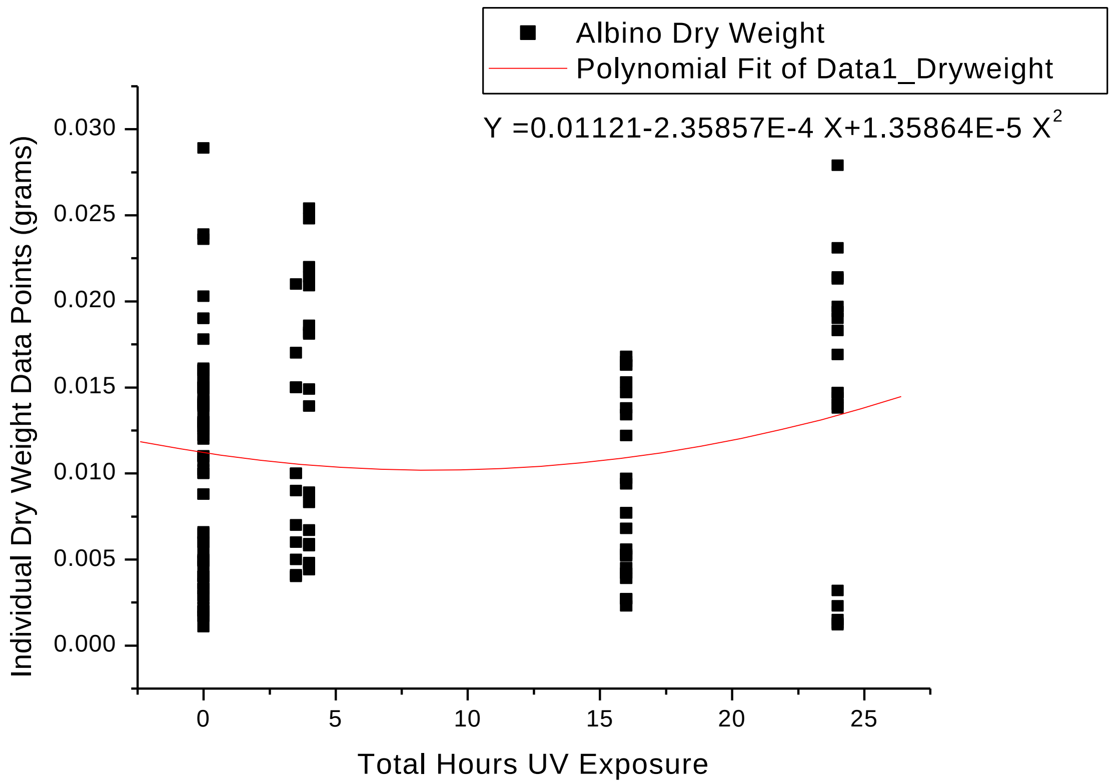


38. Fluctuating Asymmetry

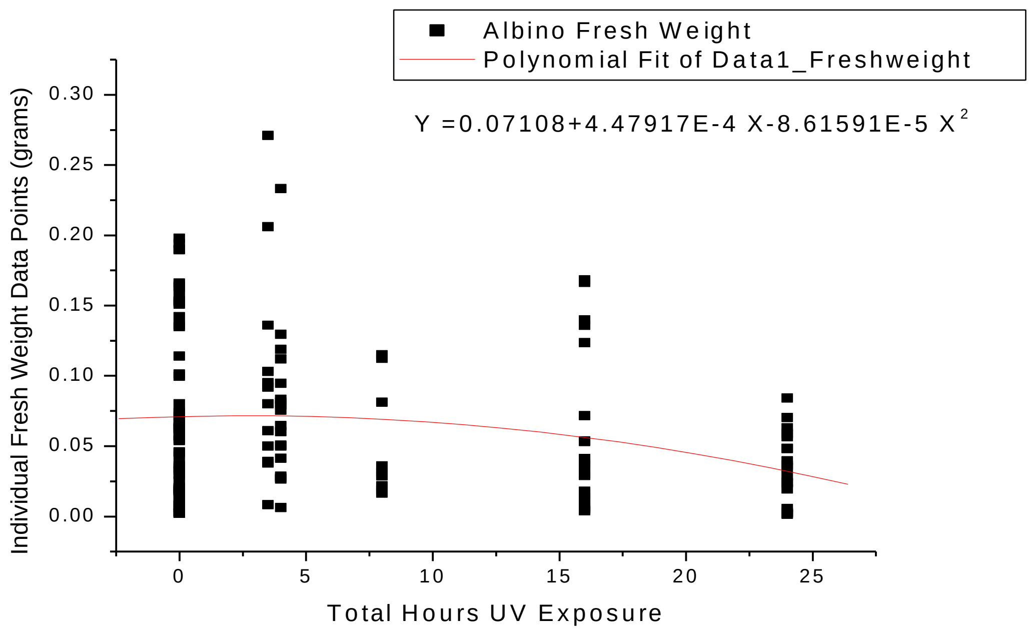


J-31 Albino UV Response Curves

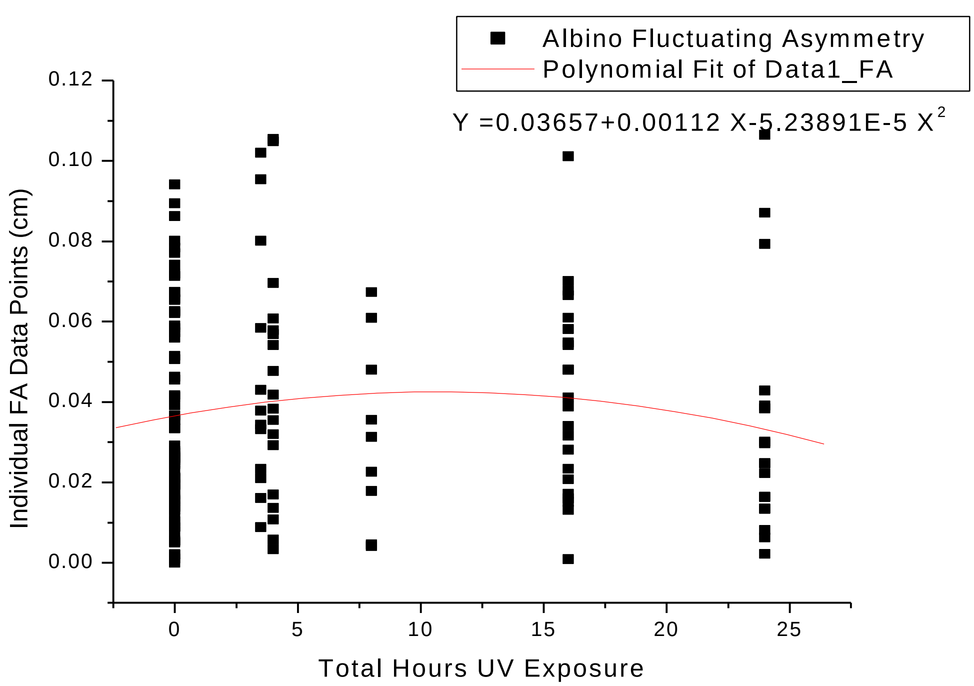
39. Dry Weight



40. Fresh Weight

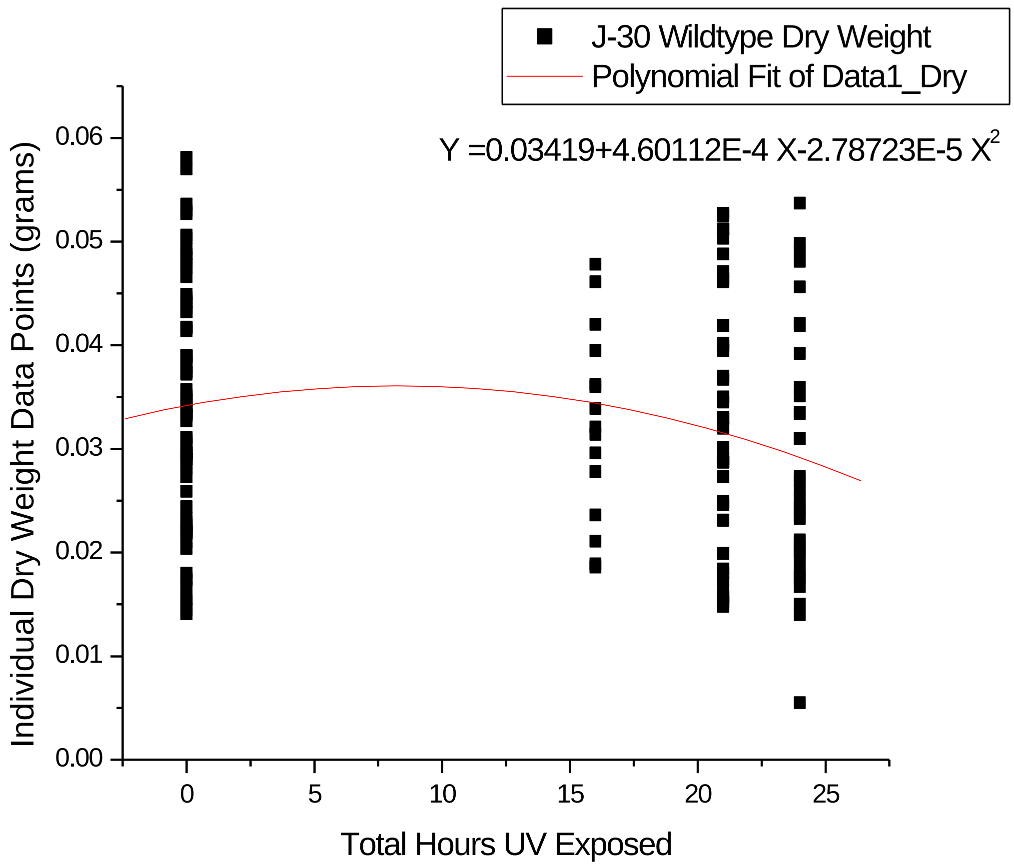


41. Fluctuating Asymmetry

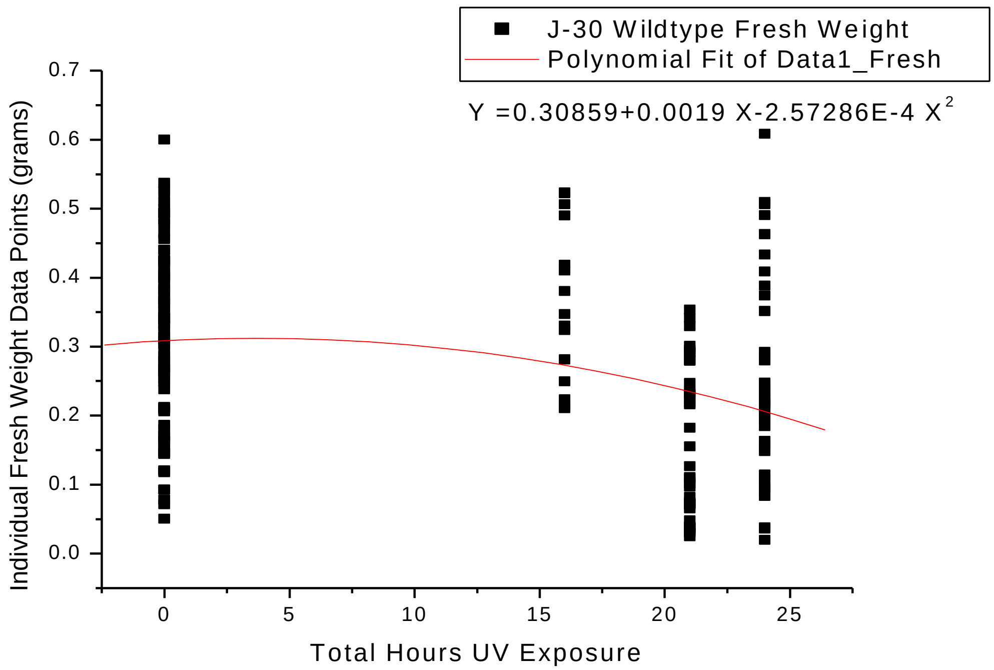


J-30 Wildtype UV Response Curves

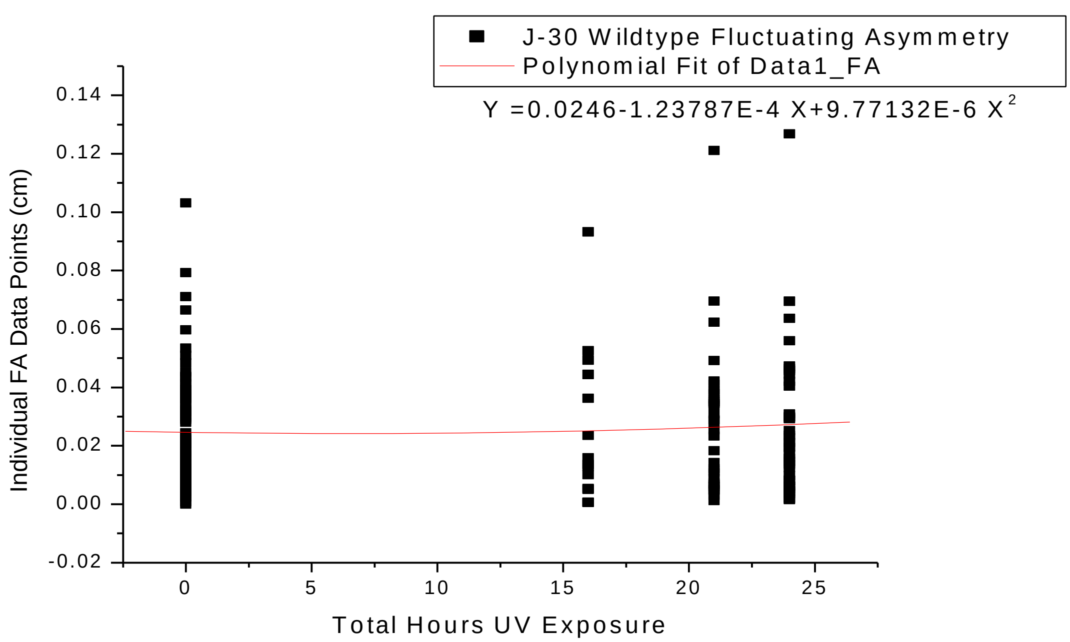
42. Dry Weight



43. Fresh Weight

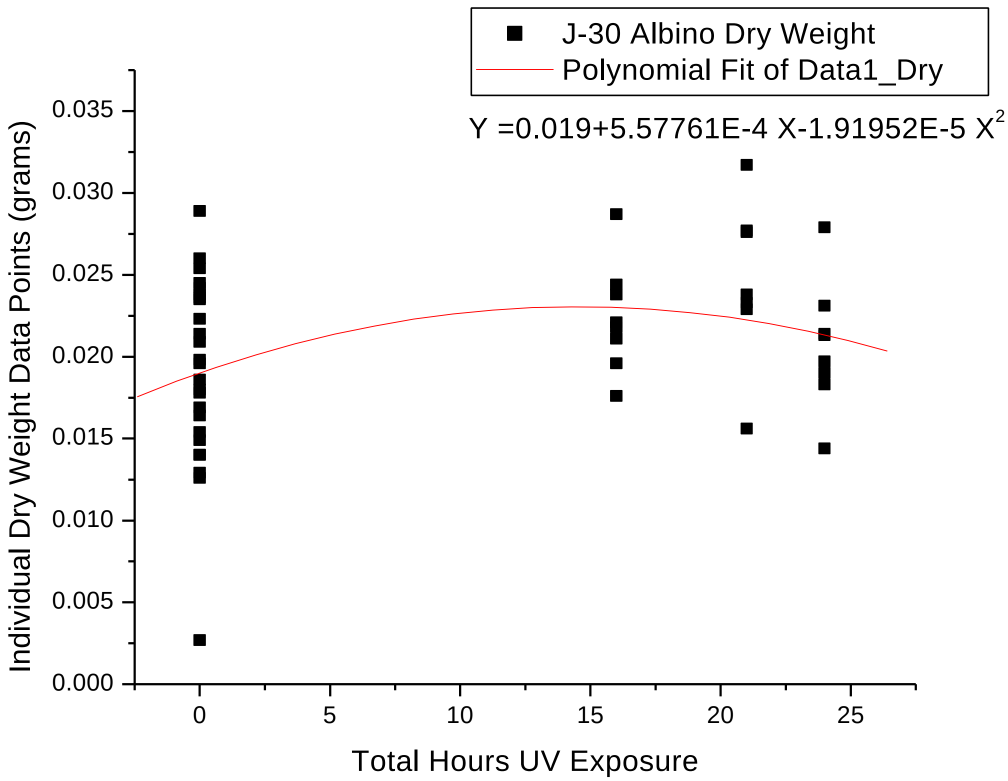


44. Fluctuating Asymmetry

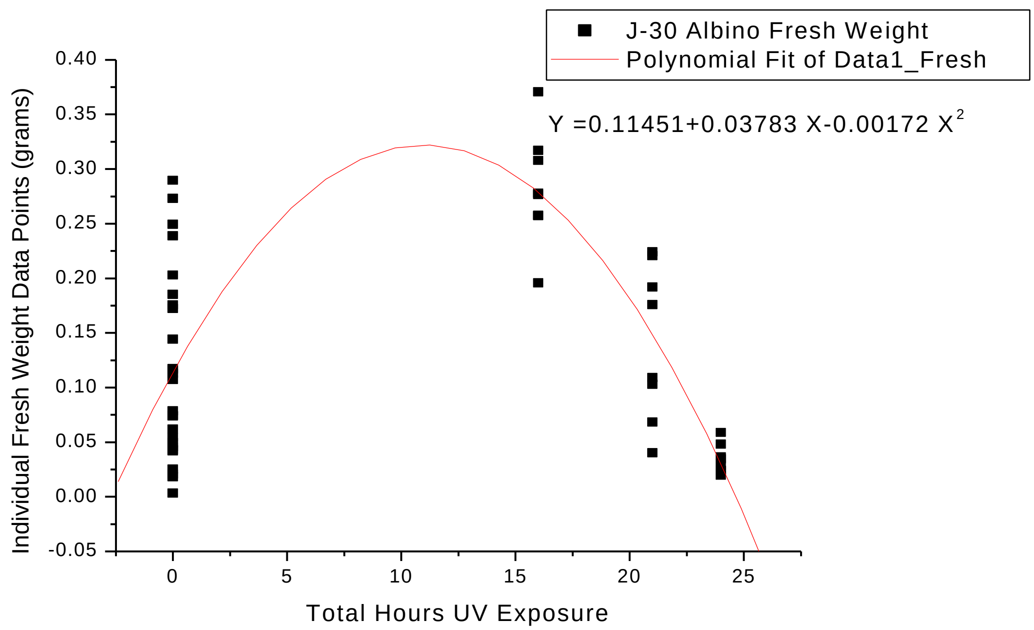


J-30 Albino UV Response Curves

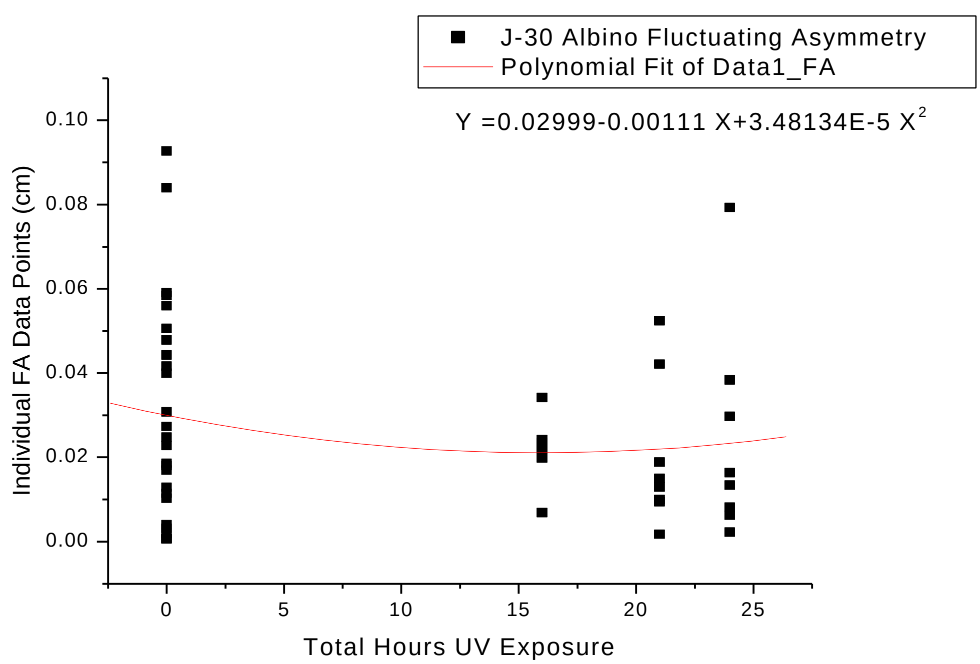
45. Dry Weight



46. Fresh Weight



47. Fluctuating Asymmetry



V. CONCLUSION

From the results, we can see that flat/ rolled ratio is a more sensitive measurement of developmental instability than the measurements of dry weight or fluctuating asymmetry. The leaf-curled response to UV exposure occurred when fluctuating asymmetry and dry weight had not been affected. These significant changes seen in the flat/rolled ratio suggest that chlorophyll, or photosynthesis, does not play a role in morphological changes seen as a result of elevated UV exposure.

The threshold UV level for response of the flat/ rolled ratio measurement appears to have been approximately 24 total hours of exposure over eight days. Any UV exposure less than approximately 24 hours total does not produce a observed effect in flat/ rolled ratio, dry weight, or fluctuating asymmetry.

A. Next Steps

For future experiments, the measurement of flat/ rolled ratio should be examined at exposure periods less than the one that experienced a significant change. Even though leaf rolling was not observed, no measurements were taken for these shorter UV exposure periods. To be sure of no previous response by leaf rolling, maize subjected to smaller periods of UV exposure should be measured.

Also the effect of UV on fresh weight of maize should be reexamined. The reoccurring significant changes in fresh weight as a result of UV exposure, although were not determined as valid, were interesting and deserve another look. More trials should be done to determine whether there is a relationship between photosynthesis and attained fresh weight during heightened UV exposure.

The weight of the original maize seed should also be taken into account in future studies. Weighing the seeds before planting would allow for the initial weight of the plants to be considered when examining results.

The duration of the UV exposures should be expanded to establish more expansive dose-response curves for the measurements of dry weight, fresh weight, fluctuating asymmetry. Also, a dose response curve for leaf rolling as a result of elevated UV exposure should be attempted.

In addition, more UV exposures should be done to determine if photosynthesis truly is not related to impaired growth characteristics as this study implies. Only having a result that is repeated once is not enough evidence to draw a substantial conclusion. More research needs to be done isolating the photosynthesis characteristic and on the impaired growth of plants as a result of elevated UV exposure.

B. Implications

The depletion of the stratospheric ozone and the resulting increase in solar ultraviolet- B radiation continue to elicit concern about the sensitivity of plant life to this stress (Midgley *at al.*, 1998). Although ozone is a minor constituent of the atmosphere, it is the only gas of the atmosphere that appreciably absorbs UV-B radiation. The enhanced radiation only becomes important for biological photochemical reactions if these reactions are much more sensitive to shorter than longer wavelength radiation. This is the case for terrestrial plants. The radiation of shorter wavelengths would be relatively more effective and cause more damage upon reaching the surface of the earth when the ozone is reduced (Caldwell *et al.*, 1989).

An important factor influencing crop yields is the effect of environmental stress on the health of the plant. Because of the proven thinning of the ozone layer and the subsequent increase of UV radiation there is concern about responses of plants. The health of crops and photosynthesizing plants correlate to the health of animal populations. It is important to continue to study the physiological parameters involved in responses to UV because it will provide critical information about plant tolerance of this environmental stress. It would be important to have knowledge of the relative impact of UV-B exposure on key developmental stages while predicting the vulnerability of plant populations in the field (Midgley *et al.*, 1998).

VI. AKNOWLEDGEMENTS

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APPENDIX

Trial letter or number number	**Appendix**
Trial A	I
Trial B	II
Trial C	III
Trial 1	IV
Trial 2	V
Trial 3	VI
Trial 4	VII
Trial 5	VIII
Trial 6	IX
Trial 7	X

Trial A data
J-31
1/2 hr for 8 days

Treatment	Line	leaf number	left width	right width	Fluctuating As	fresh weight	dry weight
control	albino	2	4.42	4.78	0.039	0.0633	0.0203
control	albino	3	2.06	1.96	0.025	0.0206	0.0046
control	albino	2	2.42	2.41	0.002	0.0327	0.0122
control	albino	3	2.90	2.81	0.016	0.0151	0.0033
control	albino	2	3.75	4.15	0.051	0.1632	0.0139
control	albino	3	4.84	4.85	0.001	0.0616	0.0150
control	albino	2	5.18	4.49	0.071	0.1420	0.0236
control	albino	3	3.73	3.87	0.018	0.0801	0.0088
control	albino	2	5.29	5.52	0.021	0.1897	0.0239
control	albino	3	5.87	5.13	0.067	0.1643	0.0139
UV	albino	2	4.99	5.49	0.048	0.1121	0.0149
UV	albino	3	4.56	3.69	0.105	0.0811	0.0067
UV	albino	2	3.93	3.50	0.058	0.0603	0.0248
UV	albino	3	3.48	3.52	0.006	0.0265	0.0083
UV	albino	2	4.53	4.50	0.003	0.0755	0.0182
UV	albino	3	2.52	2.74	0.042	0.0273	0.0058
UV	albino	2	4.70	4.60	0.011	0.1189	0.0181
UV	albino	3	3.35	3.26	0.014	0.0412	0.0044
UV	albino	2	3.64	3.93	0.038	0.0794	0.0186
UV	albino	3	3.48	3.60	0.017	0.0286	0.0059
UV	albino	2	6.55	5.80	0.061	0.2332	0.0254
UV	albino	3	3.32	3.70	0.054	0.0507	0.0048
UV	albino	2	3.66	3.88	0.029	0.0645	0.0214
UV	albino	3	2.04	2.19	0.035	0.0063	0.0047
UV	albino	2	4.48	5.15	0.070	0.0947	0.0220
UV	albino	3	3.16	2.82	0.057	0.0501	0.0089
UV	albino	2	3.55	3.33	0.032	0.0833	0.0209
UV	albino	3	4.44	5.48	0.105	0.1295	0.0139
control	green	2	6.37	6.36	0.001	0.3270	0.0300
control	green	3	5.39	4.98	0.040	0.1525	0.0153
control	green	2	6.35	6.02	0.027	0.2950	0.0282
control	green	3	4.70	5.14	0.045	0.1785	0.0183
control	green	2	5.50	5.91	0.036	0.2443	0.0262
control	green	3	5.98	4.95	0.094	0.1655	0.0163
control	green	2	4.96	4.57	0.041	0.1135	0.0132
control	green	3	5.15	4.68	0.048	0.2150	0.0224
control	green	2	6.15	6.11	0.003	0.3646	0.0359
control	green	3	4.03	3.69	0.044	0.1004	0.0113
control	green	2	5.23	5.57	0.031	0.2417	0.0225
control	green	3	5.36	5.11	0.024	0.2186	0.0229
control	green	2	5.99	5.81	0.015	0.2811	0.0267
control	green	3	5.86	5.31	0.049	0.2577	0.0272
control	green	2	4.92	5.42	0.048	0.2410	0.0238
control	green	3	4.48	3.74	0.090	0.1011	0.1140
control	green	2	5.59	5.81	0.019	0.3094	0.0301
control	green	3	6.25	4.89	0.122	0.2240	0.0246
UV	green	2	5.97	5.63	0.029	0.2808	0.0261
UV	green	3	5.39	6.43	0.088	0.3586	0.0361
UV	green	2	4.64	4.29	0.039	0.1281	0.0130
UV	green	3	3.67	4.53	0.105	0.1380	0.0127
UV	green	2	4.62	4.87	0.026	0.1361	0.0120
UV	green	3	3.96	4.61	0.076	0.0785	0.0065
UV	green	2	5.61	5.43	0.016	0.2448	0.0224
UV	green	3	4.64	3.89	0.088	0.0914	0.0097
UV	green	2	4.66	5.46	0.079	0.1275	0.0121
UV	green	3	5.24	4.44	0.083	0.1089	0.0112
UV	green	2	5.49	5.29	0.019	0.2273	0.0215
UV	green	3	5.35	5.55	0.018	0.2392	0.0242

Trial A data
J-31
1/2 hr for 8 days

UV	green	2	5.30	4.95	0.034	0.2308	0.0217
UV	green	3	4.85	5.48	0.061	0.3149	0.0305
UV	green	2	4.85	5.66	0.077	0.2274	0.0222
UV	green	3	4.74	4.44	0.033	0.1484	0.0149
UV	green	2	5.83	6.34	0.042	0.2876	0.0248
UV	green	3	5.52	5.39	0.012	0.2070	0.0192
UV	green	2	5.63	5.66	0.003	0.2507	0.0237
UV	green	3	5.16	4.68	0.049	0.1474	0.0148
UV	green	2	6.18	6.39	0.017	0.3421	0.0303
UV	green	3	6.41	5.80	0.050	0.3837	0.0373
UV	green	2	6.59	6.48	0.008	0.3109	0.0255
UV	green	3	5.37	5.18	0.018	0.1990	0.0193
UV	green	2	5.98	5.85	0.011	0.2293	0.0193
UV	green	3	5.62	5.77	0.013	0.3641	0.0311
UV	green	2	5.15	5.96	0.073	0.2459	0.0210
UV	green	3	4.70	4.33	0.041	0.1365	0.0131
UV	green	2	5.53	5.51	0.002	0.2426	0.0223
UV	green	3	5.00	4.84	0.016	0.1493	0.0138
UV	green	2	5.78	6.17	0.033	0.2525	0.2400
UV	green	3	5.75	5.08	0.062	0.2658	0.0248
UV	green	2	6.42	6.78	0.027	0.3572	0.0277
UV	green	3	6.35	5.75	0.050	0.3319	0.0297

Trial B data-
J-31
1/2 hr UV for 7 days

Plant number	Leaf Number	Strain	UV/ Control	Left width	Right Width	Fresh weight	Dry Weight	FA
1	2	Albino	UV	4.80	4.27	0.080	0.017	0.058
1	3	Albino	UV	3.09	3.31	0.008	0.004	0.034
2	2	Albino	UV	3.94	3.76	0.039	0.010	0.023
2	3	Albino	UV	5.51	4.49	0.136	0.015	0.102
3	2	Albino	UV	4.25	4.99	0.061	0.005	0.080
3	3	Albino	UV	3.94	4.25	0.095	0.010	0.038
4	2	Albino	UV	5.05	5.14	0.038	0.006	0.009
4	3	Albino	UV	4.85	4.45	0.103	0.009	0.043
5	2	Albino	UV	5.24	5.60	0.271	0.021	0.033
5	3	Albino	UV	3.56	2.94	0.050	0.004	0.095
6	2	Albino	UV	5.37	5.20	0.206	0.015	0.016
6	3	Albino	UV	3.73	3.89	0.092	0.007	0.021
7	2	Albino	Control	4.90	5.06	0.158	0.019	0.016
7	3	Albino	Control	4.08	3.41	0.074	0.006	0.089
8	2	Albino	Control	4.60	4.73	0.064	0.010	0.014
8	3	Albino	Control	4.85	4.87	0.153	0.019	0.002
9	2	Albino	Control	4.55	4.81	0.057	0.010	0.028
9	3	Albino	Control	3.56	3.76	0.054	0.010	0.027
10	2	Albino	Control	4.95	4.84	0.136	0.012	0.011
10	3	Albino	Control	3.99	3.95	0.074	0.006	0.005
11	2	Albino	Control	2.42	2.32	0.030	0.002	0.021
11	3	Albino	Control	5.39	4.76	0.194	0.016	0.062
12	2	Albino	Control	5.35	6.36	0.190	0.015	0.086
12	3	Albino	Control	5.72	5.16	0.151	0.011	0.051
13	2	Albino	Control	5.10	5.54	0.152	0.016	0.041
13	3	Albino	Control	3.51	3.27	0.063	0.004	0.035
14	2	Albino	Control	4.40	4.63	0.114	0.011	0.025
14	3	Albino	Control	3.10	3.64	0.055	0.004	0.080
15	2	Albino	Control	4.67	4.43	0.166	0.014	0.026
15	3	Albino	Control	3.33	3.53	0.067	0.005	0.029
16	2	Albino	Control	6.01	6.34	0.198	0.015	0.027
16	3	Albino	Control	5.93	5.63	0.135	0.011	0.026
17	2	Wildtype	UV	4.74	5.73	0.246	0.021	0.095
17	3	Wildtype	UV	4.13	3.96	0.122	0.012	0.021
18	2	Wildtype	UV	4.78	4.79	0.252	0.024	0.001
18	3	Wildtype	UV	3.76	4.04	0.197	0.021	0.036
19	2	Wildtype	UV	4.93	4.80	0.242	0.022	0.013
19	3	Wildtype	UV	4.36	3.78	0.154	0.017	0.071
20	2	Wildtype	UV	5.64	5.80	0.291	0.027	0.014
20	3	Wildtype	UV	4.46	4.02	0.157	0.017	0.052
21	2	Wildtype	UV	5.35	5.10	0.245	0.021	0.024
21	3	Wildtype	UV	1.96	1.76	0.012	0.002	0.054
22	2	Wildtype	UV	5.25	5.53	0.277	0.025	0.026
22	3	Wildtype	UV	2.42	1.55	0.138	0.001	0.219
23	2	Wildtype	UV	4.80	5.18	0.226	0.022	0.038
23	3	Wildtype	UV	2.00	1.85	0.019	0.002	0.039
24	2	Wildtype	UV	3.89	4.03	0.121	0.010	0.018
24	3	Wildtype	UV	3.10	3.44	0.037	0.003	0.052
25	2	Wildtype	UV	5.32	5.30	0.325	0.031	0.002
25	3	Wildtype	UV	3.93	3.04	0.095	0.010	0.128
26	2	Wildtype	UV	5.95	5.58	0.230	0.023	0.032
26	3	Wildtype	UV	2.18	2.19	0.031	0.003	0.002
27	2	Wildtype	UV	5.17	5.65	0.260	0.023	0.044
27	3	Wildtype	UV	3.53	2.62	0.054	0.006	0.148
28	2	Wildtype	Control	4.73	4.72	0.252	0.023	0.001
28	3	Wildtype	Control	3.86	3.45	0.082	0.008	0.056
29	2	Wildtype	Control	5.91	5.81	0.301	0.024	0.009
29	3	Wildtype	Control	4.93	4.02	0.122	0.012	0.102
30	2	Wildtype	Control	5.89	5.48	0.278	0.031	0.036
30	3	Wildtype	Control	3.55	4.04	0.114	0.013	0.065
31	2	Wildtype	Control	5.75	5.91	0.322	0.036	0.014
31	3	Wildtype	Control	2.40	2.35	0.029	0.004	0.011
32	2	Wildtype	Control	5.65	5.20	0.288	0.028	0.041
32	3	Wildtype	Control	5.13	5.08	0.195	0.020	0.005
33	2	Wildtype	Control	5.07	5.16	0.255	0.021	0.009

Trial B data-
J-31
1/2 hr UV for 7 days

33	3	Wildtype	Control	4.27	3.78	0.116	0.011	0.061
34	2	Wildtype	Control	5.20	5.53	0.182	0.017	0.031
34	3	Wildtype	Control	2.40	2.86	0.038	0.004	0.087
35	2	Wildtype	Control	5.77	5.77	0.288	0.026	0.000
35	3	Wildtype	Control	2.61	2.74	0.030	0.003	0.024

Trial C data-
J-31
1 hr UV for 8 days

Plant Number	Leaf number	Strain	UV/ Control	Left width	Right width	fresh weight	FA
1	2	Albino	Control	4.34	4.67	0.0368	0.037
1	3	Albino	Control	3.85	3.75	0.0184	0.013
2	2	Albino	Control	4.16	4.00	0.0097	0.020
2	3	Albino	Control	3.14	2.98	0.0127	0.026
3	2	Albino	Control	3.30	3.20	0.0181	0.015
3	3	Albino	Control	3.30	3.43	0.0192	0.019
4	2	Albino	UV	3.32	3.29	0.0166	0.005
4	3	Albino	UV	4.28	3.74	0.0358	0.067
5	2	Albino	UV	4.01	4.53	0.0218	0.061
5	3	Albino	UV	4.66	4.34	0.0314	0.036
6	2	Albino	UV	4.97	5.20	0.1124	0.023
6	3	Albino	UV	3.79	3.56	0.0289	0.031
7	2	Albino	UV	4.04	3.67	0.0811	0.048
8	2	Albino	UV	4.68	4.85	0.1149	0.018
8	3	Albino	UV	2.45	2.43	0.0188	0.004
9	2	Wildtype	Control	5.72	5.28	0.2356	0.040
9	3	Wildtype	Control	4.28	4.20	0.0900	0.009
10	2	Wildtype	Control	6.10	5.22	0.0881	0.078
10	3	Wildtype	Control	5.03	5.95	0.1399	0.084
11	2	Wildtype	Control	5.04	4.95	0.0855	0.009
11	3	Wildtype	Control	3.47	4.14	0.0823	0.088
12	2	Wildtype	Control	6.78	6.62	0.3797	0.012
12	3	Wildtype	Control	5.61	4.51	0.1240	0.109
13	2	Wildtype	Control	4.01	4.22	0.1491	0.026
14	2	Wildtype	Control	5.83	5.62	0.3015	0.018
14	3	Wildtype	Control	3.97	4.05	0.0711	0.010
15	2	Wildtype	UV	5.63	5.33	0.1899	0.027
15	3	Wildtype	UV	3.57	3.93	0.0530	0.048
16	2	Wildtype	UV	3.27	3.99	0.0705	0.099
17	2	Wildtype	UV	5.18	4.95	0.2148	0.023
17	3	Wildtype	UV	3.67	3.66	0.0765	0.001
18	2	Wildtype	UV	4.93	5.72	0.1414	0.074
18	3	Wildtype	UV	5.65	3.76	0.0936	0.201
19	2	Wildtype	UV	4.22	4.70	0.0114	0.054
19	3	Wildtype	UV	2.25	2.52	0.0170	0.057
20	2	Wildtype	UV	5.06	5.51	0.1740	0.043
20	3	Wildtype	UV	3.89	3.63	0.0630	0.035
21	2	Wildtype	UV	5.36	4.72	0.1780	0.063
21	3	Wildtype	UV	4.53	5.27	0.1620	0.076
22	2	Wildtype	UV	6.42	6.11	0.3196	0.025
22	3	Wildtype	UV	3.36	3.45	0.0409	0.013

Trial 1 data-
J-31
2 hrs UV for 8 days

UV/ Control	Strain	Plant number	Leaf number	Left width	Right width	Ear number	Fresh weight	Dry weight	FA
UV	Albino	1	2	4.84	5.53	2	0.0377	0.0147	0.067
UV	Albino	1	3	3.49	3.17	2	0.0158	0.0056	0.048
UV	Albino	2	2	5.16	4.63	2	0.0358	0.0153	0.054
UV	Albino	2	3	3.49	3.38	2	0.0112	0.0027	0.016
UV	Albino	3	2	5.26	5.02	2	0.0411	0.0134	0.023
UV	Albino	3	3	2.35	2.08	2	0.0046	0.0023	0.061
UV	Albino	4	2	5.79	5.80	1	0.1398	0.0163	0.001
UV	Albino	4	3	6.37	5.67	1	0.1236	0.0097	0.058
UV	Albino	5	2	5.88	5.44	1	0.1358	0.0122	0.039
UV	Albino	5	3	3.19	3.56	1	0.0536	0.0052	0.055
UV	Albino	6	2	6.04	5.67	1	0.1665	0.0138	0.032
UV	Albino	6	3	2.70	2.63	1	0.0290	0.0027	0.013
UV	Albino	7	2	6.58	6.06	1	0.1683	0.0168	0.041
UV	Albino	7	3	3.85	4.43	1	0.0302	0.0068	0.070
Control	Albino	8	2	3.94	3.67	2	0.0193	0.0107	0.035
Control	Albino	8	3	2.77	2.80	2	0.0079	0.0036	0.005
Control	Albino	9	2	6.43	5.51	2	0.0294	0.0154	0.077
Control	Albino	9	3	4.01	3.32	2	0.0088	0.0049	0.094
Control	Albino	10	2	3.78	4.24	2	0.0193	0.0088	0.057
Control	Albino	10	3	3.43	3.29	2	0.0075	0.0040	0.021
Control	Albino	11	2	6.49	6.18	1	0.1012	0.0178	0.024
Control	Albino	11	3	4.84	5.03	1	0.0343	0.0065	0.019
Control	Albino	12	2	5.59	5.69	1	0.1534	0.0155	0.009
Control	Albino	12	3	3.71	3.61	1	0.0713	0.0066	0.014
Control	Albino	13	2	5.69	5.59	1	0.0997	0.0133	0.009
Control	Albino	13	3	4.17	3.68	1	0.0164	0.0054	0.062
UV	Wildtype	1	2	5.00	5.67	2	0.0809	0.0174	0.063
UV	Wildtype	1	3	5.38	5.12	2	0.0948	0.0149	0.025
UV	Wildtype	2	2	5.48	5.74	2	0.0578	0.0159	0.023
UV	Wildtype	2	3	5.31	6.40	2	0.1322	0.0224	0.093
UV	Wildtype	3	2	5.15	4.77	2	0.1054	0.0161	0.038
UV	Wildtype	3	3	4.80	5.36	2	0.1060	0.0165	0.055
UV	Wildtype	4	2	5.40	5.73	2	0.0726	0.0250	0.030
UV	Wildtype	4	3	4.94	4.01	2	0.0439	0.0094	0.104
UV	Wildtype	5	2	6.25	6.29	2	0.1117	0.0284	0.003
UV	Wildtype	5	3	4.73	4.50	2	0.0355	0.0110	0.025
UV	Wildtype	6	2	4.69	5.42	2	0.0919	0.0164	0.072
UV	Wildtype	6	3	5.08	4.42	2	0.0610	0.0156	0.069
UV	Wildtype	7	2	4.71	4.61	2	0.0394	0.0147	0.011
UV	Wildtype	7	3	5.08	5.12	2	0.0859	0.0152	0.004
UV	Wildtype	8	2	4.29	4.34	2	0.0667	0.0119	0.006
UV	Wildtype	8	3	4.98	4.60	2	0.0740	0.0142	0.040
UV	Wildtype	9	2	5.22	5.37	2	0.1350	0.0224	0.014
UV	Wildtype	9	3	3.44	3.98	2	0.0204	0.0093	0.073
UV	Wildtype	10	2	5.60	5.53	2	0.0862	0.0244	0.006
UV	Wildtype	10	3	3.83	4.69	2	0.0266	0.0105	0.101
UV	Wildtype	11	2	5.13	5.02	2	0.0921	0.0195	0.011
UV	Wildtype	11	3	5.78	5.12	2	0.0781	0.0189	0.061
UV	Wildtype	12	2	5.89	5.67	2	0.1300	0.0234	0.019
UV	Wildtype	12	3	4.65	4.36	2	0.0294	0.0105	0.032
UV	Wildtype	13	2	5.95	6.55	2	0.1593	0.0232	0.048
UV	Wildtype	13	3	5.72	4.98	2	0.0993	0.0173	0.069
UV	Wildtype	14	2	5.84	6.25	2	0.1246	0.0217	0.034
UV	Wildtype	14	3	5.47	4.41	2	0.0521	0.0105	0.107
UV	Wildtype	15	2	5.60	5.93	1	0.2293	0.0273	0.029
UV	Wildtype	15	3	3.72	3.28	1	0.0117	0.0066	0.063
UV	Wildtype	16	2	6.05	6.49	1	0.1387	0.0252	0.035
UV	Wildtype	16	3	5.28	4.94	1	0.0730	0.0166	0.033
Control	Wildtype	17	2	4.84	4.48	2	0.0476	0.0185	0.039
Control	Wildtype	17	3	2.78	3.03	2	0.0098	0.0045	0.043
Control	Wildtype	18	2	5.26	5.27	2	0.0880	0.0211	0.001
Control	Wildtype	18	3	5.76	4.83	2	0.0918	0.0200	0.088
Control	Wildtype	19	2	4.84	4.36	2	0.0994	0.0166	0.052
Control	Wildtype	19	3	3.16	3.97	2	0.0147	0.0080	0.114
Control	Wildtype	20	2	5.57	5.71	2	0.0821	0.0206	0.012
Control	Wildtype	20	3	4.48	3.50	2	0.0328	0.0096	0.123
Control	Wildtype	21	2	4.84	5.64	2	0.0718	0.0177	0.076
Control	Wildtype	21	3	5.68	5.07	2	0.1115	0.0167	0.057
Control	Wildtype	22	2	5.24	5.30	2	0.1384	0.0216	0.006
Control	Wildtype	22	3	4.87	5.32	2	0.0639	0.0175	0.044
Control	Wildtype	23	2	5.84	6.52	2	0.1743	0.0254	0.055

Trial 1 data-
J-31
2 hrs UV for 8 days

Control	Wildtype	23	3	5.91	4.45	2	0.0773	0.0166	0.141
Control	Wildtype	24	2	6.48	6.18	2	0.1283	0.0271	0.024
Control	Wildtype	24	3	5.88	6.00	2	0.1461	0.0253	0.010
Control	Wildtype	25	2	6.10	6.23	2	0.1532	0.0252	0.011
Control	Wildtype	25	3	5.80	5.38	2	0.1357	0.0200	0.038
Control	Wildtype	26	2	5.23	4.87	2	0.1318	0.0197	0.036
Control	Wildtype	26	3	3.33	3.91	2	0.0206	0.0068	0.080
Control	Wildtype	27	2	6.41	5.92	2	0.2000	0.0258	0.040
Control	Wildtype	27	3	4.65	5.60	2	0.0953	0.0150	0.093
Control	Wildtype	28	2	6.54	6.31	2	0.1751	0.0250	0.018
Control	Wildtype	28	3	5.52	5.69	2	0.1252	0.0205	0.015
Control	Wildtype	29	2	5.93	6.31	2	0.1057	0.0231	0.031
Control	Wildtype	29	3	6.27	5.30	2	0.0849	0.0189	0.084
Control	Wildtype	30	2	6.49	5.88	1	0.1962	0.0236	0.049
Control	Wildtype	30	3	3.35	3.12	1	0.0104	0.0052	0.036
Control	Wildtype	31	2	5.69	5.91	1	0.1607	0.0197	0.019
Control	Wildtype	31	3	4.02	3.66	1	0.0255	0.0080	0.047
Control	Wildtype	32	2	7.68	6.70	1	0.2660	0.0304	0.068
Control	Wildtype	32	3	5.70	6.53	1	0.1486	0.0200	0.068
Control	Wildtype	33	2	6.52	6.21	1	0.1562	0.0189	0.024
Control	Wildtype	33	3	2.72	2.43	1	0.0048	0.0036	0.056
Control	Wildtype	34	2	6.04	6.95	1	0.1874	0.0259	0.070
Control	Wildtype	34	3	3.92	3.61	1	0.0359	0.0076	0.041
Control	Wildtype	35	2	6.18	5.93	1	0.1766	0.0228	0.021
Control	Wildtype	35	3	4.49	5.22	1	0.1048	0.0146	0.075

Trial 2 data-
J-31
2 hrs UV for 8 days

Plant number	Leaf number	Left width	Right width	Fresh weight	Dry weight	Strain	UV/ Control	FA	Total Width
1	2	5.08	5.28		0.0141	Albino	Control	0.019	10.360
1	3	2.94	2.68			Albino	Control	0.046	5.620
2	2	5.11	5.33		0.0102	Albino	Control	0.021	10.440
2	3	2.80	2.47		0.0017	Albino	Control	0.063	5.270
3	2	5.76	6.31		0.0161	Albino	Control	0.046	12.070
3	3	2.94	2.75		0.0033	Albino	Control	0.033	5.690
4	2	5.49	6.34		0.0127	Albino	Control	0.072	11.830
4	3	2.58	2.54		0.0029	Albino	Control	0.008	5.120
5	2	5.32	3.37		0.0117	Wildtype	Control	0.224	8.690
5	3	2.84	3.78		0.0079	Wildtype	Control	0.142	6.620
6	2	4.86	5.33		0.0143	Wildtype	Control	0.046	10.190
6	3	5.54	3.92		0.0174	Wildtype	Control	0.171	9.460
7	2	6.29	5.70		0.0250	Wildtype	Control	0.049	11.990
7	3	4.21	4.88		0.0138	Wildtype	Control	0.074	9.090
8	2	6.29	6.04		0.0291	Wildtype	Control	0.020	12.330
8	3	3.58	3.38		0.0089	Wildtype	Control	0.029	6.960
9	2	4.84	5.12	0.0129	0.0077	Albino	UV	0.028	9.960
9	3	4.30	3.51	0.0067	0.0053	Albino	UV	0.101	7.810
10	2	3.91	4.03	0.0178	0.0094	Albino	UV	0.015	7.940
10	3	3.41	3.65	0.0040	0.0039	Albino	UV	0.034	7.060
11	2	5.75	6.33	0.0716	0.0163	Albino	UV	0.048	12.080
11	3	3.07	3.20	0.0046	0.0045	Albino	UV	0.021	6.270
12	2	5.65	5.46	0.0531	0.0165	Albino	UV	0.017	11.110
12	3	2.76	2.41	0.0059	0.0042	Albino	UV	0.068	5.170
13	2	4.64	4.99	0.1122	0.0118	Wildtype	Control	0.036	9.630
13	3	2.79	2.82	0.0309	0.0043	Wildtype	Control	0.005	5.610
14	2	5.15	5.23	0.2275	0.0209	Wildtype	Control	0.008	10.380
14	3	3.45	3.96	0.0602	0.0084	Wildtype	Control	0.069	7.410
15	2	5.94	5.74	0.1673	0.0164	Wildtype	Control	0.017	11.680
15	3	5.95	5.35	0.1697	0.0171	Wildtype	Control	0.053	11.300
16	2	5.54	5.28	0.1610	0.0164	Wildtype	Control	0.024	10.820
16	3	4.57	5.25	0.1314	0.0138	Wildtype	Control	0.069	9.820
17	2	5.44	5.96	0.2149	0.0244	Wildtype	Control	0.046	11.400
17	3	4.21	3.94	0.0980	0.0124	Wildtype	Control	0.033	8.150
18	2	6.71	5.38	0.2584	0.0274	Wildtype	Control	0.110	12.090
18	3	2.95	3.24	0.0290	0.0058	Wildtype	Control	0.047	6.190
19	2	5.65	5.85	0.2536	0.0255	Wildtype	Control	0.017	11.500
19	3	3.75	3.73	0.0778	0.0098	Wildtype	Control	0.003	7.480
20	2	5.27	5.51	0.2026	0.0213	Wildtype	Control	0.022	10.780
20	3	2.09	2.00	0.0131	0.0023	Wildtype	Control	0.022	4.090
21	2	5.65	5.85	0.1725	0.0205	Wildtype	UV	0.017	11.500
21	3	4.47	5.11	0.1146	0.0121	Wildtype	UV	0.067	9.580
22	2	5.83	5.60	0.1806	0.0173	Wildtype	UV	0.020	11.430
22	3	4.72	5.06	0.1056	0.0113	Wildtype	UV	0.035	9.780
23	2	5.83	5.23	0.2344	0.0213	Wildtype	UV	0.054	11.060
23	3	2.83	2.99	0.0320	0.0044	Wildtype	UV	0.027	5.820
24	2	5.97	5.63	0.2465	0.0246	Wildtype	UV	0.029	11.600
24	3	4.29	4.77	0.1167	0.0125	Wildtype	UV	0.053	9.060
25	2	6.06	5.89	0.2186	0.0203	Wildtype	UV	0.014	11.950
25	3	5.70	5.10	0.1444	0.0153	Wildtype	UV	0.056	10.800
26	2	5.83	5.92	0.2683	0.0237	Wildtype	UV	0.008	11.750
26	3	4.63	3.79	0.0822	0.0090	Wildtype	UV	0.100	8.420
27	2	5.48	5.09	0.1910	0.0148	Wildtype	UV	0.037	10.570
27	3	3.09	3.62	0.0503	0.0050	Wildtype	UV	0.079	6.710
28	2	5.46	5.88	0.1685	0.0150	Wildtype	UV	0.037	11.340
28	3	5.59	5.03	0.2238	0.0187	Wildtype	UV	0.053	10.620

Trial 2 data-
J-31
2 hrs UV for 8 days

29	2	5.32	5.41	0.1816	0.0153	Wildtype	UV	0.008	10.730
29	3	5.37	3.96	0.1216	0.0110	Wildtype	UV	0.151	9.330
30	2	5.78	6.25	0.2925	0.0253	Wildtype	UV	0.039	12.030
30	3	2.61	2.37	0.0340	0.0043	Wildtype	UV	0.048	4.980
31	2	6.88	6.12	0.3116	0.0288	Wildtype	UV	0.058	13.000
31	3	4.29	4.34	0.1141	0.0119	Wildtype	UV	0.006	8.630
32	2	6.12	6.41	0.2786	0.0263	Wildtype	UV	0.023	12.530
32	3	3.70	3.53	0.0695	0.0075	Wildtype	UV	0.024	7.230
33	2	6.51	6.95	0.3089	0.0270	Wildtype	UV	0.033	13.460
33	3	2.80	2.69	0.0399	0.0046	Wildtype	UV	0.020	5.490
34	2	6.17	6.47	0.3076	0.0281	Wildtype	UV	0.024	12.640
34	3	3.60	3.49	0.0718	0.0080	Wildtype	UV	0.016	7.090
35	2	5.93	6.61	0.2544	0.0237	Wildtype	UV	0.054	12.540
35	3	3.40	3.37	0.0586	0.0063	Wildtype	UV	0.004	6.770

Trial 3 data-
J-31 J-30
2 hrs UV for 8 days

Plant Number	Leaf Number	Strain	Line	Left Width	Right Width	Fresh Weight	Dry Weight	UV/ Control	FA	Total Width
1	2	albino	J-30	8.07	8.06	0.2030	0.0198	Control	0.001	16.13
1	3	albino	J-30	7.47	7.28	0.1852	0.0154	Control	0.013	14.75
2	2	albino	J-30	7.34	6.95	0.2387	0.0186	Control	0.027	14.29
2	3	albino	J-30	6.85	7.58	0.2495	0.0196	Control	0.051	14.43
3	2	albino	J-30	9.04	8.71	0.2731	0.0242	Control	0.019	17.75
3	3	albino	J-30	7.77	7.95	0.2896	0.0245	Control	0.011	15.72
4	2	albino	J-30	8.67	8.79	0.2571	0.0211	UV	0.007	17.46
4	3	albino	J-30	9.61	9.17	0.3078	0.0244	UV	0.023	18.78
5	2	albino	J-30	8.87	9.31	0.2778	0.0218	UV	0.024	18.18
5	3	albino	J-30	9.49	9.07	0.3706	0.0287	UV	0.023	18.56
6	2	albino	J-30	7.82	7.48	0.1957	0.0176	UV	0.022	15.30
6	3	albino	J-30	7.72	7.21	0.2575	0.0196	UV	0.034	14.93
7	2	albino	J-30	6.93	7.21	0.2766	0.0221	UV	0.020	14.14
7	3	albino	J-30	8.19	7.84	0.3170	0.0238	UV	0.022	16.03
8	2	wildtype	J-31	4.89	4.88	0.1336	0.0150	Control	0.001	9.77
9	2	wildtype	J-31	5.73	5.36	0.1665	0.0202	Control	0.033	11.09
10	2	wildtype	J-31	6.10	5.83	0.2176	0.0242	Control	0.023	11.93
11	2	wildtype	J-31	4.96	5.14	0.1506	0.0180	Control	0.018	10.10
11	3	wildtype	J-31	3.40	2.72	0.0195	0.0043	Control	0.111	6.12
12	2	wildtype	J-31	6.49	6.35	0.2664	0.0255	Control	0.011	12.84
12	3	wildtype	J-31	4.36	4.81	0.0759	0.0103	Control	0.049	9.17
13	2	wildtype	J-31	5.88	5.91	0.1828	0.0210	Control	0.003	11.79
13	3	wildtype	J-31	3.31	3.67	0.0437	0.0063	Control	0.052	6.98
14	2	wildtype	J-31	5.14	5.39	0.0995	0.0129	Control	0.024	10.53
14	3	wildtype	J-31	2.36	2.45	0.0174	0.0030	Control	0.019	4.81
15	2	wildtype	J-31	3.96	3.96	0.0775	0.0117	Control	0.000	7.92
16	2	wildtype	J-31	3.83	4.25	0.1048	0.0092	Control	0.052	8.08
17	2	wildtype	J-31	6.32	6.84	0.2567	0.0231	Control	0.040	13.16
18	2	wildtype	J-31	5.56	5.60	0.2516	0.0245	Control	0.004	11.16
18	3	wildtype	J-31	3.04	2.59	0.0295	0.0045	Control	0.080	5.63
19	2	wildtype	J-31	6.37	5.78	0.2844	0.0248	Control	0.049	12.15
19	3	wildtype	J-31	3.48	2.93	0.0339	0.0056	Control	0.086	6.41
20	2	wildtype	J-31	6.24	6.58	0.2608	0.0227	Control	0.027	12.82
20	3	wildtype	J-31	3.48	3.48	0.0479	0.0053	Control	0.000	6.96
21	2	wildtype	J-30	7.98	7.53	0.3395	0.0290	Control	0.029	15.51
21	3	wildtype	J-30	8.29	7.45	0.4838	0.0416	Control	0.053	15.74
22	2	wildtype	J-30	7.79	7.53	0.3651	0.0339	Control	0.017	15.32
22	3	wildtype	J-30	7.92	8.67	0.4142	0.0389	Control	0.045	16.59
23	2	wildtype	J-30	7.39	6.87	0.2619	0.0244	Control	0.036	14.26
23	3	wildtype	J-30	8.37	8.24	0.4403	0.0390	Control	0.008	16.61
24	2	wildtype	J-30	7.63	7.96	0.3408	0.0327	Control	0.021	15.59
24	3	wildtype	J-30	8.35	8.28	0.4643	0.0446	Control	0.004	16.63
25	2	wildtype	J-30	8.01	8.18	0.3516	0.0332	Control	0.011	16.19
25	3	wildtype	J-30	8.16	8.48	0.5250	0.0488	Control	0.019	16.64
26	2	wildtype	J-30	8.61	8.37	0.3680	0.0340	Control	0.014	16.98
26	3	wildtype	J-30	9.29	9.43	0.5371	0.0474	Control	0.007	18.72
27	2	wildtype	J-30	7.46	7.92	0.3021	0.0296	Control	0.030	15.38
27	3	wildtype	J-30	7.95	7.99	0.4559	0.0443	Control	0.003	15.94
28	2	wildtype	J-30	6.56	6.73	0.3035	0.0297	Control	0.013	13.29
28	3	wildtype	J-30	7.84	8.18	0.4234	0.0417	Control	0.021	16.02
29	2	wildtype	J-30	7.11	7.37	0.3404	0.0333	Control	0.018	14.48
29	3	wildtype	J-30	8.31	7.98	0.4403	0.0432	Control	0.020	16.29
30	2	wildtype	J-30	7.60	7.73	0.2120	0.0210	Control	0.008	15.33
30	3	wildtype	J-30	6.27	6.38	0.4253	0.0378	Control	0.009	12.65
31	2	wildtype	J-31	5.88	5.98	0.2057	0.0194	UV	0.008	11.86
31	3	wildtype	J-31	3.27	3.14	0.0312	0.0042	UV	0.020	6.41
32	2	wildtype	J-31	6.15	6.16	0.3062	0.0290	UV	0.001	12.31
32	3	wildtype	J-31	4.39	3.99	0.0691	0.0094	UV	0.048	8.38
33	2	wildtype	J-31	6.76	6.03	0.2716	0.0260	UV	0.057	12.79
33	3	wildtype	J-31	4.21	4.69	0.0891	0.0098	UV	0.054	8.90
34	2	wildtype	J-31	5.27	5.16	0.2185	0.0200	UV	0.011	10.43
35	2	wildtype	J-31	6.40	6.23	0.2991	0.0261	UV	0.013	12.63
36	2	wildtype	J-31	5.46	5.95	0.2333	0.0209	UV	0.043	11.41
36	3	wildtype	J-31	4.28	3.85	0.0763	0.0083	UV	0.053	8.13
37	2	wildtype	J-31	5.83	5.60	0.2801	0.0243	UV	0.020	11.43
37	3	wildtype	J-31	4.25	3.88	0.0682	0.0081	UV	0.046	8.13
38	2	wildtype	J-31	5.20	5.88	0.2408	0.0216	UV	0.061	11.08
38	3	wildtype	J-31	3.42	3.35	0.0490	0.0058	UV	0.010	6.77
39	2	wildtype	J-31	4.90	6.02	0.1664	0.0149	UV	0.103	10.92
39	3	wildtype	J-31	5.39	5.23	0.1331	0.0125	UV	0.015	10.62
40	2	wildtype	J-31	5.88	6.01	0.2233	0.0198	UV	0.011	11.89
40	3	wildtype	J-31	3.52	4.28	0.0654	0.0068	UV	0.097	7.80
41	2	wildtype	J-31	5.64	5.89	0.2113	0.0187	UV	0.022	11.53
41	3	wildtype	J-31	2.99	3.08	0.0428	0.0050	UV	0.015	6.07
42	2	wildtype	J-31	6.60	6.10	0.3004	0.0257	UV	0.039	12.70
42	3	wildtype	J-31	3.40	3.51	0.0535	0.0062	UV	0.016	6.91
43	2	wildtype	J-30	9.07	9.06	0.5221	0.0461	UV	0.001	18.13
43	3	wildtype	J-30	8.57	8.34	0.3806	0.0360	UV	0.014	16.91
44	2	wildtype	J-30	6.74	6.43	0.3241	0.0296	UV	0.024	13.17

Trial 3 data-
J-31 J-30
2 hrs UV for 8 days

44	3	wildtype	J-30	7.94	8.02	0.4106	0.0362	UV	0.005	15.96
45	2	wildtype	J-30	7.89	7.69	0.3470	0.0314	UV	0.013	15.58
45	3	wildtype	J-30	7.80	7.79	0.4185	0.0339	UV	0.001	15.59
46	2	wildtype	J-30	8.51	7.66	0.3305	0.0321	UV	0.053	16.17
46	3	wildtype	J-30	8.96	8.68	0.5235	0.0478	UV	0.016	17.64
47	2	wildtype	J-30	6.91	7.43	0.2106	0.0189	UV	0.036	14.34
47	3	wildtype	J-30	6.37	7.68	0.2496	0.0236	UV	0.093	14.05
48	2	wildtype	J-30	6.49	5.88	0.2142	0.0186	UV	0.049	12.37
48	3	wildtype	J-30	7.75	8.47	0.4900	0.0395	UV	0.044	16.22
49	2	wildtype	J-30	7.35	7.36	0.2815	0.0278	UV	0.001	14.71
49	3	wildtype	J-30	7.53	7.45	0.5062	0.0420	UV	0.005	14.98
50	3	wildtype	J-30	7.00	6.86	0.2237	0.0211	UV	0.010	13.86

Trial 4 data-
J-30
3 hrs UV for 7 days

Plant number	Leaf number	Strain	UV/ Control	Left width	Right width	FA	Rolled Width	Flat width	Fresh weight	Dry weight	Flat/ rolled rati
1	2	albino	control	7.96	8.01	0.00	-14.58	15.33	0.1129	0.0254	-1.051
1	3	albino	control	6.60	7.81	0.08	-11.30	13.76	0.0542	0.0169	-1.218
2	2	albino	control	7.16	7.88	0.05	-13.59	13.84	0.0619	0.0180	-1.018
2	3	albino	control	7.13	5.92	0.09	11.72	12.57	0.0420	0.0140	1.073
3	2	albino	control	7.75	7.78	0.00	13.02	15.40	0.1158	0.0209	1.183
3	3	albino	control	8.27	7.87	0.02	14.76	15.78	0.1722	0.0235	1.069
4	2	albino	control	7.81	7.21	0.04	-12.34	14.13	0.0786	0.0178	-1.145
4	3	albino	control	7.12	7.78	0.04	12.94	14.35	0.0739	0.0164	1.109
5	2	albino	control	8.37	8.36	0.00	-11.65	16.56	0.0495	0.0164	-1.421
5	3	albino	control	8.78	8.71	0.00	16.84	16.84	0.1174	0.0223	1.000
6	2	albino	control	7.13	7.12	0.00	-11.38	14.99	0.0744	0.0214	-1.317
6	3	albino	control	7.64	7.03	0.04	-13.27	14.97	0.1441	0.0238	-1.128
7	2	albino	control	9.05	8.51	0.03	15.87	17.31	0.1072	0.0236	1.091
7	3	albino	control	8.19	7.90	0.02	14.88	16.00	0.1755	0.0260	1.075
8	2	albino	UV	7.27	7.46	0.01	0.64	13.82	0.1029	0.0233	21.594
8	3	albino	UV	7.96	8.66	0.04	9.24	15.73	0.2207	0.0317	1.702
9	2	albino	UV	7.84	7.55	0.02	6.43	14.45	0.1089	0.0238	2.247
9	3	albino	UV	8.56	8.40	0.01	15.11	16.47	0.1757	0.0229	1.090
10	2	albino	UV	7.97	8.13	0.01	2.43	15.57	0.1918	0.0277	6.407
10	3	albino	UV	8.59	8.62	0.00	13.19	16.31	0.2243	0.0276	1.237
11	2	albino	UV	7.45	7.23	0.01	11.96	13.29	0.0401	0.0156	1.111
11	3	albino	UV	7.83	7.05	0.05	12.37	14.83	0.0684	0.0156	1.199
12	2	wildtype	UV	7.26	7.33	0.00	13.01	14.29	0.0970	0.0246	1.098
12	3	wildtype	UV	8.50	7.91	0.04	13.93	15.93	0.2795	0.0395	1.144
13	2	wildtype	UV	8.47	6.64	0.12	12.24	14.67	0.0709	0.0287	1.199
13	3	wildtype	UV	9.25	9.14	0.01	9.53	17.02	0.3299	0.0503	1.786
14	2	wildtype	UV	9.01	8.40	0.04	15.38	17.35	0.1266	0.0330	1.128
14	3	wildtype	UV	8.26	8.16	0.01	14.98	15.68	0.2909	0.0488	1.047
15	2	wildtype	UV	7.56	8.01	0.03	8.37	15.58	0.0654	0.0301	1.861
15	3	wildtype	UV	10.77	9.76	0.05	14.38	19.83	0.3537	0.0512	1.379
16	2	wildtype	control	7.97	8.31	0.02	-14.41	16.12	0.2381	0.0293	-1.119
16	3	wildtype	control	8.20	7.55	0.04	-13.65	15.67	0.4928	0.0527	-1.148
17	2	wildtype	control	8.37	8.64	0.02	-16.17	16.97	0.2886	0.0390	-1.049
17	3	wildtype	control	10.43	9.79	0.03	-16.09	19.58	0.4043	0.0485	-1.217
18	2	wildtype	control	7.67	7.60	0.00	-10.15	15.43	0.1866	0.0281	-1.520
18	3	wildtype	control	7.93	8.46	0.03	-15.54	16.10	0.4005	0.0503	-1.036
19	2	wildtype	control	7.09	7.34	0.02	12.99	14.06	0.2531	0.0347	1.082
19	3	wildtype	control	8.34	8.85	0.03	-16.54	16.84	0.3993	0.0506	-1.018
20	2	wildtype	control	6.96	7.48	0.04	-13.92	14.03	0.1202	0.0218	-1.008
20	3	wildtype	control	8.26	8.80	0.03			0.3240	0.0352	
21	2	wildtype	control	7.50	7.84	0.02	-12.96	15.20	0.0928	0.0220	-1.173
21	3	wildtype	control	8.88	8.23	0.04			0.3122	0.0414	
22	3	wildtype	control	8.17	7.53	0.04			0.1450	0.0304	
23	2	wildtype	control	7.49	7.31	0.01	-14.75	14.75	0.1719	0.0204	-1.000
23	3	wildtype	control	8.54	8.31	0.01			0.4114	0.0436	
24	2	wildtype	control	7.32	7.01	0.02	-13.71	14.04	0.1659	0.0229	-1.024
24	3	wildtype	control	7.90	7.64	0.02			0.3299	0.0384	
25	2	wildtype	control	6.32	5.79	0.04	-10.68	11.98	0.2126	0.0219	-1.122
25	3	wildtype	control	5.64	5.55	0.01			0.1179	0.0166	
26	2	wildtype	control	7.42	6.33	0.08	-13.24	13.50	0.1471	0.0222	-1.020
26	3	wildtype	control	8.34	8.52	0.01	-15.03	16.52	0.3835	0.0466	-1.099
27	2	wildtype	control	6.21	7.16	0.07	-10.62	12.92	0.0782	0.0153	-1.217
27	3	wildtype	control	7.97	8.10	0.01			0.3423	0.0374	
28	2	wildtype	control	6.00	7.38	0.10			0.0712	0.0145	
28	3	wildtype	control	7.67	8.25	0.04			0.2861	0.0307	
29	2	wildtype	control	8.04	7.98	0.00	-12.63	15.42	0.2085	0.0294	-1.221
29	3	wildtype	control	8.76	7.91	0.05			0.3810	0.0432	
30	2	wildtype	control	6.10	6.72	0.05	12.56	12.76	0.2633	0.0310	1.016
30	3	wildtype	control	7.81	8.26	0.03			0.4235	0.0478	
31	2	wildtype	control	7.80	7.89	0.01	14.76	15.56	0.2487	0.0311	1.054
31	3	wildtype	control	9.82	10.04	0.01			0.4993	0.0581	
32	2	wildtype	control	6.83	6.91	0.01	-13.31	13.75	0.0503	0.0155	-1.033
32	3	wildtype	control	7.23	7.76	0.04			0.3982	0.0441	
33	2	wildtype	control	6.76	6.64	0.01	-13.02	13.25	0.2061	0.0259	-1.018
33	3	wildtype	control	8.16	7.48	0.04			0.2669	0.0357	
34	2	wildtype	UV	7.48	7.38	0.01	14.86	14.86	0.1013	0.0350	1.000
34	3	wildtype	UV	7.28	7.92	0.04			0.2801	0.0464	
35	2	wildtype	UV	8.16	8.08	0.00	15.01	16.41	0.0744	0.0345	1.093
35	3	wildtype	UV	8.84	9.56	0.04			0.3013	0.0525	
36	2	wildtype	UV	6.58	6.14	0.03	7.58	12.21	0.1090	0.0287	1.611
36	3	wildtype	UV	6.84	6.34	0.04			0.1555	0.0231	
37	2	wildtype	UV	6.79	6.83	0.00	6.80	14.07	0.0299	0.0180	2.069
37	3	wildtype	UV	7.87	7.76	0.01			0.2340	0.0370	
38	2	wildtype	UV	6.06	5.89	0.01	5.80	11.44	0.0349	0.0148	1.972
38	3	wildtype	UV	5.70	5.44	0.02			0.1104	0.0171	
39	2	wildtype	UV	6.99	6.48	0.04	12.23	13.09	0.0322	0.0152	1.070
39	3	wildtype	UV	8.34	7.84	0.03			0.2923	0.0329	
40	2	wildtype	UV	7.32	7.45	0.01	9.94	14.22	0.0722	0.0249	1.431
40	3	wildtype	UV	8.17	8.24	0.00			0.2162	0.0512	
41	2	wildtype	UV	7.09	8.15	0.07	14.27	14.86	0.1823	0.0320	1.041
41	3	wildtype	UV	6.29	5.94	0.03			0.0821	0.0157	
42	2	wildtype	UV	6.02	6.82	0.06			0.0250	0.0184	
42	3	wildtype	UV	7.85	8.02	0.01			0.3416	0.0419	
43	2	wildtype	UV	7.91	8.03	0.01	12.73	15.33	0.0478	0.0273	1.204
43	3	wildtype	UV	9.07	8.62	0.03			0.2301	0.0402	
44	2	wildtype	UV	7.85	8.03	0.01	14.55	15.90	0.0391	0.0290	1.093

Trial 4 data-
J-30
3 hrs UV for 7 days

44	3	wildtype	UV	8.13	8.33	0.01			0.2185	0.0527	
45	2	wildtype	UV	6.98	6.43	0.04	11.05	15.41	0.0379	0.0199	1.395
45	3	wildtype	UV	7.87	7.89	0.00			0.2317	0.0471	
46	2	wildtype	UV	6.05	6.49	0.04	11.91	12.39	0.0385	0.0159	1.040
46	3	wildtype	UV	7.14	7.64	0.03			0.2956	0.0461	
47	2	wildtype	UV	8.55	9.16	0.03	12.15	17.72	0.0715	0.0367	1.458
47	3	wildtype	UV	8.89	8.57	0.02			0.2470	0.0399	

Trial 5 data-
J-30
3 hrs UV for 8 days

Plant number	Leaf Number	Strain	UV/ Control	Left width	Right width	FA	Fresh weight	Dry weight	rolled	flat	Rolled flat ratic
1	2	albino	control	6.41	5.62	0.07	0.0455	0.0128	10.66	11.31	1.06
1	3	albino	control	2.71	2.74	0.01	0.0024	0.0022			
2	2	albino	control	6.02	5.26	0.07	0.0573	0.0130	10.41	10.41	1.00
2	3	albino	control	3.35	3.92	0.08	0.0060	0.0049			
3	2	albino	control	5.78	5.78	0.00	0.0359	0.0130	10.08	10.44	1.04
3	3	albino	control	2.46	2.63	0.03	0.0021	0.0017			
4	2	albino	control	6.68	5.86	0.07	0.0675	0.0142	10.79	11.93	1.11
4	3	albino	control	2.75	2.53	0.04	0.0030	0.0020			
5	2	albino	control	5.87	6.81	0.07	0.0622	0.0144	10.69	11.90	1.11
5	3	albino	control				0.0022	0.0011			
6	2	albino	UV	6.70	7.04	0.02	0.0841	0.0147	6.53	13.13	2.01
6	3	albino	UV								
7	2	albino	UV	5.86	6.02	0.01	0.0630	0.0140	9.36	10.98	1.17
7	3	albino	UV	2.79	2.58	0.04	0.0056	0.0032			
8	2	albino	UV	6.12	6.50	0.03	0.0566	0.0169	1.27	11.25	8.86
8	3	albino	UV	2.91	2.35	0.11	0.0031	0.0023			
9	2	albino	UV	6.14	6.69	0.04	0.0395	0.0138	5.16	11.42	2.21
9	3	albino	UV	2.49	2.37	0.02	0.0016	0.0012			
10	2	albino	UV	6.66	6.37	0.02	0.0702	0.0194	8.35	12.22	1.46
10	3	albino	UV	2.39	2.47	0.02	0.0021	0.0015			
11	2	albino	UV	5.66	6.74	0.09	0.0483	0.0147	6.93	11.12	1.60
11	3	albino	UV				0.0021	0.0013			
12	2	wildtype	UV	4.69	5.47	0.08	0.0297	0.0139	4.20	9.68	2.30
12	3	wildtype	UV	4.90	3.92	0.11	0.0359	0.0119			
13	2	wildtype	UV	5.85	5.43	0.04	0.0549	0.0182	9.17	10.56	1.15
13	3	wildtype	UV	4.52	4.48	0.00	0.0578	0.0114			
14	2	wildtype	UV	5.81	6.81	0.08	0.0919	0.0205	9.15	12.18	1.33
14	3	wildtype	UV				0.0032	0.0017			
15	2	wildtype	UV	4.71	5.35	0.06	0.0329	0.0155	3.15	9.60	3.05
15	3	wildtype	UV	2.57	2.37	0.04	0.0076	0.0031			
16	2	wildtype	UV	6.59	6.25	0.03	0.0646	0.0217	4.56	12.10	2.65
16	3	wildtype	UV	4.00	5.08	0.12	0.0233	0.0081			
17	2	wildtype	UV	6.27	6.04	0.02	0.1198	0.0220	7.33	11.73	1.60
17	3	wildtype	UV	2.75	2.77	0.00	0.0077	0.0032			
18	2	wildtype	UV	5.41	5.24	0.02	0.0360	0.0197	7.80	10.73	1.38
18	3	wildtype	UV	3.69	4.09	0.05	0.0335	0.0085			
19	2	wildtype	UV	5.77	5.61	0.01	0.0502	0.0189	6.33	10.66	1.68
19	3	wildtype	UV	3.51	4.38	0.11	0.0185	0.0062			
20	2	wildtype	UV	5.30	5.63	0.03	0.0856	0.0208	8.02	10.21	1.27
20	3	wildtype	UV	3.68	3.28	0.06	0.0189	0.0071			
21	2	wildtype	UV	5.95	6.29	0.03	0.1020	0.0245	8.76	11.74	1.34
21	3	wildtype	UV	4.13	4.12	0.00	0.0615	0.0111			
22	2	wildtype	UV	5.86	6.04	0.02	0.0781	0.0192	6.28	10.94	1.74
22	3	wildtype	UV	3.61	3.47	0.02	0.0234	0.0061			
23	2	wildtype	UV	5.75	5.73	0.00	0.1191	0.0235	7.33	10.98	1.50
23	3	wildtype	UV	4.19	4.03	0.02	0.0580	0.0102			
24	2	wildtype	UV	5.77	5.92	0.01	0.1487	0.0272	7.70	11.35	1.47
24	3	wildtype	UV	4.20	3.95	0.03	0.0430	0.0080			
25	2	wildtype	UV	5.51	5.66	0.01	0.0418	0.0176	7.95	10.40	1.31
25	3	wildtype	UV	4.69	3.92	0.09	0.0384	0.0100			
26	2	wildtype	UV	5.75	6.16	0.03	0.1135	0.0248	5.96	11.60	1.95
26	3	wildtype	UV	4.62	4.33	0.03	0.0527	0.0116			
27	2	wildtype	UV	5.06	5.06	0.00	0.0327	0.0184	6.17	9.29	1.51
27	3	wildtype	UV	3.86	3.89	0.00	0.0258	0.0083			
28	2	wildtype	UV	5.27	5.36	0.01	0.0509	0.0170	8.11	10.08	1.24
28	3	wildtype	UV	4.49	4.36	0.01	0.0239	0.0096			
29	2	wildtype	UV	5.18	5.54	0.03	0.0622	0.0172	0.83	9.44	11.37
29	3	wildtype	UV				0.0058	0.0015			
30	2	wildtype	UV	5.95	6.16	0.02	0.0836	0.0305	7.80	11.21	1.44
30	3	wildtype	UV	4.75	4.36	0.04	0.0669	0.0141			
31	2	wildtype	UV	6.22	5.94	0.02	0.1171	0.0236	5.08	11.19	2.20
31	3	wildtype	UV	3.07	3.07	0.00	0.0134	0.0042			
32	2	wildtype	UV	5.64	6.30	0.06	0.1413	0.0260	4.63	11.38	2.46
33	2	wildtype	UV	6.51	6.52	0.00	0.0830	0.0255	5.99	12.46	2.08
33	3	wildtype	UV	3.95	4.06	0.01	0.0356	0.0076			
34	2	wildtype	UV	6.20	6.70	0.04	0.1321	0.0247	7.74	12.34	1.59
34	3	wildtype	UV	3.36	3.40	0.01	0.0064	0.0049			
35	2	wildtype	UV	5.97	6.07	0.01	0.0713	0.0224	6.70	11.78	1.76
35	3	wildtype	UV	4.07	4.34	0.03	0.0434	0.0092			
36	2	wildtype	UV	6.16	6.41	0.02	0.0833	0.0260	4.81	12.10	2.52
36	3	wildtype	UV	4.11	3.79	0.04	0.0264	0.0080			
37	2	wildtype	control	5.93	6.32	0.03	0.1192	0.0238	-10.70	11.67	-1.09
37	3	wildtype	control	5.30	4.58	0.07	0.1133	0.0147			
38	2	wildtype	control	5.79	6.10	0.03	0.1673	0.0225	-12.01	11.45	-0.95
38	3	wildtype	control	4.25	3.73	0.07	0.0403	0.0081			
39	2	wildtype	control	5.80	5.70	0.01	0.1817	0.0191	10.12	11.31	1.12
39	3	wildtype	control	3.55	4.29	0.09	0.0197	0.0071			
40	2	wildtype	control	5.38	5.76	0.03	0.1613	0.0205	-10.36	11.04	-1.07
40	3	wildtype	control	5.54	3.69	0.20	0.0362	0.0084			
41	2	wildtype	control	5.35	5.46	0.01	0.1557	0.0190	-9.04	10.29	-1.14
41	3	wildtype	control	3.25	3.20	0.01	0.0071	0.0046			
42	2	wildtype	control	5.29	5.41	0.01	0.1678	0.0200	-9.61	10.55	-1.10
42	3	wildtype	control	4.15	4.49	0.04	0.0748	0.0101			
43	2	wildtype	control	6.39	6.08	0.02	0.2275	0.0250	-11.09	12.24	-1.10
43	3	wildtype	control	3.98	4.34	0.04	0.0548	0.0093			
44	2	wildtype	control	6.18	6.10	0.01	0.1711	0.0262	-11.56	12.37	-1.07

Trial 5 data-
J-30
3 hrs UV for 8 days

44	3 wildtype	control	4.01	3.43	0.08	0.0323	0.0060			
45	2 wildtype	control	6.67	6.46	0.02	0.2221	0.0251	12.53	13.05	1.04
45	3 wildtype	control	3.68	3.76	0.01	0.0164	0.0077			
46	2 wildtype	control	5.68	5.62	0.01	0.1308	0.0164	11.28	11.39	1.01
46	3 wildtype	control	3.47	3.39	0.01	0.0360	0.0061			
47	2 wildtype	control	5.09	5.07	0.00	0.1053	0.0149	9.63	9.80	1.02
48	2 wildtype	control	5.77	6.36	0.05	0.1824	0.0220	9.54	11.55	1.21
48	3 wildtype	control				0.0059	0.0010			
49	2 wildtype	control	5.08	4.89	0.02	0.1387	0.0180	9.90	9.90	1.00
49	3 wildtype	control				0.0088	0.0022			
50	2 wildtype	control	5.62	5.93	0.03	0.1962	0.0218	10.01	11.57	1.16
50	3 wildtype	control	3.96	3.83	0.02	0.0555	0.0085			
51	2 wildtype	control	5.91	6.27	0.03	0.2399	0.0274	-11.60	12.42	-1.07
51	3 wildtype	control	4.41	3.68	0.09	0.0551	0.0092			
52	2 wildtype	control	5.52	5.67	0.01	0.1790	0.0223	10.84	11.02	1.02
52	3 wildtype	control	4.05	4.49	0.05	0.1110	0.0147			
53	2 wildtype	control	5.55	5.05	0.05	0.1671	0.0209	-9.80	10.05	-1.03
53	3 wildtype	control	3.49	4.33	0.11	0.0610	0.0089			
54	2 wildtype	control	6.29	6.29	0.00	0.1969	0.0206	10.30	12.26	1.19
54	3 wildtype	control	4.38	3.72	0.08	0.0361	0.0088			
55	2 wildtype	control	5.65	5.60	0.00	0.2201	0.0226	-10.33	10.83	-1.05
55	3 wildtype	control	3.58	4.56	0.12	0.0547	0.0109			
56	2 wildtype	control	4.98	5.11	0.01	0.1314	0.0158	9.25	9.64	1.04
56	3 wildtype	control				0.0084	0.0016			
57	2 wildtype	control	5.56	5.78	0.02	0.2030	0.0229	11.01	11.01	1.00
57	3 wildtype	control	4.68	4.42	0.03	0.0894	0.0120			
58	2 wildtype	control	6.01	6.16	0.01	0.2606	0.0275	10.02	12.06	1.20
58	3 wildtype	control	3.93	3.74	0.02	0.0228	0.0076			
59	2 wildtype	control	5.70	5.53	0.02	0.1891	0.0222	10.96	11.20	1.02
59	3 wildtype	control	3.51	3.95	0.06	0.0347	0.0069			

Trial 6 data-
J-31
3 hrs UV for 8 days

Plant number	leaf number	Strain	UV/ Control	Left width	Right width	Fresh weight	Dry weight	Rolled width	Flat width	FA	• Flat/ Rolled
1	2	Albino	UV	5.56	5.49	0.0320	0.01710	5.76	7.99	0.006	1.387
1	3	Albino	UV			0.0048	0.00180				
2	2	Albino	UV	5.08	4.86	0.0239	0.01520	3.80	7.54	0.022	1.984
2	3	Albino	UV	2.55	2.39	0.0039	0.00330			0.032	
3	2	Albino	UV	6.10	5.02	0.0469	0.01970	6.43	9.89	0.097	1.538
3	3	Albino	UV			0.0005	0.00009				
4	2	Albino	UV	4.55	5.39	0.0155	0.01020			0.085	
4	3	Albino	UV			0.0001	0.00009				
5	2	Albino	Control	5.10	4.12	0.0214	0.01140	6.87	8.56	0.106	1.246
5	3	Albino	Control			0.0010	0.00009				
6	2	Albino	Control	5.84	5.64	0.0538	0.01550	-10.20	11.36	0.017	-1.114
6	3	Albino	Control	2.36	2.62	0.0031	0.00310			0.052	
7	2	Albino	Control	5.66	5.32	0.0775	0.01250	8.56	10.64	0.031	1.243
7	3	Albino	Control	2.08	1.87	0.0019	0.00190			0.053	
8	2	Albino	Control	6.67	6.57	0.0920	0.01710	11.75	12.78	0.008	1.088
8	3	Albino	Control	2.81	2.57	0.0048	0.00260			0.045	
9	2	Albino	Control	4.58	4.95	0.0414	0.01650	-6.05	8.73	0.039	-1.443
9	3	Albino	Control	3.72	3.76	0.0139	0.00770			0.005	
10	2	Wildtype	UV	5.08	5.28	0.1593	0.01790	4.77	9.62	0.019	2.017
10	3	Wildtype	UV	3.39	3.31	0.0677	0.00710			0.012	
11	2	Wildtype	UV	5.39	5.37	0.1991	0.01910	8.16	10.06	0.002	1.233
11	3	Wildtype	UV	3.33	3.11	0.0533	0.00520			0.034	
12	2	Wildtype	UV	4.19	4.35	0.1698	0.01520	4.93	8.44	0.019	1.712
12	3	Wildtype	UV	2.36	2.25	0.0242	0.00290			0.024	
13	2	Wildtype	UV	3.74	4.01	0.0971	0.01050	4.05	7.70	0.035	1.901
13	3	Wildtype	UV	2.50	2.58	0.0251	0.00300			0.016	
14	2	Wildtype	UV	6.33	6.97	0.3301	0.03070	12.45	13.29	0.048	1.067
14	3	Wildtype	UV	3.73	4.06	0.0886	0.00900			0.042	
15	2	Wildtype	UV	4.20	4.24	0.1095	0.01420	7.14	7.81	0.005	1.094
15	3	Wildtype	UV			0.0098	0.00009				
16	2	Wildtype	UV	5.61	5.54	0.1901	0.02420	3.94	10.54	0.006	2.675
16	3	Wildtype	UV	2.72	2.80	0.0273	0.00430			0.014	
17	2	Wildtype	UV	4.24	4.36	0.0990	0.01360	2.76	8.49	0.014	3.076
17	3	Wildtype	UV	2.89	3.05	0.0377	0.00430			0.027	
18	2	Wildtype	UV	5.18	5.72	0.1856	0.02180	10.32	10.54	0.050	1.021
18	3	Wildtype	UV	3.92	3.81	0.0976	0.01110			0.014	
19	2	Wildtype	UV	5.56	5.67	0.1663	0.02180	2.81	10.91	0.010	3.883
19	3	Wildtype	UV	3.29	3.14	0.0523	0.00660			0.023	
20	2	Wildtype	UV	5.16	5.06	0.1363	0.01680	5.16	9.61	0.010	1.862
20	3	Wildtype	UV	5.06	4.94	0.1140	0.01350			0.012	
21	2	Wildtype	UV	5.84	5.88	0.2244	0.02830	8.46	11.11	0.003	1.313
21	3	Wildtype	UV	3.45	3.43	0.0470	0.00580			0.003	
22	2	Wildtype	UV	4.93	4.99	0.1377	0.01830	8.67	9.79	0.006	1.129
22	3	Wildtype	UV	3.19	2.88	0.0604	0.00670			0.051	
23	2	Wildtype	UV	5.94	6.22	0.2393	0.02880	10.75	11.63	0.023	1.082
23	3	Wildtype	UV	5.05	4.03	0.1219	0.01250			0.112	
24	2	Wildtype	UV	5.34	5.13	0.2062	0.02220	-10.06	10.13	0.020	-1.007
24	3	Wildtype	UV	3.38	3.52	0.0820	0.00910			0.020	
25	2	Wildtype	UV	4.60	5.06	0.2045	0.02050	8.07	8.54	0.048	1.058
25	3	Wildtype	UV	3.93	3.55	0.1300	0.01360			0.051	
26	2	Wildtype	UV	5.87	5.24	0.2548	0.02480	8.67	10.98	0.057	1.266
26	3	Wildtype	UV	3.64	3.79	0.0823	0.00800			0.020	
27	2	Wildtype	UV	4.68	5.04	0.1953	0.01850	7.91	9.52	0.037	1.204
27	3	Wildtype	UV	3.25	3.12	0.0698	0.00680			0.020	
28	2	Wildtype	UV	5.27	4.33	0.0743	0.01530	4.97	9.69	0.098	1.950
28	3	Wildtype	UV	4.87	5.03	0.0414	0.01760			0.016	
29	2	Wildtype	UV	5.13	5.64	0.0445	0.01940	9.87	10.98	0.047	1.112
29	3	Wildtype	UV	4.22	4.24	0.0395	0.01260			0.002	
30	2	Wildtype	UV	5.08	5.31	0.0554	0.02070	10.00	10.00	0.022	1.000
30	3	Wildtype	UV	3.76	3.73	0.0577	0.01030			0.004	
31	2	Wildtype	UV	5.62	4.99	0.0938	0.02130	8.83	10.60	0.059	1.200
31	3	Wildtype	UV	3.31	4.08	0.0474	0.00960			0.104	
32	2	Wildtype	UV	4.80	4.67	0.1135	0.01740	5.34	8.63	0.014	1.616
32	3	Wildtype	UV	1.84	2.44	0.0130	0.00250			0.140	
33	2	Wildtype	Control	5.42	5.90	0.1117	0.02780	10.03	11.11	0.042	1.108
33	3	Wildtype	Control	3.42	3.29	0.0188	0.00600			0.019	
34	2	Wildtype	Control	5.99	5.81	0.1754	0.02530	9.69	11.11	0.015	1.147
34	3	Wildtype	Control	3.23	3.44	0.0144	0.00730			0.031	
35	2	Wildtype	Control	5.17	5.16	0.1262	0.01960	9.63	10.39	0.001	1.079
35	3	Wildtype	Control	3.40	3.11	0.0334	0.00760			0.045	
36	2	Wildtype	Control	5.98	6.35	0.1631	0.02460	-11.81	11.87	0.030	-1.005
36	3	Wildtype	Control	3.65	3.62	0.0172	0.00770			0.004	
37	2	Wildtype	Control	5.53	5.87	0.1460	0.02340	8.44	10.78	0.030	1.277
37	3	Wildtype	Control	2.02	1.93	0.0074	0.00330			0.023	
38	2	Wildtype	Control	6.42	6.15	0.2514	0.03630	11.41	12.25	0.021	1.074
38	3	Wildtype	Control	2.73	2.56	0.0061	0.00430			0.032	
39	2	Wildtype	Control	6.18	6.28	0.1768	0.02810	11.64	12.13	0.008	1.042
39	3	Wildtype	Control	4.85	4.43	0.0610	0.01200			0.045	
40	2	Wildtype	Control	6.00	5.75	0.1647	0.03290	8.80	11.51	0.021	1.308
40	3	Wildtype	Control	3.44	3.80	0.0306	0.00800			0.050	
41	2	Wildtype	Control	4.90	4.86	0.0709	0.01910	9.31	9.31	0.004	1.000
41	3	Wildtype	Control	3.27	3.15	0.0324	0.00610			0.019	
42	2	Wildtype	Control	5.51	5.60	0.1062	0.02460	-10.56	10.78	0.008	-1.021
42	3	Wildtype	Control	4.31	4.76	0.0894	0.01490			0.050	
43	2	Wildtype	Control	5.43	5.46	0.1396	0.02690	10.76	10.96	0.003	1.019
43	3	Wildtype	Control	4.39	3.72	0.0609	0.01030			0.083	

Trial 6 data-
J-31
3 hrs UV for 8 days

44	2	Wildtype	Control	3.90	3.86	0.0470	0.01360	7.20	7.20	0.005	1.000
44	3	Wildtype	Control	2.66	2.36	0.0158	0.00400			0.060	
45	2	Wildtype	Control	5.67	5.62	0.1718	0.02790	-10.67	10.92	0.004	-1.023
45	3	Wildtype	Control	5.12	4.77	0.0893	0.01320			0.035	
46	2	Wildtype	Control	4.81	4.74	0.1075	0.01830	9.46	9.46	0.007	1.000
46	3	Wildtype	Control	2.92	2.88	0.0247	0.00490			0.007	
47	2	Wildtype	Control	5.58	5.28	0.1818	0.02690	10.25	10.50	0.028	1.024
47	3	Wildtype	Control	4.25	5.12	0.1064	0.01430			0.093	
48	2	Wildtype	Control	5.69	5.40	0.1646	0.02950	-10.34	11.05	0.026	-1.069
48	3	Wildtype	Control	3.68	4.21	0.0686	0.00920			0.067	
49	2	Wildtype	Control	4.63	5.25	0.1603	0.01860	9.05	9.38	0.063	1.036
49	3	Wildtype	Control	4.68	3.71	0.0860	0.00980			0.116	
50	2	Wildtype	Control	5.69	5.69	0.1951	0.02450	10.78	11.04	0.000	1.024
50	3	Wildtype	Control	4.11	3.94	0.0792	0.01130			0.021	
51	2	Wildtype	Control	5.98	6.00	0.1649	0.02720	10.17	11.42	0.002	1.123
51	3	Wildtype	Control	3.20	3.85	0.0301	0.00670			0.092	
52	2	Wildtype	Control	5.94	6.00	0.2833	0.02520	11.52	11.66	0.005	1.012
52	3	Wildtype	Control	5.59	5.03	0.2228	0.02100			0.053	
53	2	Wildtype	Control	6.02	5.50	0.2732	0.02390	9.72	11.29	0.045	1.162
53	3	Wildtype	Control	2.88	2.87	0.0487	0.00490			0.002	
54	2	Wildtype	Control	5.76	5.90	0.2200	0.02040	-11.14	11.99	0.012	-1.076
54	3	Wildtype	Control								

Trial 7 data-
J-30
3 hrs UV for 8 days

Plant #	Leaf #	Strain	UV/ Control	Left width	Right width	Fresh weight	dry weight	Rolled width	Flat width	FA	Flat/ Rolled Ra
1	2	Albino	control	4.79	4.63	0.0206	0.0140	8.62	8.62	0.017	1.000
1	3	Albino	control	5.18	5.83	0.0252	0.0149			0.059	
2	2	Albino	control	4.64	5.19	0.0181	0.0129	8.31	9.53	0.056	1.147
2	3	Albino	control	4.43	4.34	0.0033	0.0027			0.010	
3	2	Albino	control	6.65	6.96	0.0431	0.0289	-11.21	12.86	0.023	-1.147
3	3	Albino	control	5.97	6.71	0.0458	0.0126			0.058	
4	2	Albino	UV	5.55	5.62	0.0285	0.0214	5.08	11.45	0.006	2.254
4	3	Albino	UV	6.27	6.44	0.0363	0.0213			0.013	
5	2	Albino	UV	6.81	6.70	0.0482	0.0279	7.63	11.15	0.008	1.461
5	3	Albino	UV	6.81	6.84	0.0588	0.0197			0.002	
6	2	Albino	UV	5.06	5.37	0.0242	0.0183	8.03	9.88	0.030	1.230
6	3	Albino	UV	6.02	6.22	0.0347	0.0231			0.016	
7	2	Albino	UV	5.34	6.26	0.0238	0.0190			0.079	
7	3	Albino	UV	6.63	6.14	0.0196	0.0144			0.038	
8	2	Wildtype	UV	7.42	7.30	0.4904	0.0419	14.60	14.60	0.008	1.000
8	3	Wildtype	UV	5.51	5.70	0.1632	0.0150			0.017	
9	2	Wildtype	UV	6.51	6.53	0.2333	0.0273	2.15	12.93	0.002	6.014
9	3	Wildtype	UV	7.20	7.29	0.4336	0.0421			0.006	
10	2	Wildtype	UV	7.62	7.59	0.2800	0.0260	14.19	15.32	0.002	1.080
10	3	Wildtype	UV	6.99	7.05	0.2441	0.0236			0.004	
11	2	Wildtype	UV	8.04	7.91	0.4089	0.0335	11.80	15.86	0.008	1.344
11	3	Wildtype	UV	6.70	6.97	0.2053	0.0177			0.020	
12	2	Wildtype	UV	6.57	6.64	0.2173	0.0185	12.60	13.61	0.005	1.080
12	3	Wildtype	UV	6.42	6.36	0.3742	0.0334			0.005	
13	2	Wildtype	UV	7.73	8.13	0.2254	0.0242	14.93	16.86	0.025	1.129
13	3	Wildtype	UV	8.49	8.28	0.5096	0.0481			0.013	
14	2	Wildtype	UV	7.09	7.14	0.1957	0.0196	11.15	14.37	0.004	1.289
14	3	Wildtype	UV	7.46	7.92	0.5066	0.0498			0.030	
15	2	Wildtype	UV	6.66	7.45	0.4630	0.0392	12.66	14.19	0.056	1.121
15	3	Wildtype	UV	6.05	5.52	0.1848	0.0167			0.046	
16	2	Wildtype	UV	6.85	6.44	0.2199	0.0244	5.52	13.22	0.031	2.395
16	3	Wildtype	UV	7.27	6.40	0.3516	0.0359			0.064	
17	2	Wildtype	UV	6.63	7.03	0.2923	0.0310	10.10	13.83	0.029	1.369
17	3	Wildtype	UV	7.76	7.61	0.6086	0.0491			0.010	
18	2	Wildtype	UV	6.23	5.70	0.2342	0.0209	11.85	12.07	0.044	1.019
18	3	Wildtype	UV	6.93	6.73	0.3885	0.0351			0.015	
19	2	Wildtype	UV	5.66	5.40	0.0960	0.0212	0.00	10.72	0.024	10720.000
19	3	Wildtype	UV	3.19	3.47	0.0200	0.0055			0.042	
20	2	Wildtype	UV	7.08	6.16	0.0837	0.0202	11.07	13.24	0.069	1.196
20	3	Wildtype	UV	6.92	7.14	0.2122	0.0310			0.016	
21	2	Wildtype	UV	7.38	7.29	0.0961	0.0206	10.04	14.00	0.006	1.394
21	3	Wildtype	UV	6.39	6.02	0.1081	0.0174			0.030	
22	2	Wildtype	UV	8.40	6.51	0.0934	0.0252	11.99	14.40	0.127	1.201
22	3	Wildtype	UV	9.02	8.22	0.2475	0.0537			0.046	
23	2	Wildtype	UV	5.14	5.65	0.0359	0.0233	2.50	10.03	0.047	4.012
23	3	Wildtype	UV	7.77	7.56	0.2190	0.0456			0.014	
24	2	Wildtype	UV	7.46	6.88	0.0376	0.0176	8.75	14.82	0.040	1.694
24	3	Wildtype	UV	7.42	7.09	0.1568	0.0140			0.023	
25	2	Wildtype	UV	6.26	6.53	0.1485	0.0269	11.28	12.06	0.021	1.069
25	3	Wildtype	UV	6.04	5.81	0.1144	0.0200			0.019	
26	2	Wildtype	control	8.14	8.07	0.1633	0.0222	-9.57	15.92	0.004	-1.664
26	3	Wildtype	control	7.80	7.99	0.3147	0.0374			0.012	
27	2	Wildtype	control	7.54	6.69	0.3096	0.0347	-8.55	13.84	0.060	-1.619
27	3	Wildtype	control	8.91	7.80	0.5109	0.0570			0.066	
28	2	Wildtype	control	8.30	8.91	0.2786	0.0333	-14.25	17.14	0.035	-1.203
28	3	Wildtype	control	9.60	10.33	0.6002	0.0536			0.037	
29	2	Wildtype	control	6.84	6.92	0.2101	0.0296	-10.57	13.99	0.006	-1.324
29	3	Wildtype	control	8.10	7.96	0.3529	0.0350			0.009	
30	2	Wildtype	control	6.78	7.12	0.0926	0.0141	-13.01	13.33	0.024	-1.025
30	3	Wildtype	control	7.63	7.15	0.2749	0.0290			0.032	
31	2	Wildtype	control	5.52	5.97	0.1596	0.0233	-10.72	11.06	0.039	-1.032
31	3	Wildtype	control	6.89	7.43	0.4940	0.0493			0.038	
32	2	Wildtype	control	6.96	7.06	0.1444	0.0180	13.67	13.67	0.007	1.000
32	3	Wildtype	control	8.24	7.87	0.3333	0.0336			0.023	
33	2	Wildtype	control	7.88	7.72	0.1504	0.0226	15.66	15.66	0.010	1.000
33	3	Wildtype	control	8.84	9.03	0.4261	0.0449			0.011	
34	2	Wildtype	control	6.88	6.88	0.1200	0.0173	13.02	13.80	0.000	1.060
34	3	Wildtype	control	7.07	7.15	0.3623	0.0372			0.006	
35	2	Wildtype	control	8.03	7.81	0.1805	0.0273	-6.74	15.54	0.014	-2.306
35	3	Wildtype	control	8.09	8.75	0.4779	0.0530			0.039	
36	2	Wildtype	control	7.34	7.83	0.3731	0.0388	-14.64	15.02	0.032	-1.026
36	3	Wildtype	control	8.88	8.52	0.3871	0.0417			0.021	
37	2	Wildtype	control	5.97	5.98	0.1696	0.0175	11.93	11.97	0.001	1.003
37	3	Wildtype	control	6.14	6.11	0.2708	0.0285			0.002	