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Investigating inter-specific competition between two winter grasses in Beijing. Following seeding out of *Poa annua* and *Festuca arundinacea* in different proportions, their Leaf Dry Mass Content and Root Shoot Ratio investigated over time to determine Competitive Success between these two winter grasses

Cheung Teur Teur Sally

Abstract - *Poa annua* is a perennial C_3 cool-season grass, germinating in Beijing, late summer and early autumn with soil temperature below 20°C, whereas *Festuca arundinacea*, though C_3 and a cool-season grass, grows from March to June. *F. arundinacea* is found as a large, well rooted and shooted species, whereas *P. annua* is much smaller, shallow-rooted and apparently requires disturbance such as grazing, mowing or trampling to attain full vigor. The purpose then of the present investigation was to measure competition between these two species. The parameters used were Leaf Dry Mass Content (LDMC) in grams and modified root shoot ratio (R:S) in centimeters. High LDMC reflects biomass accumulation and nutrient intake, whereas low modified R:S indicates enhanced nutrient uptake. Experiments from seed were carried out over nine weeks (two weeks germination process and seven weeks post-germination), the investigations first carried out in the greenhouse, with relatively controlled humidity and temperature, then transferred into the school lab for data collection. A once-a-week watering regime was administered to thirty pots, prepared with nutrient garden-loam, divided into five different seed density proportions. During week three, all the pots with their seedling contents were deliberately disturbed by mowing to 4.5 cm tall, to potentially enhance the supposed eco-physiological strategy of *P. annua*. Up to week three, *F. arundinacea* showed slightly higher R:S and relatively lower LDMC than *P. annua*, at most proportions. After mowing, *F. arundinacea* showed much higher R:S at most proportions and a much lower LDMC than *P. annua* at all proportions. If high R:S definitely indicates poor nutrient uptake and if high LDMC truly indicates biomass accumulation , then the results tentatively suggest that over time (perhaps months, at Beijing's latitude), *P. annua* is likely to outgrow *F. arundinacea*, particularly if *P. annua* has the initial advantage of high density sewing.

Index Term - From hereforth onwards**, Festuca arundinacea** and **Poa annua** are referred to as F. arundinacea and P. annua respectively. Proportions order would always be **P.annua : F. arundinacea**.

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1 INTRODUCTION

POA ANNUA, (also known as Annual Bluegrass) a perennial cool-season grass, is tetraploid hybrid of *P. supine*, *P. infirma* and another species. *P. annua* has a stem growth length up to 30cm. The color of the leaves are yellowish green to light green and has a canoe-shaped leaf tip. It is capable of producing inflorescence and viable seeds at the height of 6mm. Each strand of grass without been genetically modified can reproduce about 1050 to 2250 seeds. It germinates during late summer and early autumn with soil temperature below 20°C. (Pagad, 2009)

P. annua tolerates wide ranges of extreme climatic conditions and has found growing in Sub-Antarctic area and on volcanic ash with pH around 6.8 (*P. annua* can grow in soil textured from pH 4.8 - 8.0). Unsurprisingly, it is listed as potential seed contaminant and crop pest, golf courses mainly. They reduce quality, aesthetics and functionality of the grasses with shallow root system and lighter green color. Moreover, *P. annua* requires more water than other grasses. Additionally, they require continuing biotic disturbance by trampling to provide bare grounds and nutrient enrichment by molting and manuring (Pagad, 2009). So overall *P. annua* is r-strategist because it is a small sized organism, low energy is used for each individual and many seedlings as offspring, etc. (Bio.miami.edu, 2013)

Festuca arundinacea, (other name called as tall fescue) also a perennial cool-season C_3 grass of bunchgrass, has short slowly spreading rhizomes and is deeply rooted. The blades of the leaves are dark green. Rayburn, E. (2003) indicates under good care, it can grow up to 121.92cm. *F. arundinacea* is suited for high rainfall temperature climates and grows in autumn and early winter, usually from March to June. It has range of wide soil varieties and especially grows best with heavy, deep and soils that have high organic matters. Tolerates pH from 4.8 to 6.5, tall fescue can survive not only in short periods of flooding and wet soils but also in drought, though it has poor seedling vigor (Harris and Innes et al. 2003). Therefore, *F. arundinacea* is a K-strategist because it is a large size organism, high energy use for every individual and low production of offspring (seeds), etc. (Bio.miami.edu, 2013)

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The purpose of investigation is to identify possible competitive success of these two grasses measuring LDMC, measuring R:S, and calculating Chi-test and correlation graphs to further support the arguments. The experiment is worthy of investigation because competitive success is defined with the amalgam of statistics and biology math. The investigation is inspired by the research paper '*The Research and Investigation for Species and Growing of the Lawn in Beijing Region*' (Yang and Hong et al., 2002, pp. 1-17). *P. annua* is the most populated grass in Beijing while *F. arundinacea* is not so. Moreover, after interviewing the gardener at the greenhouse, he said *P. annua* was the 'stronger' species. However online research about *P. annua* seems to be more recessive than *F. arundinicea*. So this is one point why I am carrying out this investigation.

Moreover in research, competition investigation between *P. annua* and *F. arundinacea* are rarely done, especially no similar test has been found parallel to this investigation. To relate LDMC and R:S to *P. annua* and *F. arundinacea*, data are collected in week interval to measure mass and length of each individual grass.

Location of investigation: Beijing Green Abundant World Garden Machinery Distribution Center.

Leaf Dry Mass Content (LDMC, ratio of dry mass to fresh mass) is an important trait in plant ecology due to the association with many plant growth and survival critical aspects. In plants, LDMC explains variation in ecological behaviors and relative growth rates. It involves in trade-off between efficient nutrients conservation and rapid biomass production. Moreover, it is also traits of indicators of resource-use strategies and is important evaluators these traits for species of different plant in various environments. (Cui and Johnson et al. 2004)

Root-shoot ratio (R:S) is usually the ratio between the root mass and the shoot mass of a plant. However by measuring in length, supposedly the root length indicates the absorbing ability in the roots and root grow by length to explore the soil. The reduced in R:S means improving growing condition with factors such as favorable fertilization, irrigation, weather, pest control or aeration. Therefore, an increase in root-shoot ratio indicates that plants are possibly growing in a less favorable condition. (Harris, 1992)

2 MATERIALS AND METHODS

2.1 General Methods

Root shoot ratio: The R:S of grasses was collected by measuring the root length (RL) and shoot length (SL, process was carried out in the laboratory. The measurement of R:S should be carried out before LDMC because LDMC required the cutting of the plant. (Harris, 1992)

Leaf dry mass content: The LDMC of grasses was collected by weighing both dry (Dry Mass, DM) and fresh (Fresh Mass, FM) of the leaves in the laboratory. Fresh mass of the grass content should be taken with care so that there would be no water evaporation taking place. Therefore after weighing a group of grasses, they are put in plastic food wrap to avoid evaporation and before putting in an electronic for drying, unwrap the plastic wrap. After weighing all the FM by an analytical balance with 0.001g tolerance, the contents were dried in an electronic heat oven with 1°C tolerance for 48 hours under 60°C (Pontes and Louault et al. 2010). The leaves of the grasses in the oven should be smoothly spread so that maximum areas are exposed to the heat and are readily dried afterwards for weighing.

After collecting mass data of both dry mass and fresh mass for both annual bluegrass and tall fescue, LDMC was calculated by using the equation:

[LDMC = Dry Mass/ Fresh Mass] (Pontes and Louault et al. 2010)

Chi-test methodology: it was made sure there were no percentages, ratios or value below five used for the test (Key, 1997).

Soil: The same soil remains throughout the 9 weeks experiment without adding any nutrients. The soil used includes: peat, bloated perlite, humic acid, nitrate, phosphorous and potassium, production of Beijing Fengtai District Xinfadi Honghua Garden Spot.

Experimental design layout: The way to experiment on competition success is by growing annual bluegrass and tall fescue in different proportions: 1:0, 8:2, 5:5, 2:8 and 0:1. Proportion calculation is done in area method (seed coverage). Since seeds are uncountable due to their sizes, therefore the seeds put into per trait are in area, 10cm^2 total. Then with calculation of area ratios, areas of seed amount are planted into the traits. Post-germination takes 2 weeks period and afterwards, data can be collected in the laboratory. 30 traits of grasses are planted in total, 6 traits for each proportion.

On the third week onwards, post-germination, 5 traits of different proportions were brought from the greenhouse to the school laboratory for data collection. Water regime is per week in 20 cm^3 as enough water (Gethsemanegardens.com, 2013).

Table 1a: Exemplar data processing calculations and calculated results are in 3 decimal places.

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Root Shoot Ratio (R:S)	
Formula	$\text{R:S} = \frac{\text{total root length for each proportion (cm)}}{\text{total shoot length for each proportion (cm)}}$
Sample	R:S of 1:0 *P. annua* from Week 1. 30 strands of grasses are taken from the soil and root and shoot length are measured in cm with tolerance of 0.1cm. Sum of 30 samples' root and shoot length first calculated and R:S value is based on these data. $\text{R:S} = \frac{50.800}{107.700} = 0.473$
R:S found in	Table 2 *(Appendix)* and Graph 2
Leaf Dry Mass Content (LDMC)	
Formula	$\text{LDMC} = \frac{\text{total dry mass of 30 strands of grass (g)}}{\text{total fresh mass of 30 strands of grass (g)}}$
Sample	LDMC of proportion 1:0, Week 1. Total is used because after heating, individual grass strand cannot be distinguished. 3 decimal places are used for electric balance for accurate mass. $\text{LDMC} = \frac{0.005}{0.072} = 0.001$
LDMC found in	Table 3 *(Appendix)* and Graph 3
Mean ($\bar{x}$) – arithmetic average of collected data	
Formula	$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$ n – the number of samples x_i – individual data value
Sample	Mean of 0:1 *F. arundinacea* average root length of week 6. First add the sum of all 30 strands of grasses' length in cm and then divided by the number of samples. $\bar{x} = \frac{6.1+5.5+4.8+4.3+\cdots+5.9}{30} = 5.540$ cm
$\bar{x}$ found in	Table 2 and Table 3 *(Appendix)*
***Standard Deviation (SD or s)** – measurement of data spread*	
Formula	$s = \sqrt{\frac{\sum(x-\bar{x})^2}{n-1}}$ s: standard deviation; n: number of data values; x: individual data value; $\bar{x}$: mean of data values
Sample	Calculation from Table 2, 1:0, Week 1, average shoot length (cm). 30 strands of grasses are used. Data extracted from *Appendix, Data collection of Week 1*,Root and Shoot length. $s = \sqrt{\frac{(2.40-3.59)^2+(3.10-3.59)^2+\cdots+(3.50-3.59)^2}{30-1}} = 0.799$
SD found in	Table 2 and Table 3 *(Appendix)*

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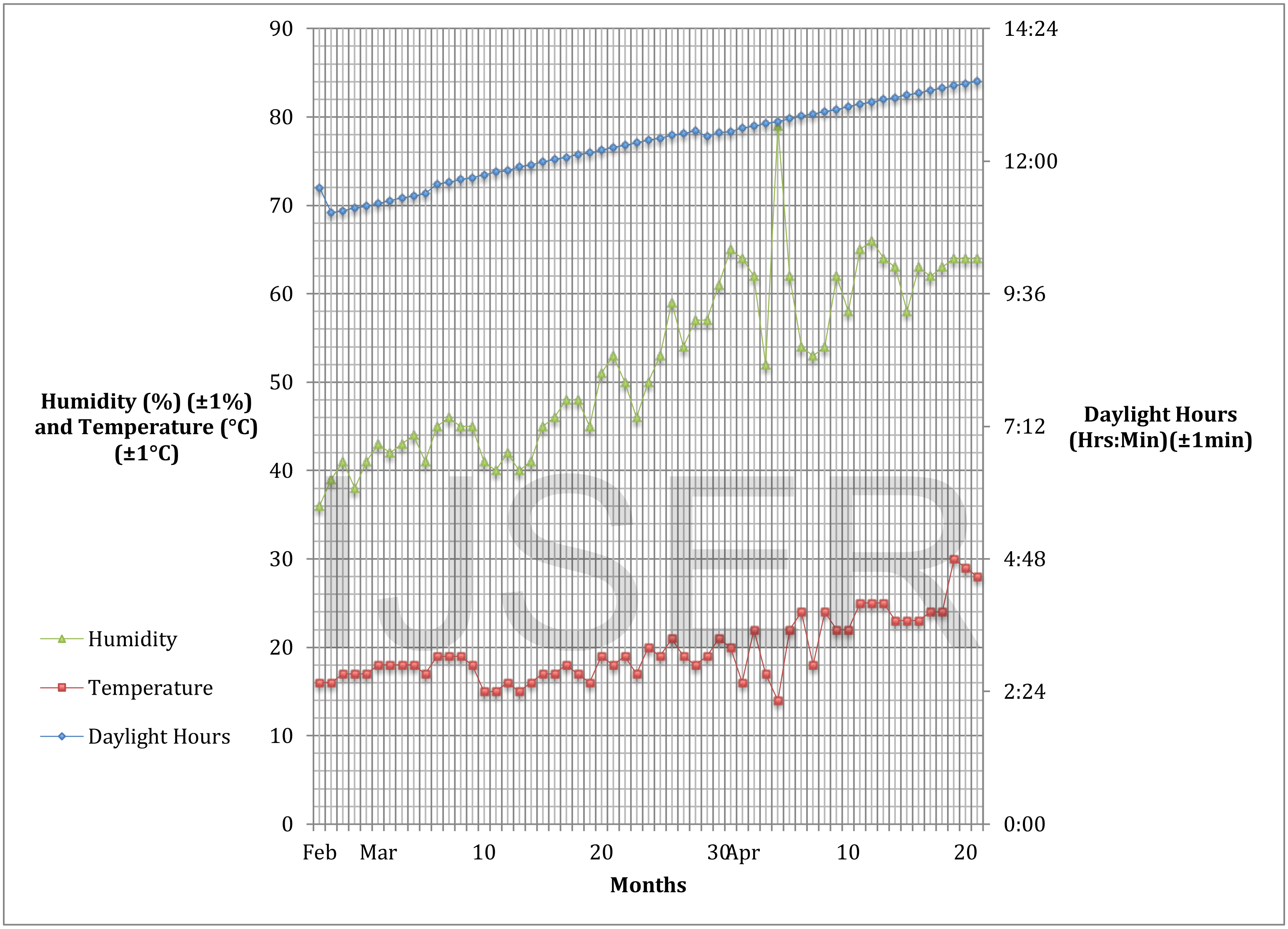
2.2 Methodology control of the Greenhouse:

Graph 1b: Daylight hours in hrs:min with tolerance of 1 min, **humidity** in % with tolerance of 1% and t**emperature** in °C with tolerance of 1°C. Humidity and temperature were measured with a mercury thermometer and a hygrometer that is hanged in the atmosphere of the greenhouse the grasses are planted in. While daylight hours is collected online from Timebie.com (2013). In the greenhouse, a veil on the rooftop that allows flowing air & humidity control, and thick wall for sustaining temperature was used to control the humidity and temperature. These are used for plants to survive in cold late February to April.



3 RAW DATA

Raw data tables containing all original raw data of root and shoot length (R:S), leaf dry and wet mass (LDMC), are to be found in *Appendix.*

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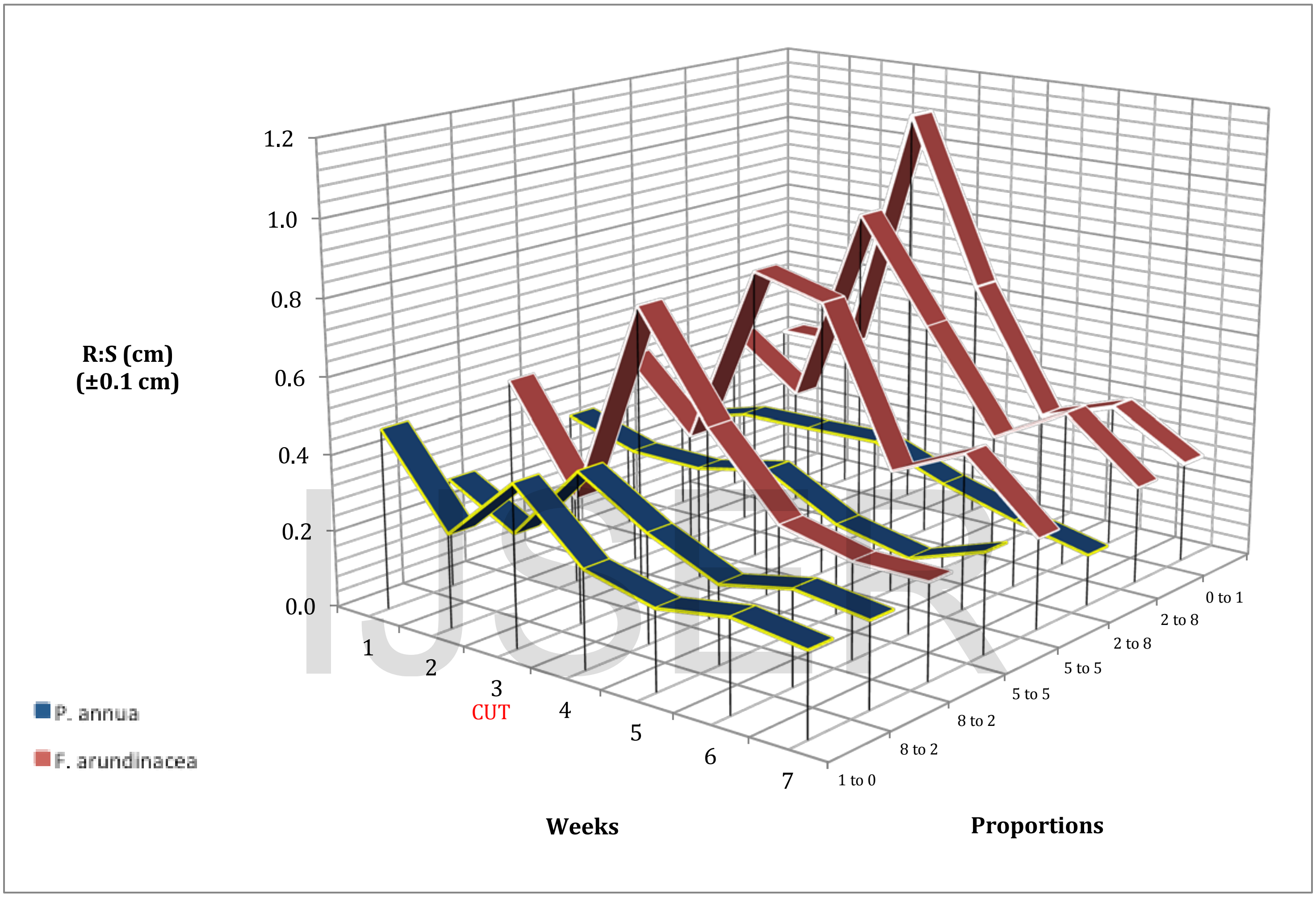
4 RESULTS

Graph 2 (the full raw data table can be found in the *Appendix*): R:S of *P. annua* and *F. arundinacea* in 7 weeks time of 5 different proportions, with tolerance of 0.1 cm. R:S is calculated in length (cm) instead of mass (g), which is also viable. There is a deliberately induced disturbance (mowing down to 4.5 cm) during Week 3 as *F. arundinacea* is 'taking advantage' physiologically by germinating in a faster speed, thus by cutting can equalize the competition between them. This graph's data is based on *Table 2, Appendix.* Further explanation is in *Conclusion*.



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<u>Chi-Squared of independence to show mathematically whether there are significant difference between 4 seeded out proportions and average root growth rates (mm per week) of *Poa annua* in 7 weeks</u>

Purpose: Using mathematic to prove that there are significant differences between 4 proportions and average growth rates:

Null hypothesis: (in decreasing order): 1:0 > 8:2 > 5:5 > 2:8

Growth rate	1:0	8:2	5:5	2:8	Row Totals	
Week 1 obs.	16.93	12.00	3.79	1.97	34.69	Row 1
exp.	10.87	9.59	8.16	6.06		
(obs. – exp.)²/ exp.	3.39	0.61	2.67	2.76		
Week 2 obs.	15.40	11.20	15.00	11.00	52.60	Row 2
exp.	16.49	14.55	12.37	9.20		
(obs. – exp.)² /exp.	0.07	0.77	0.56	0.35		
Week 3 obs.	19.00	17.88	13.33	13.50	63.71	Row 3
exp.	19.97	17.62	14.98	11.14		
(obs. – exp.)² /exp.	0.05	0.000	0.18	0.50		
Week 4 obs.	17.13	17.25	18.27	15.00	67.65	Row 4
exp.	21.20	18.71	15.91	11.83		
(obs. – exp.)² /exp.	0.78	0.11	0.35	0.85		
Week 5 obs.	17.53	15.54	16.67	11.67	61.41	Row 5
exp.	19.25	16.98	14.44	1.74		
(obs. – exp.)² /exp.	0.15	0.12	0.34	0.08		
Week 6 obs.	27.10	25.54	18.60	15.00	86.24	Row 6
exp.	27.03	23.85	2.28	15.08		
(obs. – exp.)² /exp.	0.000	0.12	0.14	0.000		
Week 7 obs.	36.87	32.92	26.87	15.50	112.16	Row 7
exp.	35.15	31.02	263.8	19.61		
(obs. – exp.)² /exp.	0.08	0.12	0.000	0.86		
Column totals	149.96	132.33	1125.3	83.64	478.46	

The data is based on Table 2, Appendix.

Degrees of freedom = (7 – 1) × (4 – 1) = 18

Sum of (obs. – exp.)² /exp. = 3.39 + 0.61 + 2.67 + 2.76 + 0.07 + 0.77 + 0.56 + 0.35 + 0.05 + 0.00 + 0.18 + 0.050 + 0.78 + 0.11 + 0.35 + 0.85 + 0.15 + 0.12 + 0.34 + 0.08 + 0.00 + 0.12 + 0.14 + 0.00 + 0.08 + 0.12 + 0.00 + 0.06 = 17.17

∴ **Chi² = 17.17**

- Comparing the critical X² value in X² table at 0.05 alpha level: 28.869 > 17.17

(See Stat.tamu.edu, 2009 for more details of X² table)

Thus the test shows insignificance mathematically.

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Chi-Squared of independence to show mathematically whether there are significant differences between 5 seeded out proportions and average root growth rates of *Festuca arundinacea* in 7 weeks

Purpose: Using mathematic to prove that there are significant differences between 5 proportions and average growth rates:
Null hypothesis: (in decreasing order): 1:0 > 8:2 > 5:5 > 2:8

Growth rate		1:0	8:2	5:5	2:8	Row Totals	
Week 1	obs.	36.87	40.75	39.93	33.00	15.055	Row 1
	exp.	41.22	38.93	37.82	32.58		
	$(obs. - exp.)^2/$ exp.	0.46	0.09	0.11	0.01		
Week 2	obs.	52.90	40.50	44.00	37.50	174.90	Row 2
	exp.	47.89	45.22	43.93	37.85		
	$(obs. - exp.)^2$ /exp.	0.52	0.49	0.00	0.00		
Week 3	obs.	49.03	38.20	34.87	34.67	156.77	Row 3
	exp.	42.93	4.54	39.38	33.93		
	$(obs. - exp.)^2$ /exp.	0.87	0.14	0.52	0.02		
Week 4	obs.	44.73	45.79	52.40	4.00	183.22	Row 4
	exp.	5.17	47.38	46.02	39.65		
	$(obs. - exp.)^2$ /exp.	0.59	0.05	0.88	0.00		
Week 5	obs.	46.87	52.75	49.00	41.50	190.12	Row 5
	exp.	52.06	49.16	47.76	41.14		
	$(obs. - exp.)^2$ /exp.	0.52	0.26	0.03	0.00		
Week 6	obs.	55.40	51.08	5.40	43.83	200.71	Row 6
	exp.	54.96	51.90	5.42	43.43		
	$(obs. - exp.)^2$ /exp.	0.00	0.01	0.00	0.00		
Week 7	obs.	52.27	5.17	39.53	36.67	178.64	Row 7
	exp.	48.92	46.19	44.87	38.66		
	$(obs. - exp.)^2$ /exp.	0.23	0.34	0.64	0.10		
Column totals		338.07	319.24	310.13	267.17	1234.61	

The data is based on Table 2, Appendix.

Degrees of freedom = $(7 - 1) \times (4 - 1) = 18$

Sum of $(obs. - exp.)^2$ /exp. = 0.46 + 0.09 + 0.11 + 0.01 + 0.52 + 0.49 + 0.00 + 0.00 + 0.87 + 0.14 + 0.52 + 0.02 + 0.59 + 0.05 + 0.88 + 0.00 + 0.52 + 0.26 + 0.03 + 0.00 + 0.00 + 0.01 + 0.00 + 0.00 + 0.23 + 0.34 + 0.64 + 0.10 = 7.28

∴ **Chi^2 = 7.28**

- Comparing the critical X^2 value in X^2 table at 0.05 alpha level: 28.869 > 7.28

(See Stat.tamu.edu, 2009 for more details of X^2 table)

Thus the test shows insignificance mathematically.

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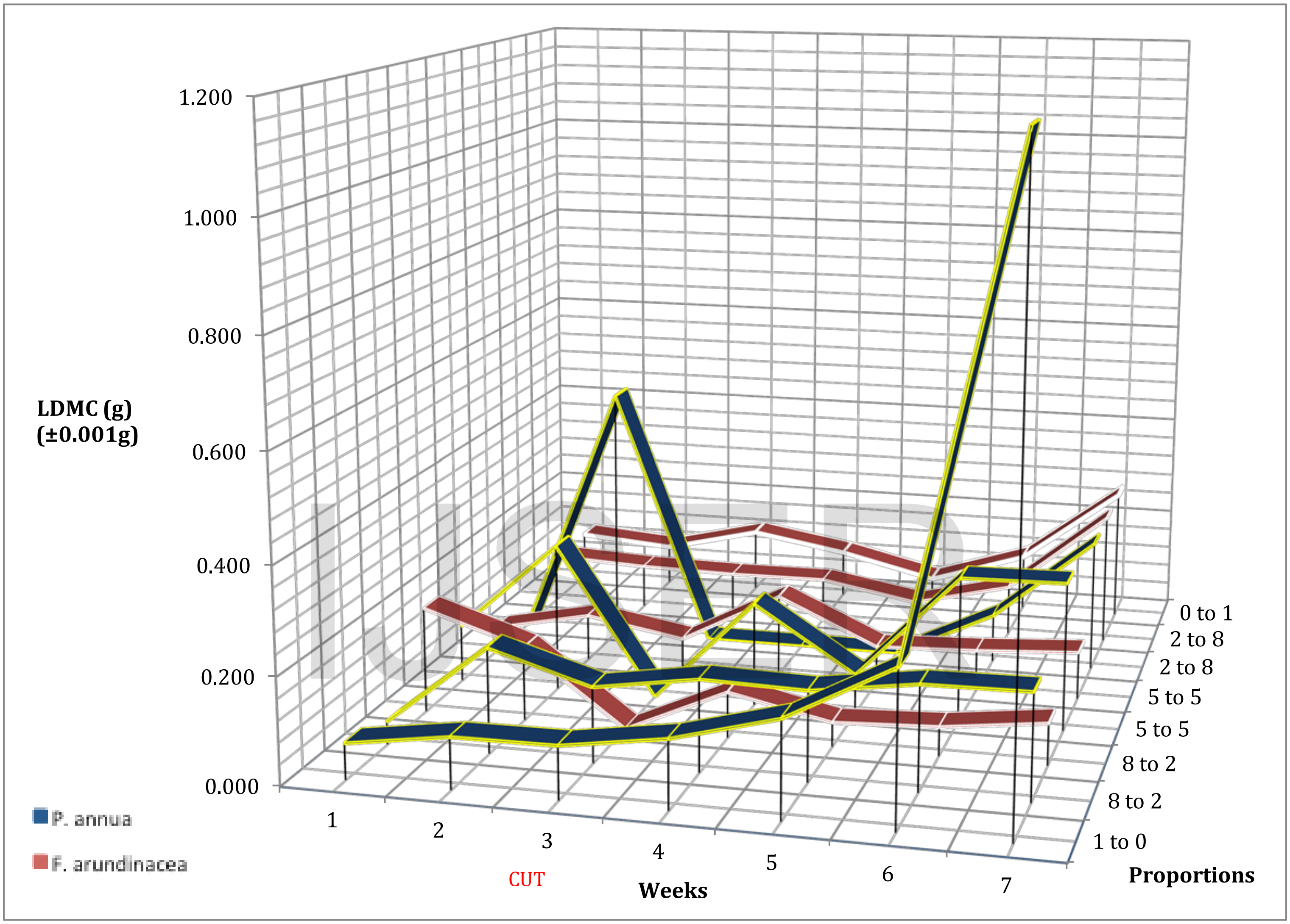
Graph 3: LDMC (dry mass to fresh mass ratio) of 7 weeks with 5 different proportions: 1:0, 8:2, 5:5, 2:8 and 0:1. The blue trends stand for *P. annua* and red trends stand for *F. arundinacea* of each week. LDMC has a tolerance of 0.001g in this experiment as the electronic balance was in 3 decimal places. There is a deliberately induced disturbance (mowing down to 4.5 cm) during Week 3 as *F. arundinacea* is 'taking advantage' physiologically by germinating in a faster speed, thus by cutting can equalize the competition between them. This graph is based on *Table 3, Appendix*. Further explanation is in *Conclusion*.



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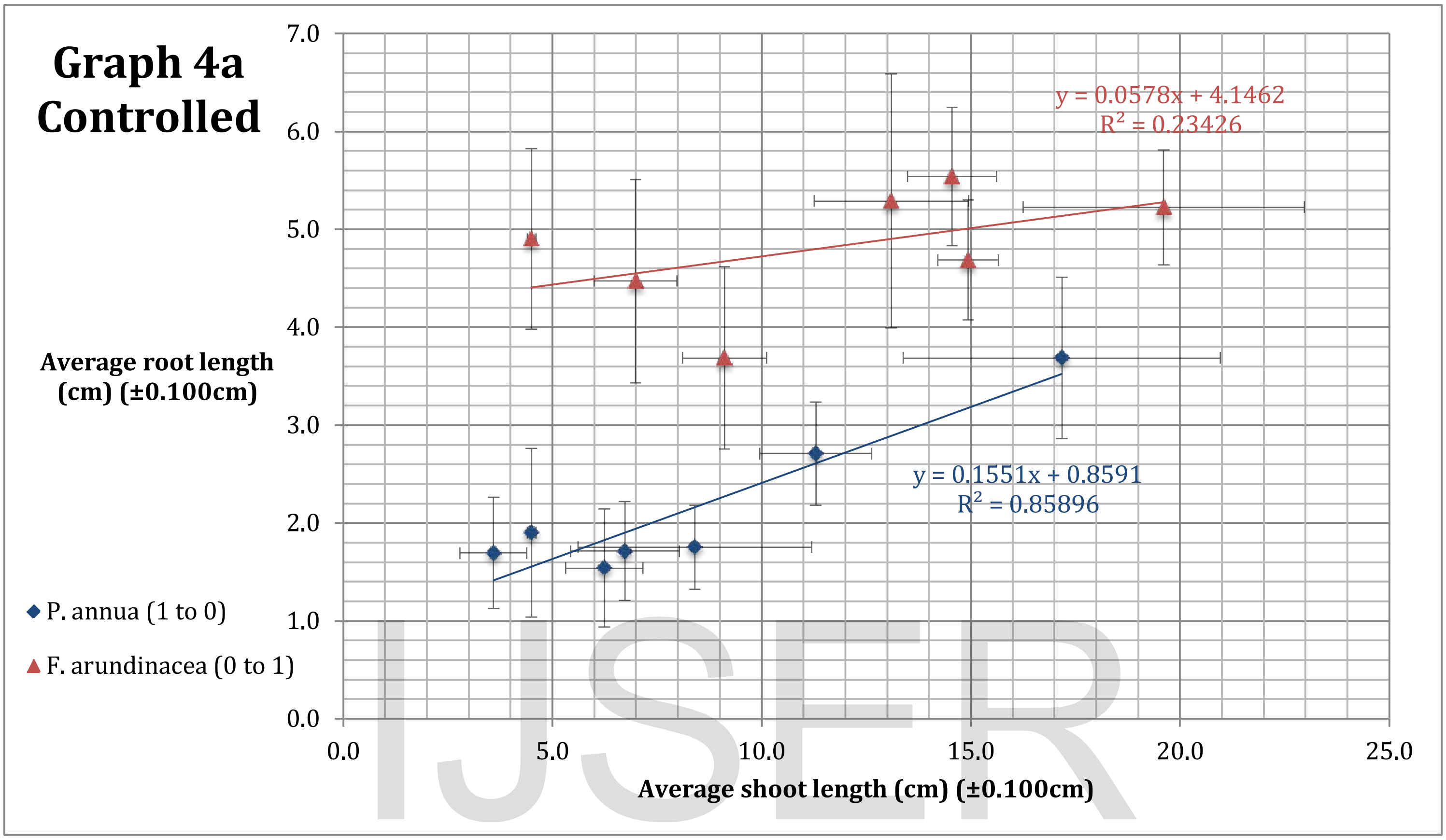
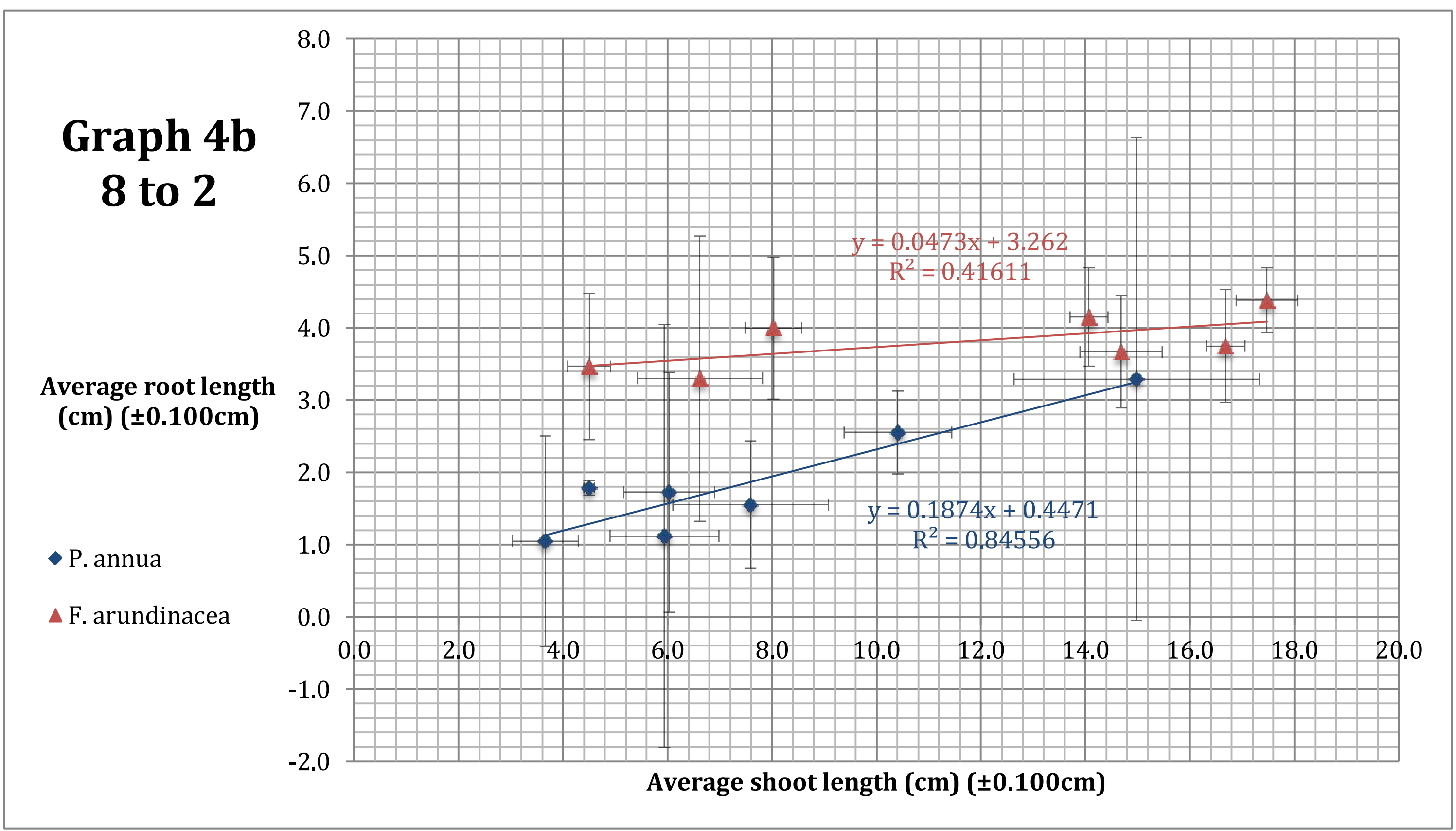
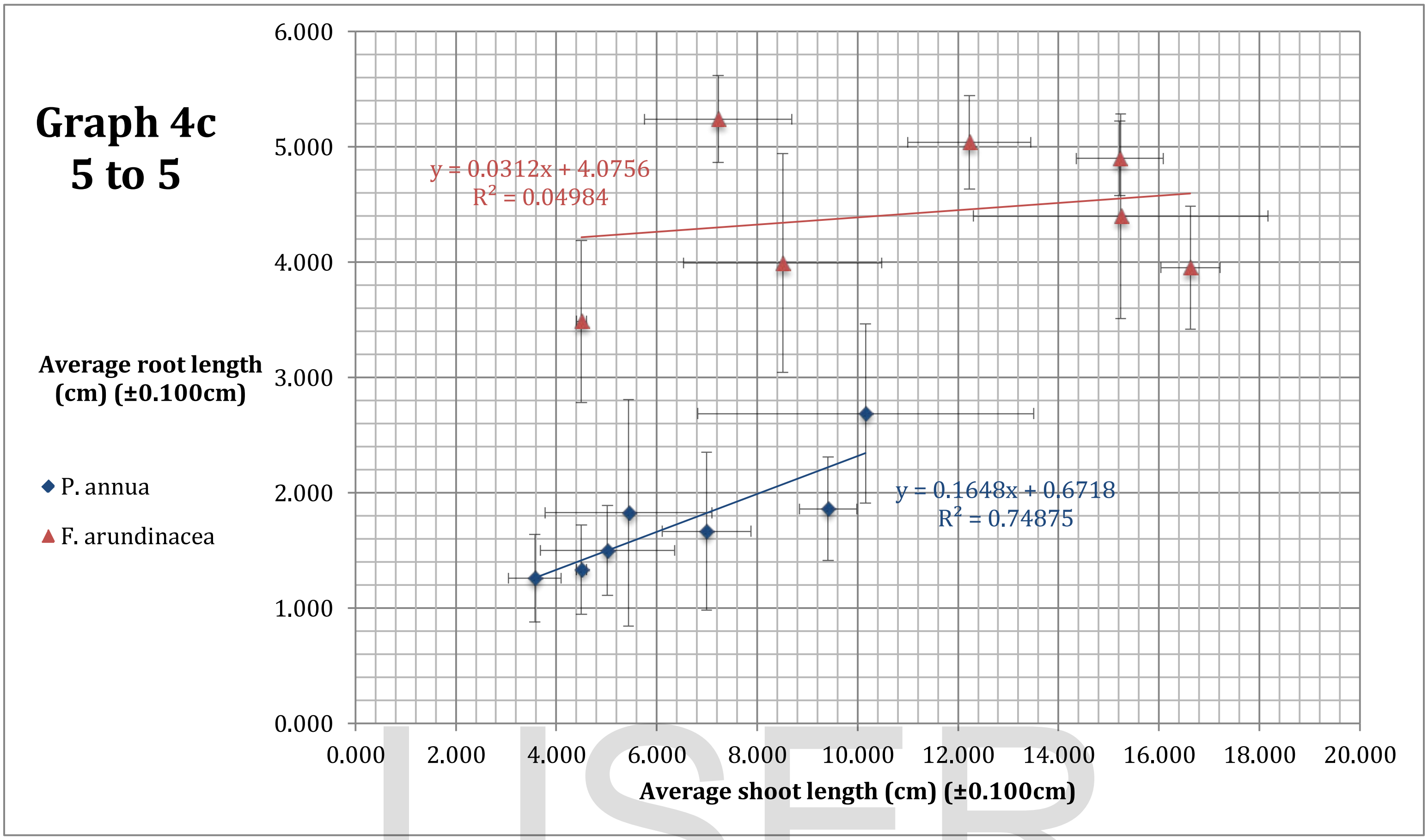
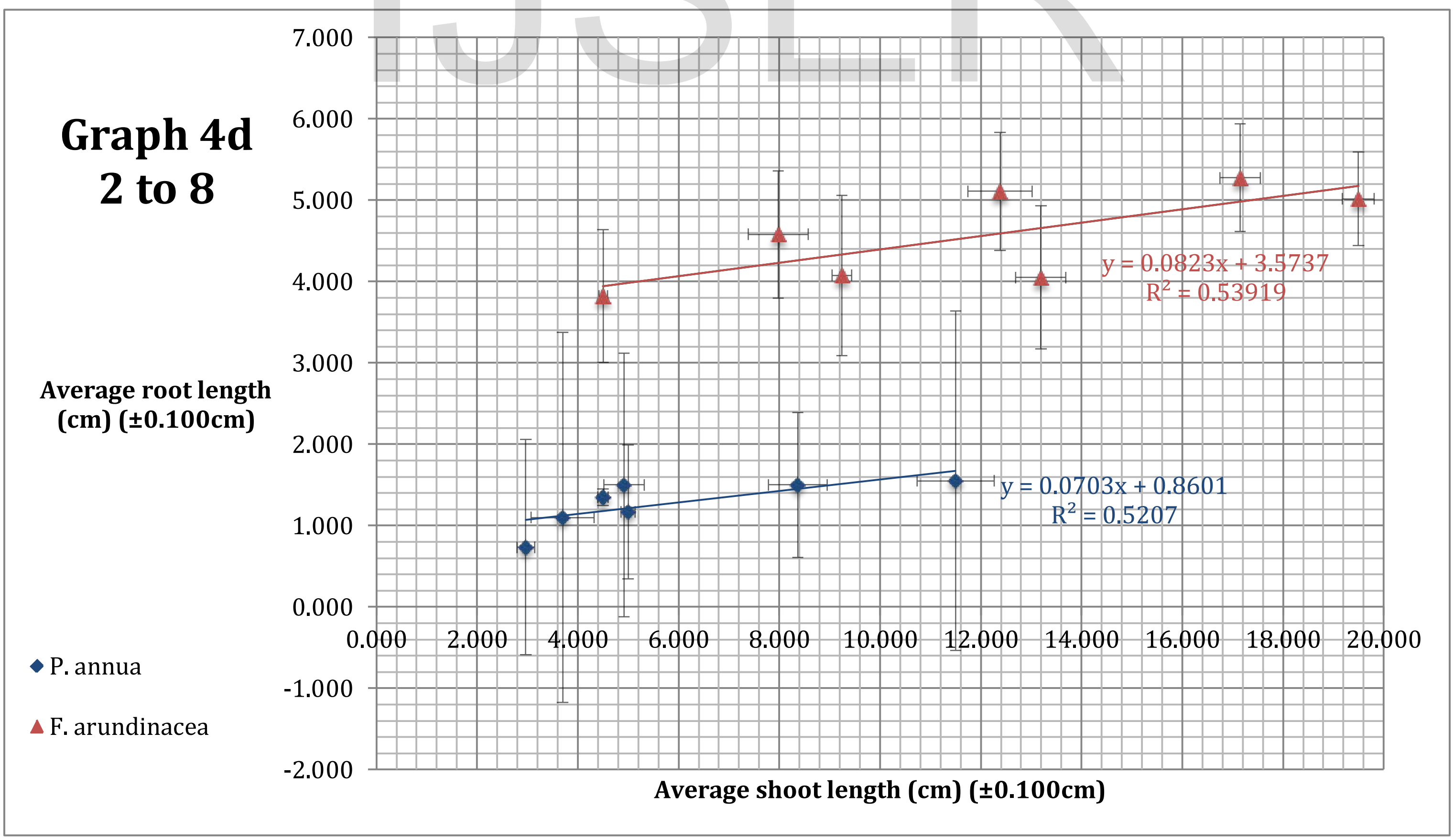
Graph 4a, b, c and d: Correlation between average root length and average shoot length by comparing *P. annua* and *F. arundinacea* of *controlled group* proportion: 1:0 and 0:1, and *competition proportions* of 8:2, 5:5 and 2:8 respectively. Proportion ratio is always *P. annua* : *F. arundinacea*. Average is collected from 30 strands of grasses, measuring the length in cm of root and shoot length. The tolerance is 0.1cm.









***All** data of Graph 4 are based on Table 2, Appendix.*

Table 4: R^2 for *P. annua* and *F. arundinacea* in Graph 4a, b, c and d. The R^2 value is based on average root and shoot length (found in Table 2, *Appendix*) of comparing *P. annua* and *F. arundinacea. Controlled group* proportion: 1:0 and 0:1, and *competition proportions* of 8:2, 5:5 and 2:8 respectively. The R^2 value is based on the linear line in Graph 4s and calculated by Excel. The values are also shown next to the linear lines in red or blue.

	P. annua	*F. arundinacea*
Controlled (Graph 4a)	0.86	0.23
8 to 2 (Graph 4b)	0.85	0.42
5 to 5 (Graph 4c)	0.75	0.05
2 to 8 (Graph 4d)	0.52	0.54

5 DISCUSSIONS

5.1 Root Shoot Ratio

Overall, the investigation determines competitive success of *P. annua* and *F. arundinacea* through Root Shoot Ratio (R:S), Leaf Dry Mass Content (LDMC), 2-tailed Chi-Test and a tentative correlation of average root with shoot length. Also, physiological characteristics such as height or growth rate are taken into account.

Chronologically, the story of the 7 weeks post-germination can be divided into Week 1-2 and Week 3-7. During Week 1 and 2, it was obvious that *F. arundinacea* was growing rapidly in shoot and root length (see Table 2, *Appendix*). *F. arundinacea* appeared to germinate a little more rapidly than *P. annua* and this indicated *F. arundinacea* might be taking advantage of quick germination and prefixed physiological features.

At the end of Week 3, all the plant material in all the pots was disturbed by being mowed/cut back to a common height of 4.5cm. This symbolized cropping on lawns or grazing by variety of animals. *F. arundinacea* naturally has a faster germination rate (personal observation in the first 2 weeks) and has taller and thicker strands than *P. annua*. Physiologically, *F. arundinacea*'s growth habit is to form bunched strands and the experimental set-up played to *F. arundinacea's* advantage, as the experiment was restricted by the smallest of the pot. Therefore a disturbance, the mowing was strategically planned, mimicking the lawn or the grassland – cut of all grasses to standardized height of 4.5 cm because all grasses reached at least that height by the end of Week 3.

It is noticeable that the S.D. is usually below 1.0 but however sometimes increased to 2.0. When s.d. took up 30% of the average number, this means the data has a very large range. Additionally, s.d. in Table 2 does not have a fixed pattern and indicates a degree of uncertainty.

Although R:S is often measured in mass for net partitioning, R:S in length is a better measurement for nutrient uptake, root absorbing ability and favoring condition level according to Hilbert (1990) and Harris (2003). High values of R:S mean grasses growing in less favorable condition. This means a relative smaller root and a longer shoot indicates the better health and nutrient intake ability. This experiment then was to give the grasses a favorable place to compete with each other where temperature and water given at moderate level for grasses (Harris, 2003).

Therefore from **R:S** (Graph 2) we clearly see *P. annua* is growing in a favorable environment and is healthy, though one factor affecting root shoot ratio is the Week 3 – disturbance- without measuring shoot length first. In summary, up to the end of Week 3 and the disturbance (mowing), *F. arundinacea* as can be seen from all the data tables and graphs appeared to be the fitter species. After that date, the situation alters in *P. annua's* favor as you might expect for an r-strategist.

To support this claim, in competition proportions of 8:2, 5:5 and 2:8 on Week 2, we can see *F. arundinacea* has a small root length percentage value compared with shoot length.

When Week 3 is reached, after the cutting disturbance, R:S value of *F. arundinacea* are much higher than *P. annua* shown in **Graph 2**. Though shoot length of 4.5cm of all grasses are used to calculated R:S week 3, this indicates *F. arundinacea* has a relative short shoot compared to *P. annua* with much more lower R:S value. And as the weeks pass by after week 3, we can clearly see *P. annua* becoming fitter because it is now growing in a favorable condition; nutrient uptake and root absorbing ability are also assumd to be strong.

This means after the cut, *P. annua* developed a strong meristematic tissue that allows elongation of root and shoot length. As Fogg has shown (1963), this tissue in *P. annua* is located at the tip of root and shoot, which is called apical meristems, controlled by hormone. Root apical meristem is formed after germination, which is unlike shoot apical meristem, formed during stage of embryo. Apical meristem in shoot allows stem, flowers and leaves to lengthen and that in root allows root to grow deep in the soil (Gethsemanegardens.com, 2013). The process of apical meristem cell elongation and division is called primary growth – leading high height of shoot ad long deep features in root.

Although *F. arundinacea* naturally has tremendous development of apical meristem that allowed it to take water and mineral resources rapidly in the first 2 weeks, after the mowing disturbance in Week 3, it is weakened. This suggests that *F. arundinacea* may have an Achille's Heel because it cannot tolerate disturbance of shoot injury and this often happens in nature such as grazing of the animals (Yang et al, 2002). However in the present experiment, cutting may have actually stimulated giberellins in *P. annua*, causing growing height in *P.annua* to increase. Shown in **Graph 4**, *P. annua's* relatively small changes in root length are complimented by enormous shoot length, bringing about the small value of R:S in that species after Week 3 (ie: after the cutting disturbance).

A 2-tailed Chi-Squared Test was carried out to see if the apparently significant root growth rate over the 7 weeks was mathematically valid. In this test, the 2 variables are week and proportions. And the proportion comparison is only with the species itself: to see whether it has significant growth rate different especially after Week 3.

However individual testing of *P. annua* and *F. arundinacea* did *not* show significant growth rate difference in either species with *P. annua* at 17.2 and *F. arundinacea* at 7.3 compared to a critical value of 28.9. Even though both of the species did not show mathematically significant root growth rate per week over 7 weeks, a shorter shoot compared to longer shoot means the plant, in this case *P. annua*, is growing in a excellent condition because this means it only needs a small growth length of root for it to sustain a longer shoot. Growing of root also costs nutrient division thus affect shoot length. So, if *P. annua*'s roots grew slower, then *F. arundinacea* grew much more slowly but *F. arundinacea* had a relative smaller height compared to its root lengths.

Moreover shown in Table 4, *P. annua* has higher R^2 value than *F. arundinacea* except in 2 to 8 proportion. Higher R^2 value means stronger correlation (People.duke.edu, 2013). This means *P. annua* has more constant root and shoot growth while *F. arundinacea* has not. This is one of the reasons why *P. annua* in Chi-Test has a closer Chi-value to the significance level than has *F. arundinacea*. The consistency of the growth of root system in both species can affect the whole plants growth (Aiken and Smucker, 1996). Therefore this consistent root growth indicates that *P. annua* is the species more fitted to the situation at almost all proportions.

5.2 Leaf Dry Mass Content

The calculation of Leaf Dry Mass Content (LDMC, dry mass to fresh mass) is shown in Table 3 (*Appendix*) and Graph 3. LDMC indicates correlation between nutrient conservation and biomass production aforementioned (Cui *et al*, 2004). Moreover, it is also a nutrient intake or resource-use-strategy-indicator ratio (Wilson and Thompson et al., 1999).

LDMC in this experiment is calculated from total because individual grass cannot be distinguished after electrical oven evaporating of water of 60 degrees Celsius of 48 hours. After evaporation of water, the dry mass of grass is the left over nutrient that remains in the grasses leaves. Additionally, grasses leaves at start are connected to stem and in later development, leaves grow in stands and are out from the stem. Therefore, higher value of LDMC suggests better nutrient intake, etc.

As a result, we can clearly see in **Graph 3** that *P. annua* has a much more higher LDMC, especially in growth proportions of 5:5 and 1:0. In week 1, *F. arundinacea* has a better nutrient intake and biomass production because after heating, dry mass f *F. arundinacea* still remains a large percentage compared to fresh mass, while *P. annua* barely has mass before and after heating. However this situation changed during Week 2, *P. annua* starts to 'catch up' in nutrient intake and biomass production. The Week 3 cutting disturbance again affected the LDMC because dry mass of a "universal" 4.5 cm long shoot after heating is used. After cutting, *P. annua* seems to recover quickly from the 'injury' of shoot while *F. arundinacea* lags behind, shown in Graph 3. In the controlled group, we can clearly see *P. annua* having a larger LDMC value than *F. arundinacea*. Therefore even in LDMC, *P. annua* shows a better condition of nutrient intake strategies and production of biomass. Something we might expect from an r strategist lately released from its restrictions.

5.3 Environmental factors, R:S and LDMC

In Harper (1978), the three most common factors used for competitive advantage are light, water and nitrates. In this investigation, nitrates are contained in the soil but do not have a definite amount because this element was found on the package label. Water amount, humidity and daylight hours are recorded. In the beginning of this paper, water regime was 20 cm^3 per week because this is the moderate amount for both species through research. Humidity in the greenhouse was relatively higher than Beijing's normal level in that season (see Graph 1b) and this means that in effect the two species were enjoying a slightly different environmental regime. Higher humidity also means lesser water loss. And as the humidity increased, the grasses could store more water in their stems, leaves and roots. The daylight hours are the same as Beijing in the greenhouse and as the hours increased as months passed, the grasses had more opportunity to be exposed to sunlight and carry out photosynthesis. This allowed plant growth and more intense competition because the grasses are growing taller and still searching for sunlight. But even if *F. arundinacea* was naturally long rooted and shooted and might have been expected to cover up the sunlight for *P. annua*, *F. arundinacea* still weakens after the CUT on Week 3 (see R:S - Graph 2 and LDMC - Graph 3). It seems R:S and LDMC correlate with each other in supporting *P. annua* as the fitter grass after the cutting disturbance in Week 3, while *F. arundinacea* is the pre-cutting successor (during Week 1-2) with its tremendous post-germination height and mass. Additionally, Chi-Squared test supports this statement as well. Could it be that *F. arundinacea* as a primary K-strategist is slower to convert to r-strategies or actually cannot convert to r-strategies, or is not plastic enough genetically to do so.

6 CONCLUSIONS

- Low R:S means better root uptake ability and growth in more favorable conditions.
- This means after the disturbance cut (Week 3), *P. annua* lowered its R:S more than *F. arundinacea* in most proportions.
- High LDMC means more biomass production and nutrient intake.
- At the end of Week 7 in all growth proportions, *P. annua* showed higher LDMC than *F. arundinacea*.
- The fact is that *P. annua* showed higher LDMC than *F. arundinacea*, something which was accelerated after the cutting disturbance in Week 3.
- A Chi squared-test showed 70~80% significance for weekly changes in *P. annua* growth rate but not in *F. arundinacea* apparently.
- Higher R^2 value (correlation) between root and shoot length for *P. annua* than for *F. arundinacea*, indicating low R:S value.
- The two species were planted in 5 proportions: 1:0, 8:2, 5:5, 2:8 and 0:1. The results of these proportional experiments indicate the competitive strength of each species but it particularly indicates *P. annua*'s strategy in adapting to initially unfavorable conditions or changes in conditions as was seen very clearly after Week 3 (cutting disturbance).
- It almost seems as if *P. annua* has a flexible stratagem for dealing with unfavorable conditions being a K-strategist when not under stress and being r-strategist when a sudden advantage opens up as it did in this experiment with Week 3 disturbance cutting.

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7 REFERENCES

Aiken, R. and Smucker, A. 1996. *Root system regulation of whole plant growth.* [e-book] US: University of Michigan. p. 34. Available through: Annualreviews.org http://www.annualreviews.org/doi/abs/10.1146/annurev.phyto.34.1.325?journalCode=phyto [Accessed: 5 Dec 2013].

Biologyreference.com. 2013. *Meristems - Biology Encyclopedia - cells, plant, body, function, process, system, different, organs, life*. [online] Available at: http://www.biologyreference.com/Ma-Mo/Meristems.html [Accessed: 15 Nov 2013].

Bio.miami.edu. 2013. *r and K selection*. [online] Available at: http://www.bio.miami.edu/tom/courses/bil160/bil160goods/16_rKselection.html [Accessed: 4 Dec 2013].

Cui, J., Johnson, D., Li, Y., Su, Y. and Zhang, T.2004.Ejournal.sinica.edu.tw. *Specific leaf area and leaf dry matter content of plants growing in sand dunes*. [online] Available at: http://ejournal.sinica.edu.tw/bbas/content/2005/2/Bot462-05.html [Accessed: 21 Aug 2013].

Fogg, G. 1963. *The growth of plants*. Baltimore: Penguin Books.

Gethsemanegardens.com. 2013. *Lawn & Garden Watering Guide*. [online] Available at: http://www.gethsemanegardens.com/category_s/121.htm [Accessed: 14 Nov 2013].

Harper, J. 1978. *Population Biology of Plants*. [e-book] New York: Academic Press Inc. pp. 1-50. [Accessed: 25 Nov 2013].

Harris, C., Innes, G. and Lowien, J. 2003. *Tall Fescue*. [e-book] New South Wales: NSW Agriculture. Available through: dpi.nsw.gov.au http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0008/166094/p256.pdf [Accessed: 22 Aug 2013].

Harris, R. 1992. *ROOT-SHOOT RATIO*. [e-book] California: Department of Environmental Horticulture, University of California. http://www.google.com.hk/url?sa=t&rct=j&q=root-shoot%20ratio&source=web&cd=7&ved=0CFQQFjAG&url=http%3a%2f%2fjoa%2eisa-arbor%2ecom%2frequest%2easp%3fJournalID%3d1%26ArticleI

Hilbert, D. 1990. Optimization of Plant Root: Shoot Ratios and Internal Nitrogen Concentration. *Annals of Botany*, 66 (1), pp. 91-99. Available at: http://aob.oxfordjournals.org/content/66/1/91.short [Accessed: 14 Nov 2013].

Pagad, S. 2009

Issg.org. *issg Database: Ecology of Poa annua*. [online] Available at: http://www.issg.org/database/species/ecology.asp?si=1418 [Accessed: 21 Aug 2013].

Key, J. 1997. *Chi Square*. [online] Available at: http://www.okstate.edu/ag/agedcm4h/academic/aged5980a/5980/newpage28.htm [Accessed: 5 Dec 2013].

Pontes, L., Louault, F., Carrere, Pascal., Maire, V., Andueza, D. and Soussane, J. 2010. Ncbi.nlm.nih.gov. *The role of plant traits and their plasticity in the response of pasture grasses to nutrients and cutting frequency*. [online] Available at: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2876009/ [Accessed: 22 Aug 2013].

Rayburn, E. 1993 Caf.wvu.edu. *Tall Fescue Management*. [online] Available at: http://www.caf.wvu.edu/~forage/tallfesc.htm [Accessed: 21 Aug 2013].

Timebie.com. 2013. *Beijing, China Daylight Hours -- Timebie*. [online] Available at: http://www.timebie.com/sun/beijing_china.php [Accessed: 15 Nov 2013].

Wilson, P., Thompson, K. and Hodgson, J. 1999. *Speci®c leaf area and leaf dry matter content as alternative predictors of plant strategies*. [e-book] Cambridge: New Phytol. p. 155. Available through: Onlinelibrary.wiley.com http://onlinelibrary.wiley.com/store/10.1046/j.1469-8137.1999.00427.x/asset/j.1469-8137.1999.00427.x.pdf;jsessionid=72AB7BF16E382872878C5113630B64A1.f03t02?v=1&t=hotemok8&s=b2acde0ee8e9de17bb61ca666d0b04ae7385dbc7&systemMessage=Wiley+Online+Library+will+be+disrupted+on+7+December+from+10%3A00-15%3A00+BST+%2805%3A00-10%3A00+EDT%29+for+essential+maintenance [Accessed: 5 Dec 2013].

Yang, X., Hong, F. and Wang, M. 2002. *The Research and Investigation for Species and Growing of the Lawn in Beijing Region*. [e-book] Beijing: Journal of Beijing Agricultural College. pp. 1-17. Available through: Doc88.com http://www.doc88.com/p-141805014014.html [Accessed: 25 Nov 2013].

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8 APPENDIX

8.1 Processed Data

Table 2: Root and shoot length in average and total, including **s.d.** of each variable. **R:S** is calculated most importantly. Every parameter has a tolerance of 0.100 cm. 7 weeks of root shoot lengths is collected for 5 different proportions: 1:0, 8:2, 5:5, 2:8 and 0:1 of *P. annua* : *F. arundinacea*. During Week 3, there is a cut of shoot length to 4.5cm to observe whether this act alters trend of health and growth. That calculated data are based on *Part B Appendix from Table 1 to 9*.

Weeks	Parameters (cm) (±0.100cm)	1 : 0	8 : 2		5 : 5		2 : 8		0 : 1
		P	P	F	P	F	P	F	F
1	$\bar{x}$ shoot length	3.59	3.65	6.61	3.57	8.50	2.96	9.24	9.11
	S.D. of $\bar{x}$ shoot length	0.79	0.63	1.45	0.52	1.97	0.18	1.32	0.99
	Total shoot length	107.70	87.80	39.70	53.60	127.60	17.80	221.80	273.40
	$\bar{x}$ root length	1.69	1.05	3.30	1.26	3.99	0.73	4.07	3.68
	S.D. of $\bar{x}$ root length	0.56	1.20	1.97	0.37	0.95	0.19	0.98	0.93
	Total root length	50.80	17.80	221.80	18.90	59.90	4.40	97.80	110.60
	Root Shoot Ratio	0.47	0.28	0.49	0.35	0.46	0.24	0.44	0.40
2	$\bar{x}$ SL	6.24	5.93	16.68	5.02	15.24	3.70	13.19	13.10
	S.D. - $\bar{x}$ SL	0.92	1.04	2.92	1.34	2.93	0.62	2.27	1.84
	T. SL	187.20	142.50	100.10	75.30	228.60	22.20	316.60	393.00
	$\bar{x}$ RL	1.54	1.12	3.75	1.50	4.40	1.10	4.05	5.29
	S.D. - $\bar{x}$ RL	0.60	0.36	0.78	0.39	0.88	0.49	0.88	1.29
	T. RL	46.20	26.90	22.50	22.50	66.60	6.60	97.30	158.80
	R:S	0.24	0.18	0.22	0.29	0.28	0.29	0.30	0.40
3 (CUT)	$\bar{x}$ SL	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50
	S.D. - $\bar{x}$ SL	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
	T. SL	135.00	108.00	27.00	67.50	67.50	27.00	108.00	135.00
	$\bar{x}$ RL	1.90	1.78	3.46	1.33	3.48	1.35	3.82	4.90
	S.D. - $\bar{x}$ RL	0.86	0.41	1.01	0.38	0.70	0.08	0.81	0.92
	T. RL	57.00	42.90	20.80	20.00	52.30	8.10	91.70	147.10
	R:S	0.42	0.39	0.77	0.29	0.77	0.30	0.84	1.08
4	$\bar{x}$ SL	6.73	6.03	8.03	5.44	7.22	4.91	7.97	6.98
	S.D. - $\bar{x}$ SL	1.29	0.87	1.65	1.46	1.17	0.39	1.62	0.98
	T. SL	201.90	144.80	48.50	81.60	108.40	29.50	191.50	209.60
	$\bar{x}$ RL	1.71	1.72	4.00	1.82	5.24	1.50	4.57	4.47
	S.D. - $\bar{x}$ RL	0.50	0.54	0.98	0.37	1.30	0.59	0.78	1.03
	T. RL	51.40	41.40	24.00	27.40	78.60	9.00	109.90	134.20
	R:S	0.25	0.28	0.49	0.33	0.72	0.30	0.57	0.64
5	$\bar{x}$ SL	8.40	7.58	14.06	6.93	15.22	5.00	17.15	14.93
	S.D. - $\bar{x}$ SL	2.79	1.48	0.87	0.86	1.47	0.14	0.82	0.72
	T. SL	252.10	182.10	84.40	104.90	228.30	30.00	411.70	448.00
	$\bar{x}$ RL	1.75	1.55	4.15	1.66	4.90	1.16	5.27	4.68
	S.D. - Av. RL	0.43	0.35	0.68	0.32	0.43	0.39	0.66	0.61

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	T. RL	52.60	37.30	24.90	25.00	73.50	7.00	126.60	140.60
	R:S	0.20	0.20	0.29	0.23	0.32	0.23	0.30	0.31
6	$\bar{x}$ SL	11.29	10.40	17.47	9.41	12.22	8.36	12.38	14.55
	S.D. - $\bar{x}$ SL	1.33	1.02	0.57	1.22	1.05	0.58	0.88	1.07
	T. SL	338.80	249.80	69.90	141.20	183.40	50.20	297.20	436.50
	$\bar{x}$ RL	2.71	2.55	4.38	1.86	5.04	1.50	5.10	5.54
	S.D. - $\bar{x}$ RL	0.52	0.59	0.44	0.40	0.47	0.64	0.72	0.70
	T. RL	81.30	61.30	26.30	27.90	75.60	9.00	122.60	166.20
	R:S	0.24	0.24	0.25	0.19	0.41	0.17	0.41	0.38
7	$\bar{x}$ SL	17.17	14.97	14.68	10.16	16.62	11.50	19.49	19.61
	S.D. - $\bar{x}$ SL	3.78	2.35	3.34	0.58	2.65	0.76	2.08	3.36
	T. SL	515.20	359.50	88.10	152.40	249.40	69.00	467.90	588.30
	$\bar{x}$ RL	3.68	3.29	3.66	2.68	3.95	1.55	5.01	5.22
	S.D. - $\bar{x}$ RL	0.82	0.78	0.77	0.53	0.23	0.31	0.57	0.58
	T. RL	110.60	76.00	22.00	40.30	59.30	9.30	120.40	156.80
	R:S	0.21	0.22	0.25	0.26	0.23	0.13	0.25	0.26

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Table 3: Total dry mass (T. DM)**, total fresh mass** (T. FM) **and LDMC** (DM:FM). Only fresh mass' s.d. is calculated because individual data value can be identified but after warming them in the electric oven, individual value cannot be weighed but total.

Weeks	Parameters (g) (±0.001g)	1 : 0	8 : 2		5 : 5		2 : 8		0 : 1
		P	P	F	P	F	P	F	F
1	Total Dry Mass	0.005	0.002	0.004	0.001	0.014	0.000	0.026	0.030
	Total Fresh Mass	0.072	0.045	0.039	0.009	0.274	0.003	0.269	0.317
	s.d. of Total Fresh Mass	0.001	0.001	0.001	0.001	0.031	0.001	0.002	0.003
	LDMC	0.069	0.044	0.203	0.111	0.051	0.000	0.097	0.095
2	T. DM	0.004	0.003	0.011	0.002	0.018	0.001	0.020	0.026
	T. FM	0.042	0.015	0.077	0.007	0.197	0.002	0.225	0.323
	S.D.-T. FM	0.001	0.001	0.004	0.001	0.002	0.001	0.003	0.002
	LDMC	0.098	0.200	0.142	0.286	0.091	0.500	0.088	0.080
3 (CUT)	T. DM	0.002	0.003	0.000	0.000	0.003	0.000	0.010	0.015
	T. FM	0.020	0.021	0.017	0.009	0.052	0.002	0.118	0.118
	S.D.-T. FM	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002
	LDMC	0.100	0.143	0.000	0.000	0.058	0.000	0.085	0.127
4	T. DM	0.006	0.004	0.003	0.001	0.013	0.000	0.013	0.015
	T. FM	0.046	0.023	0.034	0.005	0.081	0.006	0.149	0.158
	S.D.-T. FM	0.001	0.001	0.002	0.001	0.003	0.001	0.003	0.002
	LDMC	0.130	0.174	0.088	0.200	0.160	0.000	0.087	0.095
5	T. DM	0.015	0.014	0.003	0.003	0.013	0.000	0.014	0.015
	T. FM	0.082	0.082	0.064	0.039	0.179	0.003	0.263	0.297
	S.D.-T. FM	0.002	0.002	0.003	0.001	0.002	0.001	0.003	0.002
	LDMC	0.183	0.170	0.047	0.077	0.073	0.000	0.053	0.050
6	T. DM	0.069	0.034	0.003	0.028	0.019	0.004	0.026	0.037
	T. FM	0.239	0.172	0.054	0.100	0.236	0.042	0.259	0.326
	S.D.-T. FM	0.001	0.001	0.001	0.001	0.021	0.001	0.001	0.002
	LDMC	0.289	0.198	0.056	0.280	0.081	0.095	0.100	0.113
7	T. DM	0.071	0.038	0.006	0.025	0.020	0.009	0.118	0.143
	T. FM	0.244	0.189	0.075	0.088	0.216	0.035	0.454	0.547
	S.D.-T. FM	0.002	0.001	0.002	0.001	0.001	0.001	0.004	0.003
	LDMC	1.184	0.201	0.080	0.284	0.093	0.257	0.260	0.261

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8.2 Root and Shoot Length Raw Data

Below are 7 tables during **post-germination** of *P. annua* and *F. arundinacea*. **Tables 1 to 7** are showing **root and shoot length** measured by the ruler. Therefore the tolerance for each data is 0.1 cm. Processed data table of Table 2 is based on these sets of data. Root shoot ratio graph are based on this primary data. The environment situation for this collected data is shown in *Materials and Methods, Table 1b*. In competition proportions of 5:5, 2:8 and 8:2, highlighted yellow area means *P. annua* and not highlighted area means *F. arundinacea*. These are relevant to actual number of grasses in a proportion as30 strands of each proportion are used for each proportion.

Table 1: Week 1

	P		5:5		F		P:F, 2:8		P:F. 8:2	
	Root	Shoot	Root	Shoot	Root	Shoot	Root	Shoot	Root	Shoot
1	1.3	2.4	1.5	3.6	3.0	9.4	0.8	3.1	0.9	4.1
2	1.8	3.1	1.1	2.9	3.3	9.0	0.9	3.0	1.1	3.6
3	1.6	2.6	1.5	3.7	4.1	9.0	0.9	2.7	1.0	3.1
4	2.3	3.2	1.1	2.9	5.3	8.0	0.4	2.8	0.9	3.1
5	1.8	2.5	1.0	4.3	3.5	9.9	0.6	3.2	1.2	3.4
6	1.2	1.7	1.5	4.5	1.8	9.0	0.8	3.0	0.5	3.5
7	1.6	2.7	1.1	4.0	4.0	8.0	5.4	11.0	1.5	4.8
8	1.3	4.3	1.2	3.3	4.2	10.6	3.2	9.0	1.1	4.0
9	1.4	4.7	0.6	3.5	2.4	11.0	2.6	11.0	1.2	4.8
10	1.1	2.6	2.0	4.7	3.0	8.6	3.4	11.0	1.0	4.0
11	2.9	4.0	1.0	4.0	2.8	8.5	4.0	9.7	1.1	3.5
12	1.4	4.3	1.0	2.5	3.0	9.0	4.8	10.3	0.8	3.7
13	2.3	3.6	1.2	3.4	4.0	9.8	3.6	9.7	0.8	3.8
14	1.4	4.3	1.1	3.0	5.0	9.6	3.6	10.2	1.0	3.5
15	1.9	3.8	2.0	3.3	4.0	7.0	5.5	10.1	0.3	3.3
16	1.0	4.2	5.5	8.0	2.4	10.0	4.0	8.7	1.0	2.5
17	1.8	4.1	3.3	10.0	4.6	10.5	4.9	6.2	1.0	4.0
18	0.5	2.5	3.5	8.0	3.2	10.4	4.8	7.4	1.2	3.6
19	1.5	3.7	2.2	8.0	4.0	9.0	3.0	7.0	1.4	3.1
20	2.6	4.9	3.5	9.0	3.0	8.0	3.0	7.6	0.8	3.8
21	2.7	4.4	4.1	8.9	4.3	9.0	5.0	10.0	1.1	4.0
22	1.5	3.5	4.8	6.5	2.0	10.1	2.5	8.6	1.8	3.9
23	1.7	3.7	3.5	8.8	4.3	9.0	6.2	10.3	1.7	3.1
24	1.0	4.2	5.0	10.0	4.0	8.0	3.8	9.2	0.8	3.6
25	2.0	3.1	4.0	8.5	5.2	8.5	4.5	8.0	3.5	5.8
26	2.5	4.5	3.0	6.5	4.0	10.2	4.3	8.5	2.0	5.5
27	1.0	3.4	3.0	6.6	5.3	10.2	4.9	9.6	4.8	5.5
28	1.6	4.0	4.5	8.2	4.0	8.2	3.4	8.3	2.0	6.1
29	2.3	4.2	5.0	8.6	3.0	8.0	3.0	10.2	3.0	10.6
30	1.8	3.5	5.0	12.0	3.9	7.9	4.4	10.2	4.5	6.2

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Table 2: Week 2

	P		5:5		F		P:F, 2:8		P:F. 8:2	
	Root	Shoot	Root	Shoot	Root	Shoot	Root	Shoot	Root	Shoot
1	0.8	5.1	1.5	5.0	7.0	12.6	1.0	3.5	1.0	5.0
2	1.3	4.5	2.1	6.0	6.0	14.2	1.2	4.2	2.1	7.5
3	1.9	6.5	1.7	7.2	7.0	13.1	2.0	4.3	1.5	6.3
4	2.1	7.4	1.4	4.0	6.0	11.0	1.1	3.6	1.6	7.3
5	2.6	7.0	1.0	6.1	6.2	14.0	0.6	2.6	1.5	6.7
6	1.4	7.8	1.0	3.5	5.5	10.9	0.7	4.0	1.6	6.1
7	1.0	5.6	1.8	4.6	5.8	13.9	3.1	12.8	1.2	6.2
8	1.2	4.8	2.3	5.3	5.6	14.8	4.5	12.5	0.8	6.3
9	1.0	5.3	1.4	3.0	7.3	10.6	3.0	10.5	0.9	4.9
10	1.0	6.1	1.8	7.4	5.3	14.3	3.5	13.2	0.6	5.3
11	1.3	7.8	1.0	3.9	5.0	10.6	3.4	13.0	0.7	8.2
12	2.0	6.0	1.2	4.0	5.5	14.0	3.0	13.2	1.2	5.1
13	1.4	5.0	1.4	4.0	4.4	11.6	5.0	13.3	1.2	7.3
14	1.0	5.6	1.3	5.0	7.0	10.7	4.0	12.1	0.9	6.2
15	1.1	5.1	1.6	6.3	6.0	11.3	5.0	12.5	1.2	5.0
16	1.5	7.1	2.3	11.2	7.0	15.0	5.4	14.3	0.7	4.1
17	1.1	7.6	5.1	11.0	3.0	11.8	3.9	11.0	0.9	5.0
18	1.3	6.4	4.8	14.5	3.0	16.2	5.0	18.0	1.0	5.2
19	2.2	6.8	3.0	12.2	3.0	13.3	4.4	14.5	0.9	5.0
20	1.1	7.1	5.0	18.6	6.2	14.7	4.5	17.9	1.0	6.2
21	2.5	6.9	5.1	21.5	4.3	11.5	3.0	13.2	0.8	7.3
22	1.4	5.7	5.0	18.4	5.6	14.0	4.1	10.3	1.0	5.3
23	2.1	6.1	3.8	13.2	4.6	13.3	5.0	11.5	1.6	5.0
24	1.5	6.2	4.3	14.6	4.7	14.8	5.9	16.0	1.0	6.0
25	0.9	6.0	4.8	17.1	6.1	13.0	4.6	15.0	4.5	18.0
26	2.0	7.6	3.5	13.0	3.2	16.8	3.6	12.1	2.5	11.2
27	1.2	6.0	4.8	16.8	6.1	16.0	2.6	9.6	3.8	17.5
28	3.4	6.4	5.0	15.2	3.9	10.3	3.5	16.2	4.5	19.9
29	1.1	5.5	4.8	16.0	3.5	11.2	4.0	10.0	4.0	16.6
30	1.8	6.2	5.3	15.3	5.0	13.5	3.3	13.9	3.2	16.9

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Table 3: Week 3 (CUT)

	P		5:5		F		P:F, 2:8		P:F. 8:2	
	Root	Shoot	Root	Shoot	Root	Shoot	Root	Shoot	Root	Shoot
1	1.9		0.8		4.4		1.3		1.4	
2	3.0		1.1		4.0		1.3		1.0	
3	2.3		0.5		5.0		1.5		1.0	
4	1.3		1.5		3.5		1.3		1.9	
5	1.5		1.7		5.0		1.4		2.3	
6	3.0		1.5		5.0		1.3		1.5	
7	4.1		1.5		6.8		3.6		1.5	
8	1.3		1.5		5.8		3.2		1.8	
9	2.5		1.1		4.5		3.5		2.3	
10	1.7		2.0		5.0		4.3		1.9	
11	1.7		1.6		5.5		3.0		1.3	
12	1.0		1.4		4.5		3.2		2.0	
13	1.7		1.6		5.4		4.1		1.2	
14	1.0		0.9		4.6		3.0		2.0	
15	1.8		1.3		6.5		3.6		1.8	
16	1.7		3.0		4.5		3.2		1.8	
17	1.5		3.1		7.5		3.0		1.5	
18	3.0		4.0		4.0		3.2		2.1	
19	1.2		3.0		6.0		3.8		2.5	
20	1.0		2.0		5.0		3.7		1.9	
21	1.0		3.5		4.5		5.0		2.3	
22	1.0		3.7		4.0		4.1		2.1	
23	1.2		3.9		4.3		5.1		2.0	
24	1.2		4.1		4.8		4.0		1.8	
25	3.9		4.3		3.9		2.0		2.5	
26	2.0		3.0		4.0		5.0		2.8	
27	3.0		4.5		5.0		3.9		4.6	
28	1.5		4.3		4.8		4.3		4.0	
29	1.6		2.8		5.5		4.4		4.5	
30	2.4		3.1		3.8		5.5		2.4	

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Table 4: Week 4

	P		5:5		F		P:F, 2:8		P:F. 8:2	
	Root	Shoot	Root	Shoot	Root	Shoot	Root	Shoot	Root	Shoot
1	1.5	6.5	2.4	4.5	3.6	7.6	2.1	4.5	1.5	5.0
2	1.2	7.2	1.8	7.5	2.5	7.8	0.9	4.8	2.1	5.9
3	1.2	6.7	1.5	4.5	4.5	8.5	0.9	4.6	1.4	4.6
4	1.2	5.7	2.0	4.5	4.6	6.2	1.3	4.8	1.4	6.5
5	1.5	6.9	1.4	4.5	3.0	6.1	1.5	5.5	0.8	5.3
6	1.1	5.5	2.3	8.1	3.6	7.8	2.3	5.3	1.0	6.3
7	1.8	8.6	1.5	8.6	3.2	6.3	6.3	8.5	0.9	4.5
8	1.8	9.1	2.1	6.0	3.1	7.5	5.3	10.0	1.5	5.7
9	1.9	9.2	1.5	4.5	2.5	5.6	4.5	6.0	2.1	4.7
10	1.7	6.2	1.4	4.6	3.5	7.0	5.2	12.3	2.8	7.5
11	2.4	6.3	1.5	4.7	4.0	6.8	4.6	7.4	1.4	5.7
12	1.1	7.6	2.4	6.0	4.3	6.6	5.0	7.7	2.0	6.3
13	2.5	7.3	2.1	4.6	4.0	7.0	5.0	9.9	1.6	7.0
14	1.7	5.0	2.0	4.5	5.3	9.0	5.3	7.4	1.9	6.9
15	2.9	5.3	1.5	4.5	5.7	6.3	4.8	6.3	1.5	5.2
16	2.6	7.8	5.5	7.4	5.5	7.1	4.8	7.0	2.0	6.2
17	2.3	8.5	7.0	8.0	5.2	7.0	4.2	7.2	2.1	6.6
18	1.4	7.3	4.8	7.6	4.5	8.0	5.5	7.3	2.6	7.8
19	1.4	6.9	7.0	8.8	4.6	5.6	3.0	8.0	1.8	6.2
20	2.0	5.2	3.4	7.6	5.5	5.2	5.0	8.0	1.2	5.7
21	1.8	9.1	4.9	7.8	6.0	7.2	3.4	5.5	2.5	6.9
22	2.5	7.0	5.0	8.5	4.5	6.3	5.0	8.4	1.5	5.9
23	1.3	6.3	3.6	8.2	5.5	8.0	3.8	10.9	1.3	6.5
24	1.4	6.7	4.3	7.5	6.0	7.1	3.4	6.0	2.5	5.9
25	2.0	5.3	7.5	7.1	5.0	5.2	5.1	6.5	4.5	10.5
26	1.1	5.0	6.5	7.6	5.6	6.2	4.2	9.3	5.7	9.5
27	1.5	5.0	4.5	6.0	5.9	7.5	3.5	8.1	3.1	7.2
28	1.1	7.2	5.6	6.2	4.0	8.1	4.5	7.3	3.2	7.2
29	1.6	6.5	3.6	4.5	4.0	6.5	4.0	7.6	4.0	8.1
30	1.9	5.0	5.4	5.6	5.0	8.5	4.5	8.9	3.5	6.0

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Table 5: Week 5

	P		5:5		F		P:F, 2:8		P:F. 8:2	
	Root	Shoot	Root	Shoot	Root	Shoot	Root	Shoot	Root	Shoot
1	1.0	8.2	1.3	7.0	3.0	15.0	1.9	5.0	2.1	6.0
2	1.1	6.2	1.6	8.1	4.5	15.2	1.3	4.8	1.4	7.1
3	1.5	9.6	2.0	7.9	5.0	14.8	0.8	4.9	1.3	8.0
4	1.3	10.6	1.9	7.8	5.3	16.3	0.9	5.0	1.5	7.9
5	1.2	14.6	1.5	6.2	5.2	15.3	1.0	5.1	1.0	6.0
6	2.1	6.3	1.3	6.3	5.1	15.1	1.1	5.2	1.2	5.3
7	2.0	5.3	2.0	6.1	5.0	14.7	4.5	17.8	1.2	5.4
8	2.0	6.0	1.6	7.8	4.1	15.2	5.5	18.0	1.4	5.6
9	1.9	9.1	0.9	5.0	4.6	16.2	6.0	19.0	1.6	5.9
10	2.5	11.4	1.9	6.5	4.5	14.8	5.0	17.0	2.1	7.3
11	1.3	5.0	1.9	7.2	4.7	14.5	4.9	17.1	0.8	5.0
12	2.0	15.0	1.5	7.0	5.0	15.3	4.8	16.9	1.8	7.8
13	2.1	6.0	1.7	6.9	5.3	15.6	5.0	17.0	1.9	8.8
14	1.5	9.5	1.9	7.1	5.4	15.8	6.0	16.8	1.9	8.6
15	1.9	5.0	2.0	8.0	5.5	15.7	4.5	16.6	1.6	7.4
16	1.7	7.8	4.1	17.8	3.5	13.4	4.7	16.7	1.7	9.3
17	1.5	5.2	4.5	16.0	4.6	14.5	4.8	16.9	1.3	8.9
18	1.5	7.3	5.0	15.8	4.9	13.9	4.0	16.9	1.7	9.2
19	1.0	9.5	3.9	15.3	4.8	14.3	5.0	17.3	2.0	10.0
20	2.0	9.0	4.9	16.1	4.5	14.6	6.0	18.3	2.1	8.9
21	2.0	12.0	5.1	16.2	4.3	14.5	4.8	17.5	1.3	7.8
22	1.7	11.5	5.3	17.1	4.6	15.2	5.9	17.9	1.5	9.2
23	2.0	11.0	4.9	14.0	4.1	15.1	5.6	15.0	1.2	7.8
24	1.2	10.2	5.1	14.5	3.9	13.9	5.8	17.0	1.7	8.9
25	1.5	7.0	5.5	15.9	4.3	15.1	6.3	17.2	4.0	15.1
26	2.0	6.5	5.3	12.0	4.9	15.0	6.2	17.3	5.0	14.2
27	2.1	7.8	4.9	13.6	5.2	14.9	5.7	16.3	4.8	13.8
28	2.5	9.3	5.1	14.5	5.3	15.4	5.0	16.9	3.3	14.3
29	2.3	5.0	5.0	14.0	5.6	15.5	6.1	18.3	3.5	12.5
30	2.2	5.2	4.9	15.5	3.9	13.2	4.5	16.0	4.3	14.5

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Table 6: Week 6

	P		5:5		F		P:F, 2:8		P:F. 8:2	
	Root	Shoot	Root	Shoot	Root	Shoot	Root	Shoot	Root	Shoot
1	3.0	12.2	2.0	10.5	6.1	15.0	2.0	8.7	1.5	8.5
2	2.9	12.0	1.5	8.3	5.5	14.0	0.8	7.8	3.4	11.8
3	2.5	11.7	1.3	8.0	4.8	11.8	1.5	8.5	1.6	8.7
4	2.8	11.8	2.2	10.6	4.3	15.3	2.3	9.0	1.6	8.6
5	3.1	12.0	2.5	11.0	4.3	12.5	1.7	8.7	1.7	8.8
6	1.9	8.5	1.3	8.0	5.3	15.5	0.7	7.5	2.4	10.4
7	2.3	9.4	1.5	8.3	4.4	14.3	6.0	12.3	2.8	10.5
8	2.5	9.3	1.8	8.6	5.5	15.1	6.5	14.6	3.1	11.6
9	2.8	9.6	2.0	10.4	4.7	14.8	4.2	11.5	3.4	11.8
10	3.1	12.3	1.7	8.5	4.8	14.5	4.6	11.7	2.9	11.2
11	3.4	13.0	2.1	10.6	7.3	17.5	6.0	13.2	3.1	11.6
12	2.8	11.9	2.5	10.9	5.9	14.5	5.3	12.9	2.1	10.2
13	2.8	11.6	1.9	8.7	5.5	14.3	5.8	12.8	2.6	10.3
14	2.2	10.0	1.4	8.2	6.0	15.0	4.5	11.5	2.3	10.3
15	1.6	8.3	2.2	10.6	4.5	12.6	5.4	12.8	2.8	10.6
16	1.9	8.7	4.9	15.3	5.3	14.0	6.3	14.3	1.9	8.8
17	2.1	11.3	4.5	11.2	5.4	14.1	4.9	12.3	2.0	10.0
18	1.9	10.3	4.8	11.7	5.9	14.4	5.1	12.5	2.6	10.7
19	2.9	12.1	5.1	12.2	6.1	14.8	5.3	12.6	2.5	10.6
20	3.1	11.9	5.3	12.5	6.5	14.9	4.9	11.9	3.0	11.0
21	3.3	12.5	4.6	11.5	5.4	14.2	5.0	13.0	2.9	10.9
22	3.5	12.4	5.6	12.6	5.6	14.3	5.9	13.5	3.1	11.0
23	3.0	12.1	5.9	12.8	5.9	14.4	4.5	11.5	3.2	11.1
24	2.5	11.6	4.6	11.3	6.3	15.3	6.0	12.0	2.8	10.8
25	2.0	11.9	4.5	11.2	5.3	14.2	4.5	11.6	4.0	12.0
26	2.7	11.7	5.4	12.6	5.4	14.1	4.4	11.3	4.9	12.3
27	3.2	12.0	5.0	12.1	6.3	16.5	4.8	12.4	3.7	10.8
28	3.3	12.3	5.1	12.2	5.8	14.4	4.2	11.5	4.7	12.1
29	3.5	12.5	5.8	13.0	6.2	15.2	4.3	11.9	4.5	11.4
30	2.7	11.9	4.5	11.2	5.9	15.0	4.2	11.6	4.5	11.3

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Table 7: Week 7

	P		5:5		F		P:F, 2:8		P:F. 8:2	
	Root	Shoot	Root	Shoot	Root	Shoot	Root	Shoot	Root	Shoot
1	3.4	23.0	2.9	10.5	4.7	12.4	1.0	12.0	1.9	12.1
2	5.0	20.3	2.5	10.7	4.3	17.5	1.5	12.2	2.3	13.2
3	2.5	17.0	3.5	11.0	5.7	23.5	1.9	10.3	3.4	12.1
4	2.3	10.0	2.3	9.6	5.0	22.0	1.5	10.9	3.8	18.3
5	2.8	18.0	2.9	9.8	4.8	23.9	1.8	12.1	2.8	12.2
6	2.9	18.5	3.1	10.4	5.1	18.8	1.6	11.5	2.9	14.0
7	3.1	21.1	3.0	10.7	4.8	22.0	4.8	21.6	2.0	13.9
8	2.9	17.9	2.5	9.2	4.9	18.2	4.6	21.8	2.1	13.2
9	3.5	23.3	2.8	9.9	5.5	23.5	5.1	15.8	3.1	12.1
10	4.2	24.4	2.1	10.0	6.1	21.9	4.6	22.1	3.9	18.3
11	4.8	19.0	3.3	10.9	5.0	18.5	4.5	15.7	3.8	17.8
12	3.2	17.0	2.2	10.2	6.2	19.4	5.9	18.6	3.0	15.6
13	4.5	19.5	1.9	9.2	4.0	23.0	4.1	22.0	4.5	12.9
14	4.9	19.3	3.4	10.6	5.2	17.1	4.3	21.5	3.1	14.0
15	3.4	16.6	1.9	9.7	5.0	23.8	5.3	19.6	2.6	15.1
16	3.7	10.5	4.0	18.3	5.4	22.1	4.7	19.8	2.9	14.9
17	4.3	14.2	3.5	12.6	5.3	22.0	5.1	16.0	2.9	15.1
18	3.6	13.0	3.8	13.0	4.9	17.0	5.8	17.9	3.1	19.1
19	4.8	19.8	4.1	18.7	6.2	24.1	4.9	16.1	3.0	15.3
20	4.1	13.3	3.9	17.9	5.6	22.1	5.7	18.1	4.3	14.5
21	5.0	16.6	4.4	19.3	5.8	16.9	5.1	19.5	4.2	12.9
22	4.9	17.7	4.0	18.5	6.3	21.4	4.5	21.5	3.0	16.0
23	3.3	13.3	3.6	12.9	5.3	15.0	5.9	18.7	2.6	17.1
24	3.3	14.4	4.1	17.6	5.4	16.8	5.3	19.5	4.8	19.8
25	3.2	13.9	3.8	13.3	4.5	19.2	5.4	20.6	4.5	11.4
26	2.7	17.2	4.3	19.0	4.5	15.1	5.7	19.8	2.6	20.5
27	4.3	21.1	3.8	13.5	6.1	22.2	4.5	21.2	3.6	16.5
28	2.9	10.1	3.9	18.0	4.9	13.2	4.7	22.0	2.9	12.2
29	4.1	15.8	4.1	18.9	5.3	15.8	4.1	19.9	4.3	13.6
30	3.0	19.4	4.0	17.9	5.0	19.9	5.8	18.6	4.1	13.9

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8.3 Leaf Dry Mass and Wet Mass Raw Data

Below are 7 tables during **post-germination** of *P. annua* and *F. arundinacea*. Tables 1 to 7 are showing **leaf dry mass and wet mass** measured by an electronic balance. However total dry mass is not shown here, although it is part of raw data, it is shown in *Appendix Part A, Table 3*. The reason to show dry mass here is to show primary raw data table format. The tolerance for each data measured by the electronic balance is 0.001g. Processed data table of Table 3 is based on these sets of data. Leaf Dry Mass Content graph is based on this primary data. The environment situation for this collected data is shown in *Materials and Methods, Table 1b*. In competition proportions of 5:5, 2:8 and 8:2, highlighted yellow area means *P. annua* and not highlighted area means *F. arundinacea*. These are relevant to actual number of grasses in a proportion as30 strands of each proportion are used for each proportion. Because individual grass' dry mass cannot be distinguished after heating, total dry mass is used.

Table 1: Week 1

	P		5:5		F		P:F, 2:8		P:F. 8:2	
	FM	DM	FM	DM	FM	DM	FM	DM	FM	DM
1	0.005		0.001		0.006		0.001		0.002	
2	0.005		0.000		0.009		0.001		0.003	
3	0.002		0.001		0.010		0.000		0.002	
4	0.003		0.000		0.010		0.000		0.002	
5	0.002		0.001		0.011		0.000		0.003	
6	0.003		0.001		0.010		0.001		0.001	
7	0.002		0.000		0.009		0.015		0.002	
8	0.004		0.001		0.013		0.011		0.003	
9	0.003		0.001		0.013		0.009		0.002	
10	0.002		0.001		0.009		0.013		0.002	
11	0.004		0.001		0.005		0.012		0.001	
12	0.002		0.000		0.009		0.014		0.002	
13	0.003		0.000		0.010		0.009		0.003	
14	0.002		0.001		0.014		0.015		0.002	
15	0.003		0.000		0.009		0.007		0.001	
16	0.002		0.007		0.012		0.011		0.003	
17	0.003		0.013		0.016		0.008		0.002	
18	0.002		0.008		0.011		0.008		0.001	
19	0.001		0.010		0.011		0.010		0.001	
20	0.001		0.008		0.011		0.012		0.002	
21	0.002		0.130		0.013		0.012		0.001	
22	0.001		0.009		0.014		0.011		0.001	
23	0.001		0.013		0.009		0.013		0.001	
24	0.001		0.014		0.013		0.008		0.002	
25	0.001		0.010		0.006		0.009		0.007	
26	0.002		0.007		0.014		0.013		0.007	
27	0.002		0.008		0.006		0.013		0.006	
28	0.003		0.009		0.010		0.010		0.007	
29	0.001		0.013		0.009		0.013		0.006	
30	0.002		0.015		0.005		0.013		0.006	

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Table 2: Week 2

	P		5:5		F		P:F, 2:8		P:F. 8:2	
	FM	DM	FM	DM	FM	DM	FM	DM	FM	DM
1	0.001		0.000		0.011		0.000		0.000	
2	0.001		0.000		0.012		0.001		0.002	
3	0.001		0.002		0.012		0.001		0.000	
4	0.002		0.000		0.008		0.000		0.001	
5	0.001		0.002		0.011		0.000		0.002	
6	0.001		0.000		0.010		0.000		0.001	
7	0.001		0.001		0.011		0.008		0.001	
8	0.001		0.000		0.012		0.009		0.002	
9	0.002		0.000		0.009		0.007		0.000	
10	0.001		0.002		0.008		0.008		0.000	
11	0.003		0.000		0.009		0.007		0.002	
12	0.001		0.000		0.014		0.006		0.000	
13	0.001		0.000		0.011		0.010		0.002	
14	0.001		0.000		0.010		0.008		0.001	
15	0.001		0.000		0.008		0.009		0.000	
16	0.001		0.010		0.015		0.013		0.000	
17	0.002		0.012		0.012		0.011		0.000	
18	0.001		0.014		0.014		0.012		0.000	
19	0.001		0.006		0.011		0.011		0.000	
20	0.002		0.018		0.014		0.016		0.000	
21	0.001		0.021		0.010		0.008		0.001	
22	0.001		0.015		0.010		0.007		0.000	
23	0.001		0.007		0.009		0.009		0.000	
24	0.002		0.014		0.011		0.018		0.000	
25	0.001		0.012		0.009		0.013		0.016	
26	0.002		0.011		0.012		0.007		0.006	
27	0.001		0.014		0.011		0.005		0.013	
28	0.002		0.012		0.011		0.010		0.018	
29	0.002		0.016		0.007		0.006		0.013	
30	0.003		0.015		0.011		0.007		0.011	

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Table 3: Week 3 (CUT)

	P		5:5		F		P:F, 2:8		P:F. 8:2	
	FM	DM	FM	DM	FM	DM	FM	DM	FM	DM
1	0.001		0.000		0.011		0.000		0.000	
2	0.001		0.000		0.012		0.001		0.002	
3	0.001		0.002		0.012		0.001		0.000	
4	0.002		0.000		0.008		0.000		0.001	
5	0.001		0.002		0.011		0.000		0.002	
6	0.001		0.000		0.010		0.000		0.001	
7	0.001		0.001		0.011		0.008		0.001	
8	0.001		0.000		0.012		0.009		0.002	
9	0.002		0.000		0.009		0.007		0.000	
10	0.001		0.002		0.008		0.008		0.000	
11	0.003		0.000		0.009		0.007		0.002	
12	0.001		0.000		0.014		0.006		0.000	
13	0.001		0.000		0.011		0.010		0.002	
14	0.001		0.000		0.010		0.008		0.001	
15	0.001		0.000		0.008		0.009		0.000	
16	0.001		0.010		0.015		0.013		0.000	
17	0.002		0.012		0.012		0.011		0.000	
18	0.001		0.014		0.014		0.012		0.000	
19	0.001		0.006		0.011		0.011		0.000	
20	0.002		0.018		0.014		0.016		0.000	
21	0.001		0.021		0.010		0.008		0.001	
22	0.001		0.015		0.010		0.007		0.000	
23	0.001		0.007		0.009		0.009		0.000	
24	0.002		0.014		0.011		0.018		0.000	
25	0.001		0.012		0.009		0.013		0.016	
26	0.002		0.011		0.012		0.007		0.006	
27	0.001		0.014		0.011		0.005		0.013	
28	0.002		0.012		0.011		0.010		0.018	
29	0.002		0.016		0.007		0.006		0.013	
30	0.003		0.015		0.011		0.007		0.011	

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Table 4: Week 4

	P		5:5		F		P:F, 2:8		P:F. 8:2	
	FM	DM	FM	DM	FM	DM	FM	DM	FM	DM
1	0.000		0.000		0.007		0.000		0.000	
2	0.002		0.002		0.008		0.001		0.000	
3	0.001		0.000		0.007		0.001		0.000	
4	0.001		0.000		0.005		0.002		0.001	
5	0.002		0.000		0.005		0.001		0.001	
6	0.002		0.001		0.010		0.001		0.001	
7	0.001		0.001		0.005		0.010		0.000	
8	0.002		0.000		0.007		0.010		0.002	
9	0.001		0.000		0.003		0.005		0.001	
10	0.001		0.000		0.004		0.013		0.001	
11	0.000		0.000		0.007		0.004		0.000	
12	0.003		0.001		0.005		0.004		0.001	
13	0.003		0.000		0.004		0.007		0.000	
14	0.001		0.000		0.010		0.006		0.001	
15	0.001		0.000		0.005		0.007		0.000	
16	0.002		0.005		0.004		0.004		0.002	
17	0.002		0.007		0.004		0.007		0.000	
18	0.002		0.005		0.005		0.007		0.002	
19	0.000		0.006		0.003		0.005		0.002	
20	0.000		0.003		0.003		0.004		0.001	
21	0.001		0.010		0.005		0.002		0.002	
22	0.003		0.009		0.004		0.010		0.002	
23	0.002		0.005		0.004		0.008		0.002	
24	0.002		0.007		0.004		0.004		0.001	
25	0.003		0.006		0.002		0.007		0.007	
26	0.000		0.008		0.005		0.005		0.009	
27	0.001		0.003		0.006		0.003		0.005	
28	0.003		0.003		0.005		0.007		0.003	
29	0.003		0.002		0.006		0.005		0.006	
30	0.001		0.002		0.005		0.005		0.004	

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Table 5: Week 5

	P		5:5		F		P:F, 2:8		P:F. 8:2	
	FM	DM	FM	DM	FM	DM	FM	DM	FM	DM
1	0.001		0.003		0.010		0.001		0.002	
2	0.002		0.005		0.011		0.000		0.003	
3	0.003		0.002		0.009		0.000		0.004	
4	0.002		0.003		0.012		0.000		0.004	
5	0.007		0.002		0.010		0.001		0.002	
6	0.002		0.002		0.010		0.001		0.003	
7	0.001		0.001		0.009		0.014		0.001	
8	0.003		0.003		0.009		0.014		0.001	
9	0.003		0.000		0.008		0.015		0.003	
10	0.005		0.004		0.007		0.013		0.004	
11	0.002		0.003		0.010		0.012		0.001	
12	0.005		0.002		0.011		0.009		0.003	
13	0.002		0.003		0.012		0.010		0.005	
14	0.004		0.002		0.013		0.008		0.005	
15	0.002		0.004		0.007		0.007		0.004	
16	0.002		0.014		0.013		0.009		0.007	
17	0.002		0.012		0.012		0.010		0.006	
18	0.002		0.011		0.010		0.010		0.004	
19	0.001		0.010		0.010		0.013		0.005	
20	0.001		0.009		0.011		0.015		0.004	
21	0.005		0.010		0.012		0.012		0.002	
22	0.005		0.012		0.011		0.013		0.004	
23	0.002		0.013		0.010		0.006		0.003	
24	0.004		0.014		0.007		0.009		0.002	
25	0.002		0.008		0.009		0.010		0.009	
26	0.002		0.012		0.009		0.011		0.008	
27	0.003		0.013		0.008		0.012		0.008	
28	0.005		0.014		0.010		0.009		0.013	
29	0.001		0.014		0.010		0.014		0.012	
30	0.001		0.013		0.007		0.008		0.014	

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Table 6: Week 6

	P		5:5		F		P:F, 2:8		P:F. 8:2	
	FM	DM	FM	DM	FM	DM	FM	DM	FM	DM
1	0.009		0.008		0.012		0.007		0.006	
2	0.008		0.006		0.012		0.006		0.008	
3	0.008		0.005		0.008		0.007		0.006	
4	0.008		0.008		0.008		0.008		0.006	
5	0.009		0.008		0.011		0.008		0.006	
6	0.006		0.005		0.010		0.006		0.007	
7	0.007		0.005		0.008		0.010		0.007	
8	0.007		0.006		0.010		0.012		0.008	
9	0.007		0.008		0.012		0.009		0.008	
10	0.009		0.006		0.013		0.009		0.007	
11	0.010		0.008		0.015		0.012		0.008	
12	0.008		0.008		0.008		0.011		0.007	
13	0.007		0.006		0.008		0.011		0.007	
14	0.007		0.005		0.009		0.010		0.007	
15	0.006		0.008		0.010		0.012		0.007	
16	0.006		0.013		0.012		0.013		0.006	
17	0.008		0.010		0.011		0.012		0.007	
18	0.007		0.011		0.011		0.011		0.008	
19	0.009		0.011		0.012		0.011		0.007	
20	0.009		0.010		0.011		0.011		0.008	
21	0.009		0.009		0.011		0.012		0.008	
22	0.009		0.011		0.011		0.012		0.008	
23	0.008		0.009		0.011		0.011		0.008	
24	0.008		0.010		0.012		0.010		0.007	
25	0.007		0.011		0.011		0.010		0.010	
26	0.008		0.009		0.011		0.010		0.009	
27	0.009		0.010		0.013		0.011		0.008	
28	0.009		0.010		0.011		0.009		0.009	
29	0.009		0.012		0.012		0.010		0.009	
30	0.008		0.09		0.012		0.010		0.009	

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Table 7: Week 7

	P		5:5		F		P:F, 2:8		P:F. 8:2	
	FM	DM	FM	DM	FM	DM	FM	DM	FM	DM
1	0.007		0.006		0.013		0.007		0.009	
2	0.014		0.006		0.015		0.007		0.008	
3	0.005		0.007		0.026		0.005		0.008	
4	0.005		0.005		0.017		0.005		0.006	
5	0.006		0.004		0.017		0.005		0.005	
6	0.008		0.006		0.018		0.006		0.009	
7	0.005		0.005		0.013		0.023		0.010	
8	0.007		0.006		0.015		0.015		0.007	
9	0.008		0.006		0.015		0.010		0.008	
10	0.010		0.007		0.018		0.028		0.008	
11	0.007		0.005		0.021		0.018		0.008	
12	0.008		0.006		0.019		0.019		0.008	
13	0.009		0.006		0.017		0.021		0.006	
14	0.008		0.007		0.019		0.017		0.009	
15	0.005		0.006		0.018		0.019		0.007	
16	0.006		0.015		0.014		0.018		0.010	
17	0.009		0.013		0.016		0.023		0.011	
18	0.007		0.013		0.021		0.021		0.006	
19	0.011		0.014		0.020		0.015		0.009	
20	0.014		0.015		0.019		0.018		0.008	
21	0.006		0.016		0.023		0.016		0.007	
22	0.009		0.015		0.016		0.016		0.007	
23	0.008		0.016		0.022		0.015		0.009	
24	0.008		0.014		0.022		0.022		0.006	
25	0.007		0.011		0.017		0.019		0.011	
26	0.009		0.014		0.016		0.017		0.015	
27	0.006		0.014		0.014		0.022		0.013	
28	0.013		0.015		0.022		0.023		0.012	
29	0.010		0.016		0.023		0.020		0.013	
30	0.009		0.015		0.021		0.019		0.011	

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